CHEMICAL ENGINEERING

May 2009

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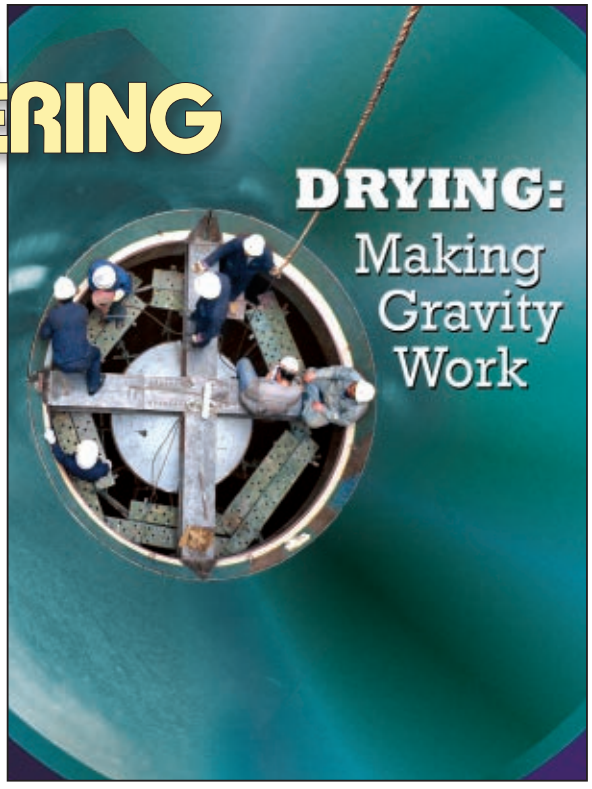

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Editor's Page

Keep the GHG debate on point

The anthropogenic global warming debate experienced a reawakening last month, following the U.S. Environmental Protection Agency's proposed finding that greenhouse gases contribute to air pollution that may endanger public health or welfare. In an effort to keep the debate from heading far off course, I must comment on one particular argument that is, in my view, nonsensical and ultimately distracts attention away from the interests of the chemical process industries (CPI).

The argument is that carbon dioxide is somehow exempt from being considered a pollutant simply because it is a naturally occurring substance that is essential for plant life — and, therefore, human life. In addition to letters and emails, I've seen this argument everywhere from small-town newspapers to well-known trade and consumer publications — and, of course, on their blogs. Each time, numerous contradictions come to mind.

Carbon dioxide is not the first substance with positive use to be classified as a pollutant. Many well-established precedents already exist throughout the CPI. At certain concentrations these substances are indeed valuable — if not essential — to human life. Like the current proposals for regulating carbon dioxide and other greenhouse gases (GHGs), the natural existence of these substances is not controlled. And in many cases, the industrial emission of these substances into the air, water or ground is all but ignored up to a certain point (which is usually defined on the basis of concentration or mass). A simple, yet important fact that is seemingly ignored in the argument "CO_2 is automatically exempt from pollutant status" is that the distinction of pollutant applies exclusively to human activities that exceed certain emission thresholds.

Perhaps the simplest of these examples is warm water, which arguably is essential to the developed world but is also classified by the U.S. EPA and others as "thermal pollution" when released into a nearby stream, river, lake or ocean. Indeed, in the design of industrial cooling water systems, warm water discharge is a key consideration (for more see p. 45).

Ozone (O_3) is classified as a pollutant even though it naturally sustains life on earth (in the stratospheric ozone layer) and has beneficial commercial applications (such as water treatment). Meanwhile, hydrochloric acid is considered a hazardous air pollutant in the U.S. and elsewhere, yet it is produced naturally by the human body for digesting food.

The point is that once again a group of scientists has developed a hypothesis about the potentially harmful effects of human activities and has presented enough supporting evidence to raise concern in substantial numbers of the scientific community and the public alike. Regulation is now unavoidable. Flawed arguments don't do anything to change that and actually hurt the interests of CPI by distracting everyone from the important decisions that are already taking place — how those regulations should be defined and carried out.

True industry advocates should instead focus on helping shape greenhouse gas policies that are both effective and realistic in terms of their immediate and longterm impacts on global economics (see p. 6). In this effort, I agree with the premise that more education on greenhouse gases and their effects is needed. But, instead of diverting to carbon dioxide's life-giving characteristics, which are part of most elementary-school science classes anyhow, I suggest, for one, raising awareness of other, lesser-known greenhouse gases with higher estimated global warming potential. For instance, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride and N_2O global warming impacts are estimated to be 298–22,800 times that of CO_2 (per unit mass) over a 100 year period. ■

Rebekkah Marshall

Letters

Shaping GHG policies

Edison Electric Institute (EEI) member companies support action to lower the country's carbon and other greenhouse gas (GHG) emissions by 80% from current levels by 2050. And we want to do so in a way that softens electricity price increases for families and our energy-intensive customers, such as chemical manufacturers. A critical factor for achieving this goal within a federal cap-and-trade program is by allocating rather than auctioning emissions allowances.

Under a cap-and-trade program, the government sets a national cap on GHG emissions. Over time, this cap becomes lower until the ultimate GHG reduction goal is met. The government would create allowances for electric utilities and others to emit GHG emissions under the cap. The method by which the government initially introduces these allowances into the market — by allocation or auction — is crucial.

Auctioning allowances sharply increase costs by requiring companies to pay both for the allowances and for the cost of actually reducing emissions. All of these costs would be passed on to consumers. In contrast, if allowances are allocated, only the costs of actually reducing emissions are passed along.

A portion of the revenue raised through an auction may be returned to customers via a tax rebate. But this isn't an efficient mechanism for channeling relief to all customers. Nor is it assured that all of the revenue raised would be directed to mitigating energy prices or developing the technologies that we as a nation need to transition to a vibrant, low-carbon economy.

Support is growing for allocating allowances. The U.S. Climate Action Partnership — an alliance of major businesses, such as Dow and DuPont, as well as leading climate and environmental groups — is in favor of allocating emissions allowances. So is the Pew Center on Global Climate Change, the National Association of Regulatory Utility Commissioners, and a number of labor groups among others.

Although additional measures will certainly need to play roles in lessening energy cost increases under a national climate change program, allocating emissions allowances will be vital. Please contact your members of Congress and ask that they support allocating allowances in any climate change legislation. For more information on EEI and its climate principles, please visit www.eei.org/climate.

Thomas R. Kuhn
President
Edison Electric Institute

Poscripts, corrections

April, Capital Costs Quickly Calculated, pp. 46–52: In three places in the box at the top of p. 47, the factor 0.8 should have been rendered as an exponent and was not [30.8 at the bottom of the first column, 20.8 at the top of the second column, and (0.635/2)0.8 at the third line from bottom of second column]. A corrected version of the article can be found by searching for the title of the article at www.che.com.

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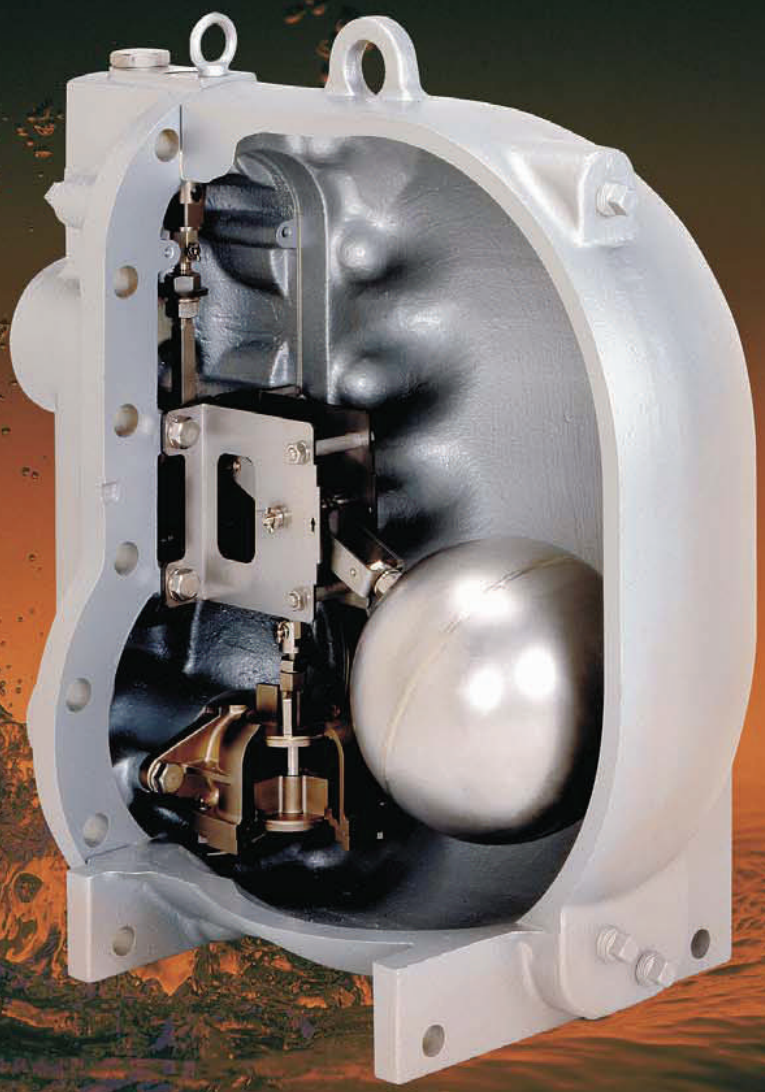

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Hazards of Oil Refining Distillation Units. By BP International Ltd. (BP Process Safety Series). Institution of Chemical Engineers, Davis Building, Railway Terrace, Rugby CV21 3HQ, U.K. Web: icheme.org. 2008. 81 pages, £27.

Reviewed by Stanley S. Grossel, Process Safety & Design, Inc., Clifton, N.J.

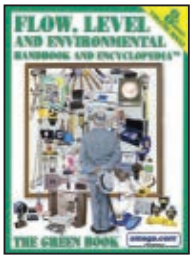
This booklet was written as a reference tool for operators, engineers and technicians working on crude and vacuum distillation units (CDUs and VDUs) in the petroleum industry. It outlines the main hazards associated with these units and promotes the adoption of safe operating practices and procedures in order to prevent the recurrence of serious incidents.

The book contains seven chapters, a list of relevant references, an incidents list, and a glossary. Chapter 1, the introduction, opens with a process description of crude oil distillation with a schematic of CDU and VDU process flows and products, followed by a summary of the main hazards in these units, and a breakdown of when CDU and VDU incidents occur. Chapter 2 discusses the chemicals found in crude oil that contribute to the hazards in distillation, such as hydrocarbons, inorganic and other materials imported with crude oil, and other hazardous substances in common use on CDU and VDUs [superheated steam, water, ammonia, chemicals used for breaking desalter emulsions and for corrosion control, nitrogen, and nucleonic sources (used in liquid level instruments)]. In Chapter 3, entitled Physical Hazards, a number of incidents are described that occurred during startup and shutdown, normal operation, and unit turnarounds. The chapter covers a large number of causes, and is very informative. Hazards related to equipment failure of columns and other associated equipment are discussed in Chapter 4. Among the topics covered are: columns and other pressure vessels and piping (corrosion and inadequate design and construction), desalters, fired heaters, rotating equipment, heat exchangers and distillation column overfilling. Much useful information is presented in this Chapter.

Chapter 5 covers safe operating practices and procedures, discussing startup, shutdown, and normal operating and emergency procedures. Also briefly discussed are troubleshooting and the concept of a safe operating envelope.

In Chapter 6, some serious incidents that have occurred on CDU and VDUs are described. These include: fire and casualties at a crude unit tower, electrocution incident at a CDU desalter, hazards of water entering vacuum towers, hazards of atmospheric relief valves, an internal VDU tower fire during a turnaround, and four fatalities during the repair of piping. Chapter 7 is a self-test questionnaire containing 21 questions designed to assess the effectiveness of knowledge transfer following a review of this booklet. The incidents list is a compilation of 144 accidents that have occurred to refinery columns and associated equipment.

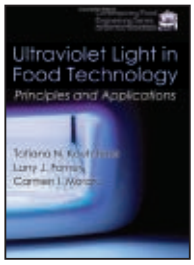
This booklet contains much useful and practical information on problems that have occurred in distillation of crude oil. Although it pertains primarily to CDUs and VDCs in the petroleum industry, many of the incidents discussed and the lessons learned can be applied to distillation columns in chemical, petrochemical and pharmaceutical plants.



The Green Book: Flow, Level and Environmental Handbook and Encyclopedia. 8th Edition. Omega Engineering, Inc. One Omega Drive, Stamford, CT 06907. Web: omega.com. 2007. 1,300 pages. Free.

Modern Drying Technology: Experimental Techniques. Volume 2. Edited by E. Tsotsas and A. S. Mujumdar John Wiley & Sons, Inc. 111 River St., MS 8-01, Hoboken, NJ 07030-5774. Web: wiley.com. 2009. 412 pages. $215.

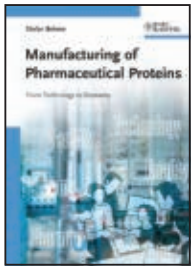
Handbook of Maintenance Management and Engineering. By M. Ben-Daya, S. O. Duffuaa, A. Raouf, J. Knezevic, D. Ait-Kadi. Springer, 233 Spring Street, New York, NY 10013. Web: springer.com. 2009. 741 pages. $209.



Ultraviolet Light in Food Technology: Principles and Applications. Second edition. By T. Koutchma, L. J. Forney and C. I. Moraru. CRC Press, 6000 Broken Sound Parkway, NW, Suite 300, Boca Raton, FL 33487. Web: crcpress.com. 2009. 296 pages. $179.95.

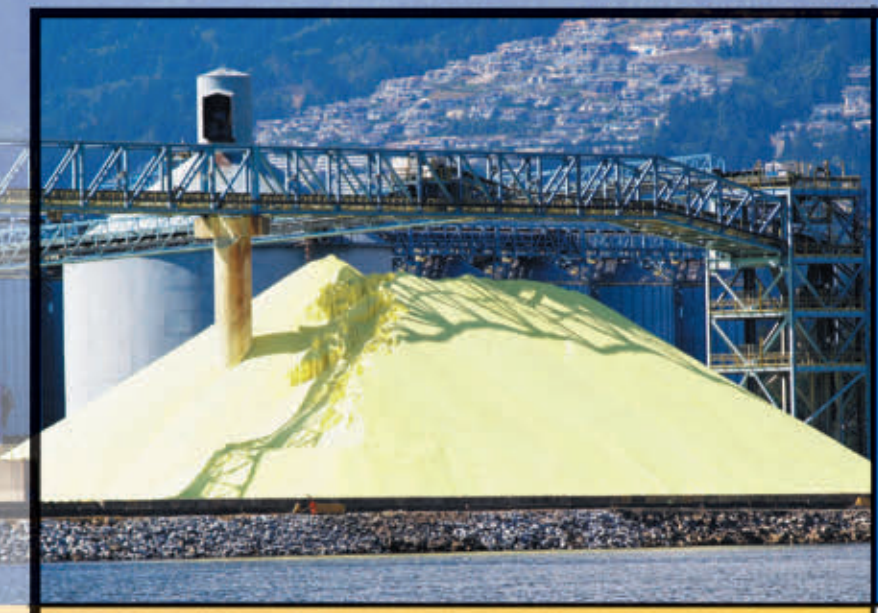
PVC Formulary. By G. Wypych. ChemTec Publishing, 38 Earswick Drive, Toronto, Ontario M1E 1C6, Canada. Web: chemtec.org. 2009. 324 pages. $275.

Engineering Materials Properties and Selection: International Edition. By K. Budinski and M. Budinski. Pearson Higher Education, One Lake St., Upper Saddle River, NJ 07458. Web: pearsonhighered.com. 2009. 784 pages. $135.20.



Manufacturing of Pharmaceutical Proteins: From Technology to Economy. By S. Behme. John Wiley & Sons, Inc. 111 River St., MS 8-01, Hoboken, NJ 07030-5774. Web: wiley.com. 2009. 404 pages. $130. ■

Kate Torzewski



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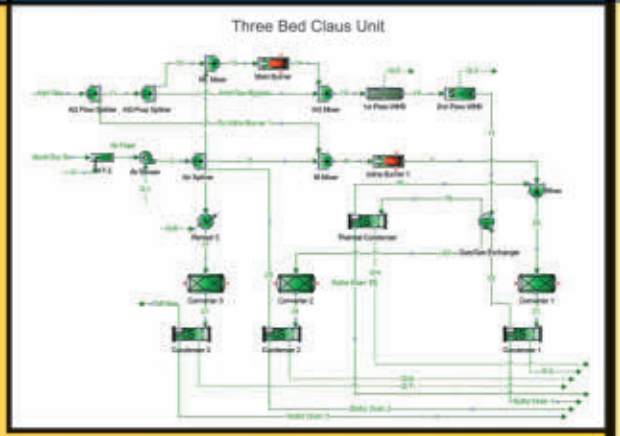

With increasing environmental concerns, sulfur recovery has become one of the leading issues in emissions reduction. Bryan Research & Engineering's process simulator, ProMax, contains a complete reactor suite for modeling kinetic (plug flow and stirred tank), equilibrium, conversion, and Gibbs minimization schemes. A variety of sulfur recovery and tail gas cleanup processes may be modeled using this suite of options. Some of the most commonly modeled processes include:

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Petroleum refiners seek to increase distillate yield, decrease emissions . . .

Strategies for extracting more distillate from petroleum to meet the growing demand for diesel fuel constituted a major theme of the recent annual meeting of the National Petrochemical and Petroleum Refiners Association (NPRA, Washington D.C.; www.npra.gov) in San Antonio, Tex. Worldwide, the demand for distillate is expected to increase by more than 5 million bbl/d over the next 10 years, says Richard Rossi, business manager for conversion technologies with UOP LLC (Des Plaines, Ill.; www.uop.com).

Many of the diesel-boosting technologies discussed at the meeting involve modifying the operation of fluid catalytic crackers (FCCs) and the use of new FCC catalysts to increase distillate yield. Another leading topic was pollution control for FCCs, which are a major source of refinery emissions. Rossi noted that complex refineries with FCC and hydrocracking units have significant potential to shift toward diesel fuel production, with attractive economics and minimal investment.

An increase in the ratio of light cycle oil (LCO) to gasoline in an FCC can be readily achieved by adjusting the unit's operating conditions and reducing the catalyst activity, noted David Hunt, technical service manager for Grace Davison (Houston, Tex.; www.grace.com). The drawback is an increase in bottoms yield, said Hunt, so "maximizing LCO in the FCCU at reduced conversion without producing incremental bottoms oil is the true challenge."

Grace Davison and other catalyst manufacturers have developed new catalysts that crack more of the bottoms to obtain LCO. Grace's latest catalyst, Midas 300, can increase LCO yield by 6 vol% without slurry recycle. Hunt adds that recycling part of the feed can also boost LCO yield. In laboratory tests, using a Midas catalyst, Grace found that the highest LCO yield was achieved by recycling the fraction that boils at 650–850°F. "Recycling isn't that common," he says, "but it may become more common in the future."

Albemarle Corp. (Houston, Tex.; www.albermarle.com) offers a new family of FCC catalysts, called Upgrader, for processing residual oil. In one of its first applications, in a North American refinery, the catalyst has led to a 6% increase in feed throughput. This increases profitability by $10 million/yr, according to Kenneth Bruno, Albemarle's global applications technology manager for FCC, who spoke at the NPRA meeting.

In a separate, commercial trial in a residual FCCU, an Upgrader MD (maximum distillate) catalyst increased LCO yield by nearly 3 wt.% and decreased the bottoms yield by 1 wt.%.

BASF Catalysts LLC (Iselin, N.J.; basf.com) has also commercialized a new FCC catalyst, HDXtra. In its initial installations the catalyst has increased LCO yield from 10 vol% to as much as 30 vol%, says Joe McLean, global marketing manager for refining catalysts.

. . . knock out NOx . . .

A relatively inexpensive way to treat oxides of nitrogen (NOx) emissions from an FCC is to use an additive, which is mixed with the catalyst and minimizes NOx formation by manipulating N_2 oxidation/reduction reactions in the regenerator. Additives can reduce NOx by up to 70–75%, says, Martin Evans, vice-president engineering for Intercat Inc. (Sea Girt, N.J.; www.intercatinc.com), which makes additives that are a mix of catalytically active metals. Higher removal levels require additional technology, such as selective catalytic reduction, he says.

Shell Global Solutions (Houston, Tex.; www.shell.com/globalsolutions) and Praxair, Inc. (Tonawanda, N.Y.; www.praxair.com) have joined forces to develop a novel NOx-control system for FCCs called CONOx. The system combines Shell's NOx-control process with a Praxair oxygen-injection technique.

Shell's process redirects the airflow in the catalyst regenerator to reduce NOx output to below 40 ppm (*CE* June 2008, p. 15). In CONOx, a jet of hot oxygen is subsequently injected through a lance into the fluegas. The O_2 oxidizes CO and destroys NOx precursors. In pilot tests CONOx has reduced NOx emissions by 70–80%, says Ye-Mon Chen, Shell

(*Continues on p. 12*)

Note: For more information, circle the 3-digit number on p. 70, or use the website designation.

Wireless add-on

ABB Instrumentation (Warminster, Pa.; www.abb.com/instrumentation) has made its entry into wireless communications technology with the WirelessHART upgrade adapter, previewed at ABB's recent Automation & Power World. This adapter is used to connect existing HART transmitters that are wired to existing systems that do not take full advantage of the transmitters' functionality.

Most HART instruments continuously monitor over 15, possibly up to 50 conditions and these instruments are likely to hold valuable maintenance and process information that the user may be unaware of, according to ABB. The upgrade adapter allows full usage of an instrument's capabilities and transmits this information wirelessly. It works on all makes of HART instruments.

While other wireless adapters exist, the advantages of this one, according to ABB, are its small size and the fact that it does not run on batteries. Battery life can be an area of concern for wireless transmitter users. ABB is planning to launch this product later this year, and is currently looking for testers to ensure full interoperability of this adapter.

Corrosion protection

A coating with comparable or even superior corrosion resistance than those based on chromium has been developed by scientists at Brookhaven National Laboratory (Upton, N.Y.; www.bnl.gov). The patented technology can be applied to aluminum, steel, nickel, copper, bronze and brass, making it promising for protecting components of valves, pumps and other equipment. The technology is available for licensing.

The coating can be applied by a variety of ways, including spraying or dipping compo-

(*Continues on p. 12*)

NOx (*Continued from p. 11*)

Global's FCC regional manager.

Praxair and Shell have licensed their first system, which is scheduled to start up in a U.S. refinery later this year. Chen says the capital cost is approximately $10 million, around one-tenth the cost of selective catalytic reduction (SCR).

. . and control SOx

Most of the sulfur emanating from FCCs is either contained in the products or released as hydrogen sulfide in the fluegas, from which it is scrubbed by amines. However, about 10% is emitted as sulfur oxides (SOx). Aside from hydrotreating the feed, the two popular ways to reduce SOx emissions from the FCC catalyst regenerator are to use an SOx-reduction additive or treat the fluegas by wet scrubbing, says Alan Kramer, global FCC additives specialist for Albemarle.

An advantage of additives over wet scrubbers is that there is practically no capital cost, he says, but the competitiveness of additives in terms of cost and effectiveness depends on the cost of scrubber caustic and the nature of the FCC operation. Albemarle makes additives of hydrotalcite, a magnesium-aluminum hydrate compound, which is added to the FCC regenerator along with the catalyst. The additive absorbs SO_3 and releases the sulfur into the reactor product stream as H_2S. However, Kramer notes that additives tend to be less effective when an FCC is operated in partial-burn mode.

Albemarle's newest additive, SOxMaster, overcomes this disadvantage by combining the hydrotalcite technology with novel materials, says Kramer. In an initial commercial installation, SOxMaster has achieved 90% sulfur reduction in a deep partial-burn unit, versus a maximum of 40% for a conventional additive. Kramer adds that SOxMaster has a half-life of about 30 days, against 5–7 days for a conventional additive.

A catchall emissions control system for FCCs is offered by Intercat and Pall Corp. (Port Washington, N.Y.; www.pall.com). The system combines Intercat's NOx and SOx (magnesium hydrotalcite) additives with Pall's self-cleaning blowback filter for particles. The filter consists of porous metal or ceramic tubular elements, and captures fine, dry catalyst particles emitted by the regenerator. Evans, of Intercat, says the total capital cost could be as low as half that of a conventional system that uses a wet scrubber for SOx, NOx and particulate-matter control.

(*Continued from p. 11*)

nents to be treated into a solution of the components. Cross linking of the components is then induced by subsequent treatment steps, such as heating, to form corrosion-inhibiting metal oxide nanoparticles, such as cerium-based oxides. The resulting coating is water repellent and strongly bound to the metal, making it especially resistant to brine. And because an ultra-thin (10-nm thick) film is formed, BNL says the coating is "highly" economical and efficient.

Heavy gems

Rubicon Technology, Inc. (Franklin Park, Ill.; www.rubicon-es2.com) has grown what it believes to be the world's largest sapphire crystal. At 200 kg, the super boule will enable the company to offer large-size optical windows and next-generation wafer products with dimensions over 12 in. Rubicon's proprietary ES2 crystal-growth technology — routinely producing bulk sapphire crystals up to 85 kg for 8-in.-dia. wafers and optical windows with 10-in. dimensions — can be scaled up to produce even larger-sized sapphire products in the future, says the firm.

Reducing foundry emissions

Cast parts, such as engine blocks, are typically made by pouring molten metal into so-called cores — sand-based molds that have internal passages for the component to be cast. Such casting cores are typically made by reacting sand with organic binders in a curing process. In recent years, industry has been seeking alternatives to organic binders to avoid releasing toxic emissions during curing.

Last month, Süd-Chemie AG (Munich, Germany; www.sud-chemie.com) inaugurated in Moosburg a new production plant of its subsidiary, WD-Gieserei-Technik GmbH (Fuldabrück, Germany), for the production of casting cores using the Inotec process. Developed and patented by Ashland-Südchemie-Kernfest GmbH — a joint venture between Süd-Chemie and Ashland, Inc. (Covington, Ky.; www.ashland.com) — the Inotec binding system combines a liquid component (a modified silicate solution) with promoters that contain high concentrations of minerals. Because the binding system is inorganic, virtually no emissions are emitted in the process, says the company.

From May, the Moosburg plant is expected to begin series production of a package consisting of various cores, including those to be used for the casting of cylinder blocks for a new, six-cylinder diesel engine of BMW AG (Munich, Germany; www.bmw.com). BMW is said to be the first OEM in automotives to gradually reduce the use of organic binding agents, and use only inorganic-bound cores from 2010 onwards.

Inotec was first demonstrated in 2005 in the production of light-metal castings, when BMW's foundry in Landshut, Germany, decided to use the inorganic binding system.

Cold-war cleanup

On March 31, U.S. Dept. of Energy (DOE; Washington, D.C.) Secretary Steven Chu announced $6 billion in new funding under the American Recovery and Reinvestment Act to accelerate environmental cleanup work and create jobs across 12 states. Projects identified for funding involve the cleanup of soil and groundwater, transportation and disposal of waste, and cleaning and demolishing former weapons complex facilities. These projects and the new funding are managed by the DOE's Office of Environmental Management, which is responsible for the risk reduction and cleanup of the environmental legacy from the U.S.'s nuclear weapons program.

Among the 12 states and DOE sites that will receive funding is the Richland Operations (Wash.; $1.961 billion) to demolish nuclear and other facilities, remediate waste sites, remediate contaminated groundwater and retrieve solid waste from burial grounds. Also, the funding will accelerate cleanup of facilities, waste sites and groundwater along the Columbia River to support shrinking the active area of cleanup at the 586-sq. mi. Hanford Site to 75 sq. mi. or less by 2015. More information can be obtained at www.em.doe.gov

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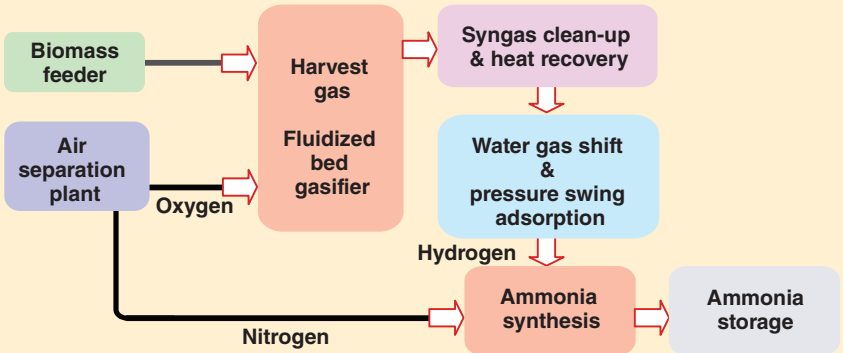
Ammonia from biomass



SynGest, Inc. (San Francisco, Calif.; www.syngest.com) plans to commercialize a process for the production of ammonia from biomass by the fall of 2011. The first plant, to be located in Menlo, Iowa, will convert 150,000 ton/yr of corncobs into 50,000 ton/yr of ammonia, enough to fertilize 500,000 acres of nearby farmland.

Chopped corncobs will be gasified in a bubbling bed gasifier at 1,700°F and 100 psi, using oxygen from a cryogenic air-separation plant (flowsheet). The resultant syngas, primarily hydrogen and carbon monoxide, will be subjected to a water-gas shift reaction, followed by pressure-swing adsorption, to obtain 99.9%-pure H_2. The H_2 will be combined with N_2 from the air-separation unit to produce ammonia.

Although the plant will be miniscule by world scale ammonia standards, Jack Oswald, chief executive officer, is confident that it will be competitive for two reasons: it will use a cheap feedstock instead of natural gas, and distribution costs will be low because the product will be used locally. "With a conventional plant, distribution accounts for half the cost of bringing ammonia to the market," he says. "Our long-term plan is to build small plants, located near sources of biomass and local markets. Each plant will cost approximately $80 million and will generate revenues of about $30 million/yr."

Solid catalyst simplifies turning algae into biodiesel

Researchers at United Environment & Energy (UE&E; Horseheads, N.Y.) have developed a catalyst for the efficient conversion of algae to biodiesel. The mixed-metal oxide catalyst (comprised of metals that are resistant to corrosion yet reactive) facilitates the transesterification of algae oil and methanol. The mechanism for the reaction over the solid catalyst is still under study, but preliminary results indicate that fine methanol/oil drops contact the catalyst surface, and the active sites of the catalyst prompt reaction along the methanol/oil interface.

The conversion process is 40% less expensive than an industrial-scale version of the traditional methanol-and-lye process. Furthermore, it eliminates the need for a purification step, since there is no liquid catalyst mixed into the resulting fuel. UE&E has produced 10 gal. of algae biodiesel by this method and plans to sell the technology for commercialization by other companies. One company has produced over 100 gal. of fuel by this method, and has certified the process to ASTM standards.

While algae is easy to grow, extraction of its oil is a challenge. UE&E has established a relationship with a non-U.S. supplier of algae oil, because U.S. environmental regulations limit use of the toxic solvents needed to extract oil from algae.

A better way to make efficient catalysts

A new procedure for making uniform, metallic nanoparticles has been developed by the research group of Kousuke Mori, an associate professor at Osaka University (www.mat.eng.osaka-u.ac.jp), with support from New Energy and Industrial Technology Development Organization (NEDO; Kawasaki, both Japan). The photo-assisted process, which uses ultraviolet (UV) light to deposit precursor metals onto active sites of a titanium substrate, is said to be less expensive and simpler than conventional impregnation methods, while producing smaller (1–3-nm dia.) particles with a controlled, narrow size distribution.

The resulting nanoparticles exhibit enhanced catalytic properties; for example, a palladium catalyst with uniform diameters of 2 nm are found to be twice as active as those prepared by impregnation for the production of hydrogen peroxide from H_2 and O_2 in water. The catalytic activity is further enhanced by adding gold during the UV deposition, which leads to the formation of nanoparticles of Pd-Au alloy. The technique is applicable to precious metals, such as Pt, Pd and Au, and shows promise for reducing the environmental burden of solvent-based reactions, such as the anthraquinone route to H_2O_2.

The threat of GHGs

After a thorough scientific review ordered by the U.S. Supreme Court, the U.S. Environmental Protection Agency (EPA; Washington, D.C.) issued a proposed finding that "greenhouse gases (GHGs) contribute to air pollution that may endanger public health or welfare." The proposed finding, which now moves to a public comment period, identified six GHGs that pose a potential threat: CO_2, CH_4, N_2O, hexafluorocarbons, perfluorocarbons and sulfur hexafluoride. According to the EPA, "science clearly shows that concentrations of these gases are at unprecedented levels as a result of human emissions, and these high levels are very likely the cause of the increase in average temperature and other changes in our climate."

Hydrocracking

UOP (see p. 11) now offers an enhanced, two-stage hydrocracking process that uses two new catalysts to increase distillate yield by 5–6%. The company has licensed the process to several companies, says Rossi, of UOP, and the first commercial units will start up in 3–4 years.

Keep computers cool

As electronics products continue to get smaller while at the same time incorporating more components, new ways to take away the heat is an important quest. Researchers at the Fraunhofer Institute for Manufacturing Engineering and Applied Materials Research (IFAM; Dresden, Germany; www.ifam.fraunhofer.de) may have a

(*Continues on p. 17*)

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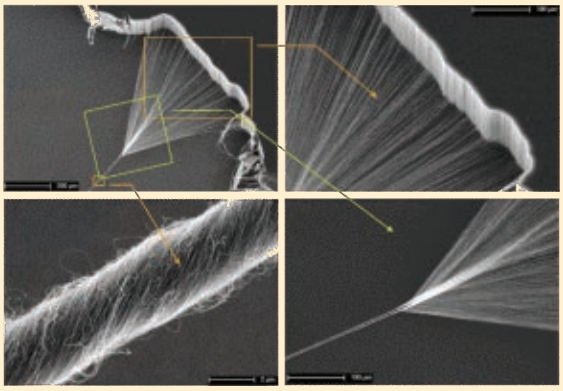
Spinning yarns of CNTs



The exceptional properties of carbon nanotubes (CNTs), such as high tensile strength and high thermal and electrical conductivities, have suggested a number of applications, including lightweight materials for ballistics protection, actuators for muscles or artificial muscles, filaments for light sources, electrodes, super-capacitors, and flow sensors. So, many researchers have tried to prepare macroscopic CNT materials that exhibit at least some of the properties of individual CNTs. This has so far proved elusive.

One method of assembling CNTs into macroscopic structures is to disperse them into a binder. However, a rapid increase of viscosity with concentration limits the final concentrations to about 7 wt.%. Researchers from CSIRO Textile and Fibre Technology (Belmont, Victoria, Australia; www.csiro.au), and the NanoTech Institute and Department of Chemistry at the University of Texas at Dallas (http://nanotech.utdallas.edu), have developed a way to make pure, CNT yarns and webs, avoiding the problems associated with the presence of a binder.

The technology under development involves growing "drawable" forests, which means that CNTs taken off the wall of the forest cause the drawing off of CNTs from the next layer. Continuous application of this process leads to the formation of a continuous web of CNTs that may be used directly or twisted into a yarn (photo).

The team has grown drawable forests on a silicon wafer with a 5-nm film of an iron catalyst. Aligned forests of multi-wall CNTs are grown on the wafer in a 45-mm dia. quartz tube by chemical vapor deposition of 5 mol% C_2H_2 in He at 670°C and atmospheric pressure. The yarn is spun using a spinner adapted from a conventional spinning method.

The resulting yarns have a range of useful properties. Single yarns have a breaking strength of 600 MPa and electrical conductivities of about 300 S/cm. Young's moduli of 25 to 50 GPa were measured and the typical breaking strain was found to be about 5%.

Alkaline-earth-based catalysts for C–C bond formation

Salts of alkaline-earth metals have been shown to catalyze reactions for the selective formation of carbon-carbon bonds, by chemistry professor Shu Kobayashi and colleagues at the University of Tokyo (www.chem.s.u-tokyo.ac.jp). The research, supported by the Japan Science and Technology Agency (Tokyo), promises to deliver alternatives to conventional catalysts that contain toxic, scarce and expensive metals. The researchers found that alkaline-earth-metal salts can activate, with an atomic efficiency of 100%, the nucleating agent sulfonyl imidate, which enables them to selectively form C–C bonds. Futhermore, Kobayashi's group has shown that the stereoselectivity can be adjusted by using different solvents.

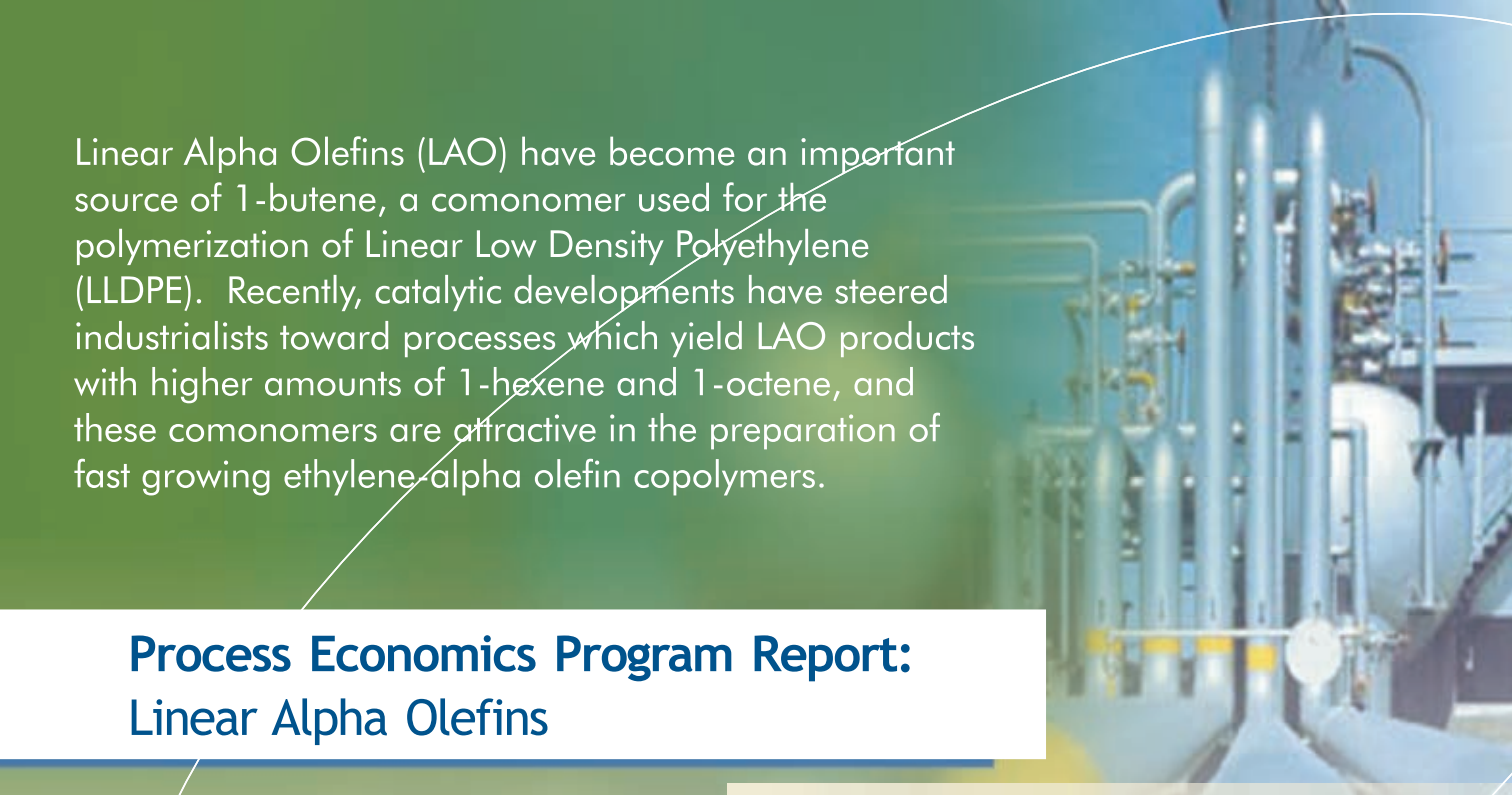
For example, the Mannich reaction of benzaldehyde-derived imine and sulfonyl imidate results in a 94% yield with a syn-to-anti ratio of 4-to-96 after 17 h, when performed with 10 mol% $Mg(OtBu)_2$, in dimethyl formaldehyde solvent at room temperature (OtBu = *tert*-butoxy). Switching to 10 mol% of $Sr(HMDS)_2$ (with 11 % ligand) and THF (tetrahydrofuran) solvent (HMDS = hexamethyldisilazide), the Mannich reaction leads to a 92% yield after 24 h, with syn-to-anti ratio of 93-to-7.

The group has confirmed that it can select anti- or syn-type products for various imines substrates derived from aromatic compounds, aliphatic compounds, and aromatic compounds containing oxygen and sulfur atoms. The reaction procedure has also been extended to asymmetric synthesis, achieving enantio-selective Mannich reaction with 85% yield after 48 h, syn-to-anti ratio of 83-to-17 and 57% enantiomeric excess when using using 10 mol% of $Sr(OiPr)_2$ (12 mol% of asymmetric ligand) and 10 mol% of Et_3N in THF (OiPr = isopropoxy; Et_3N = triethylamine). ■

(*Continued from p. 14*)
solution. Together with industrial partners in the ExtraMat project, scientists have developed a material (a mixture of diamond powder and copper bonded together with chrome) that has a thermal conductivity 1.5 times higher than that of copper, yet expands no more than ceramics when heated.

H_2-generating tablets

The Energy and Environmental Research Laboratories of the Industrial Technology Research Institute (ITRI) of Taiwan (www.itri.org.tw) has developed a pill that stores H_2 gas in a solid substance, instead of a large and hazardous pressurized bottle. Called the *Power-gra*, the pill is composed of hydrides (primarily $NaBH_4$), a catalyst and other patented ingredients. When water is added, the pill releases H_2, which can be used to power a fuel cell to generate electricity. In the near future, 1 g of *Power-gra* will be sufficient to fully charge a cell phone. ❑



Linear Alpha Olefins (LAO) have become an important source of 1-butene, a comonomer used for the polymerization of Linear Low Density Polyethylene (LLDPE). Recently, catalytic developments have steered industrialists toward processes which yield LAO products with higher amounts of 1-hexene and 1-octene, and these comonomers are attractive in the preparation of fast growing ethylene-alpha olefin copolymers.

Process Economics Program Report: Linear Alpha Olefins

As a result of improvements and new developments in LAO catalysts, various types of market-targeted processes have been developed and some of them are commercialized now. Side by side, operationally, these new catalysts systems are so versatile that they can be injected into the process online and tailored to produce products in specific ranges according to market demand.

A new player in this market is SABIC, who recently commercialized a technology jointly with Linde by commissioning a 150,000 T/A LAO plant. This new technology, commercially known as ALPHA-SABLIN™, can not only produce broad-ranged LAO product, but also be adjusted to produce a short-ranged LAO product attractive for the ethylene polymer industry.

SRI Consulting's (SRIC) Process Economics Program (PEP) *Linear Alpha Olefins* report evaluates new technologies in detail from SABIC/Linde and DuPont as well as updating the technical and economic appraisal of technologies covered previously in a PEP report for Shell, Chevron-Phillips, Ineos, IFP (Institut Francais du Petrole), UOP and Exxon.

The *Linear Alpha Olefins* report includes:

Introduction
Summary
- Commercial Status
- Industrial Producers/Licensors
- Linear Alpha Olefins Technologies by Process
- Process Economics

Industry Status
Overall Review of Processes
Technical Review by Process including:
- Material of Construction
- Process Waste Effluents
- Cost Estimates
- Fixed-Capital Costs
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Evaluation of Process Economics
Patent Summary Tables
Design and Cost Bases
Cited References
Patent References by Company
Process Flow Diagram

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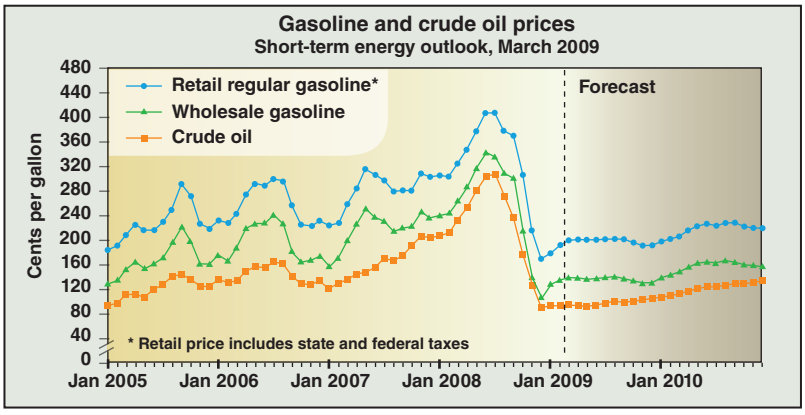
REFINERS FACE UNCERTAIN FUTURE

Declining product demand, volatile margins, and a global recession are forcing many refiners to rethink investment decisions



Source: EIA

FIGURE 1. Gasoline and crude prices will exhibit a slow recovery after falling from record highs in mid 2008

Petroleum refiners throughout the world are faced with increasing uncertainty regarding future refining margins, crude prices and project costs. These factors, along with falling demand for refined products, a global recession, and tighter credit markets, are forcing global refiners to reconsider, postpone, or cancel expansion projects.

At the same time, mandated reduction of sulfur levels in refined products — both gasoline and diesel fuel — are significant factors affecting refiners' spending plans for the next few years. Changing fuel regulations in the U.S., Europe, Asia, and Latin America will force petroleum refiners that import gasoline and diesel fuel into those regions to invest additional capital.

In addition to satisfying the more-stringent fuel specifications, refiners must produce fuels from lower quality crude oils. If crude oil prices rise in the next few years, as they did in 2008, petroleum refiners are more likely to process less expensive crudes, which are heavier and contain more sulfur.

Meanwhile, refiners in the U.S. are also faced with uncertainty regarding future regulations for greenhouse gas emissions and the potential for higher requirements of biofuels including ethanol.

Falling demand

Demand for refined petroleum products is declining worldwide, and especially in the U.S. A global economy in recession, improvements in fuel efficiency standards, and the replacement of petroleum-based fuels by renewable fuels are factors that combined to place downward pressure on demand.

In 2008, price of West Texas Intermediate (WTI) crude oil averaged $100/bbl according to the U.S. Dept.of Energy's (DOE; Washington, D.C.) Energy Information Admin. (EIA; www.eia.doe.gov). EIA predicts that the global economic slowdown will cut the 2008 average price by more than half, to an average of $42/bbl in 2009 and $53/bbl in 2010.

During early 2009, however, gasoline prices have been slowly increasing while crude oil prices have stabilized; refiner margins have recovered from their recent lows. After averaging $1.69/gal in December 2008, the retail gasoline price in February rose to $1.92/gal, according to EIA. Retail gasoline prices are expected to average $1.96/gal in 2009 and $2.18/gal in 2010 (Figure 1).

U.S. demand for oil fell by about 1.3-million bbl/d in 2008, according to Alan Gelder, head of Downstream Consulting Americas for Wood Mackenzie (Houston, Tex.; www.woodmac-research.com). "However, rather than this resulting in a drop in imports," Gelder says, "U.S. refinery utilization actually fell to accommodate continued exports from other regions, notably gasoline from Europe."

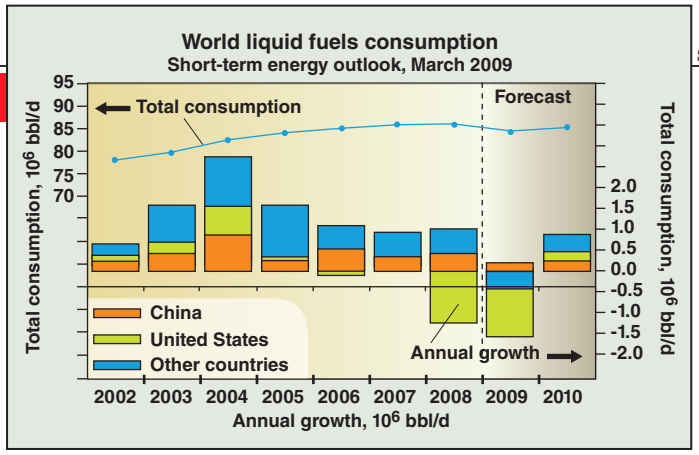
Wood Mackenzie believes that industry dynamics have fundamentally changed from a U.S. "demand pull" environment to a European "supply push." This is because Europe is treating gasoline as a byproduct in its attempt to satisfy its diesel deficit. U.S. refining utilizations, therefore, fell further than those of Europe, with the U.S. East Coast especially suffering.

According to EIA, total consumption of refined products in 2008 fell nearly 1.3-million bbl/d, or 6.1%, from consumption levels in 2007 (Figure 2). Major factors contributing to declining demand were a rise in retail gasoline and diesel prices to record levels during the first half of 2008 and a deteriorating economy in the second half of the year.

EIA is projecting that total product consumption in 2009 will decline another 420,000 bbl/d, or 2.2%, due to continued economic weakness. The expected economic recovery in 2010 should boost total refined-product consumption by 210,000 bbl/d, or 1.1%, with all of the major fuels registering increases in consumption (Figure 3).

In the long term, EIA is predicting that total U.S. demand for liquid fuels will grow only about 1-million bbl/d between 2007 and 2030.

EIA expects a peak in gasoline prices of slightly more than $2/gal in 2009. It is possible, however, that weekly prices could rise significantly higher at some point this spring or summer.



Source: EIA

FIGURE 2. Demand for refined products will recover in 2010 after declining in 2008–2009

For on-highway diesel fuel prices, EIA is projecting an average of $2.19/gal in 2009 and $2.51/gal in 2010. A continuing decline in diesel fuel consumption in the U.S. in 2009, combined with growing weakness in distillate fuel demand outside the U.S. will reduce refining margins for distillate. Because of the global weakness in industrial output, it is possible that diesel prices will fall below gasoline prices this summer.

High inventory levels of gasoline and diesel are also placing downward pressure on prices. Figure 4 shows that EIA expects inventories to remain at the top of their historical bands in 2009 and 2010.

Refining margins

Although crude prices were at record highs in 2008, gasoline and diesel fuel prices kept pace, which allowed U.S. refiners to enjoy healthy profit margins initially. The high prices, however, ultimately caused most consumers to reduce consumption, which has now lead to a severe decline in margins.

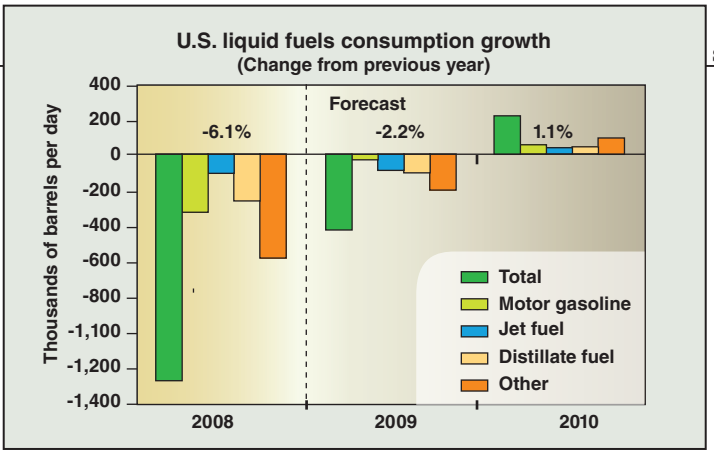
Worldwide-refining margins in 2008 were weaker than in 2007, with the U.S. suffering the greatest decline. This decline in refining margins reflected lower refinery utilization, which was a response to the fall in demand in Europe and North America, according to Gelder.

In 2009, refinery utilization in the U.S. has averaged about 82%. In January 2008, utilization hit a peak of 91%, and as recently as the summer of 2005, refiners were running full out, reaching utilization rates of 97–98%.

Because of lower motor-gasoline consumption, EIA expects refining margins for gasoline to remain depressed for much of 2009 but to increase slightly in 2010 as consumption begins to recover.

One indicator of a recovery in U.S. refining margins is surplus capacity, which is determined by changes in oil product demand and new projects, according to Gelder. Wood Mackenzie is expecting a significant reduction in oil demand in 2009, with a further fall of 700,000 bbl/d in the U.S.

"Recovery in U.S. economic growth is projected for 2010, but we now believe that U.S. gasoline demand has



Source: EIA

FIGURE 3. Demand for all fuels in the US will increase in 2010

already peaked and will continue to decline from now on," says Gelder. "This is due to the combination of the recession in the near term and improving vehicle fuel efficiency over the medium term."

Gelder projects that U.S. petroleum refining mid-cycle margins will be lower than the recent past. In particular, U.S. East Coast refiners will be in a weak competitive position that could challenge their economic sustainability. And given declining gasoline demand, it is essential for refiners with a strong location advantage to manage local supply in order to not undermine a key driver of their earnings.

Immediate opportunities for U.S. refiners are to shift away from gasoline to diesel fuel and then consider innovative approaches to either protect or enhance their current competitive position, according to Gelder.

Project cancellations

Recent announcements are proving that refiners are moving forward more cautiously and reconsidering their plans to expand their refining capacity. In mid March, for example, Motiva Enterprises LLC (Houston, Tex.; www.motivaenterprises.com) announced that it was delaying its $7-billion expansion project at its Port Arthur, Tex., refinery. The project would expand the 285,000-bbl/d refinery to a capacity of more than 600,000 bbl/d.

Motiva, a joint venture of Royal Dutch Shell (The Hague, Netherlands; www.shell.com) and Saudi Refining Inc. (Houston, Tex.), was planning to complete the project in late 2010. The project, which would make the Port Arthur refinery the largest in the U.S., is now slated to start up in the first quarter of 2012.

In early February, in conjunction with its annual report, Marathon Oil Co. (Houston; www.marathon.com) announced that it was delaying the final completion date of its $2-billion project to expand its Detroit, Mich., refinery. The $2.2-billion project would add 100,000 bbl/d in order to process additional volumes of Canadian crude oil.

Construction on Marathon's Heavy Oil Upgrading Project started at the end of the second quarter of 2008. The company says it is delaying the project

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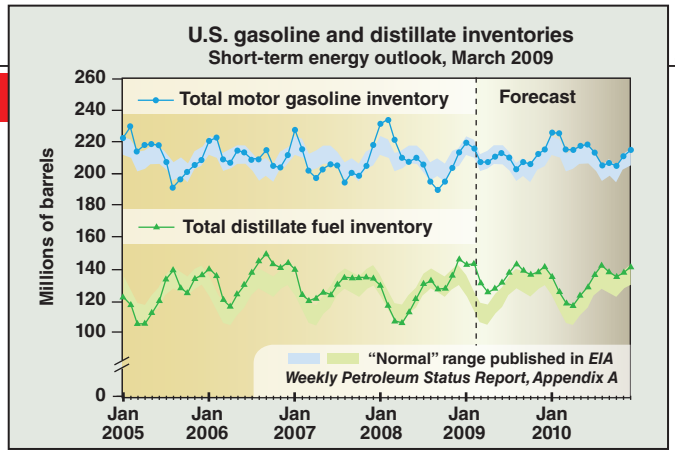


Source: EIA

FIGURE 4. U.S. inventories of gasoline and diesel will remain high during the next two years

due to delays in the projected production of Canadian oil sands and current market conditions.

The company now forecasts the project will cost about 15% more than its original $1.9-billion estimate, due primarily to additional costs associated with the project deferral from the original fourth-quarter 2010 startup, as well as increased project scope.

The project delays, however, are not confined to U.S. refiners. Refiners outside the U.S. are also reevaluating their expansion plans.

In late March, Kuwait National Petroleum Co. (Safat; www.knpc.com.kw) announced that it had cancelled plans to build a 615,000 bbl/d refinery at Al-Zour. The refinery, if built, would be the largest facility in the Middle East. The petroleum refiner had an initial estimate of $10 billion, but this was later increased to $15 billion. Construction on the refinery was halted after a council-of-ministers meeting, at which time the contractors were notified that their contracts were cancelled.

The project is reportedly not completely dead, however. The Kuwait oil minister said that the next Kuwaiti cabinet would review the project and decide whether or not to proceed.

A global shift

Although many refiners are postponing or cancelling project plans, many projects in certain areas of the world are going forward. The oil companies that own these projects are most often supported by government subsidies; therefore, the refineries are less sensitive to low margins.

In one of the largest refinery expansions, India's Reliance Industries Ltd. (Mumbai; www.ril.com) is in the process of starting up its 580,000-bbl/d project in Jamnagar. The expansion, combined with the existing 660,000-bbl/d refinery, will comprise a total capacity of 1.24-million bbl/d of crude, which will make the complex the largest in the world.

The refinery, which exports all of its refined products, was commissioned in late December 2008. By the following March, the company was commissioning all of the secondary units at the new refinery, and expects to be at full capac-

ity by September 2009 at the latest.

In February 2009, the Dung Quat refinery in Vietnam officially became operational. This 140,000 bbl/d petroleum refinery — the first in Vietnam — will be at full capacity by the end of June 2009.

Other significant refinery additions are occurring in China. Projects that should start up in the next six months include two PetroChina Co. (Beijing; www.petrochina.com.cn) refineries with a combined crude processing capacity of 250,000 bbl/d, China Petroleum & Chemical Corp.'s (Beijing; www.sinopec.com) 160,000 bbl/d refinery in Quanzhou, and China National Offshore Oil Corp.'s (Beijing; www.cnooc.com.cn) 240,000-bbl/d refinery in Huizhou.

Upgrading capacity

In the past few years, refiners have installed significant hydrotreating capacity to comply with more stringent diesel requirements. The solutions for reducing diesel sulfur are much more complex than those for gasoline.

The primary process for converting hard-to-remove sulfur species in diesel is high-pressure hydrotreating. These units, both new and revamped, are expensive.

The additional required hydrotreating capacity is also affecting other process units in refineries. Additional hydrogen-generation capacity will have to be installed to meet the higher hydrotreating demands.

In addition, to process heavier crudes, many refiners are opting to install coking units, which convert heavy residual streams to higher-value gasoline and diesel, and a byproduct petroleum coke.

Renewable fuels

Increasing requirements for ethanol in the gasoline pool further weakens demand for refinery-based gasoline. This demand decline will have a negative effect on U.S. refinery utilization, due to its gasoline orientation, according to Gelder.

The short-term addition of 1.9-million bbl/d of new refining capacity in the Atlantic Basin only increases the problems of oversupply. Gelder expects that refiners on the U.S. East Coast will have to cut production runs the most, followed by the Gulf Coast, where refiners will have to cut runs more than those in Europe. The European industry will suffer less than its U.S. counterparts.

EIA predicts, in its Annual Energy Outlook 2009, that overall consumption of marketed renewable fuels will grow 3.3%/yr — much faster than the 0.5%/yr growth in total energy use. This strong growth is due mainly to the renewable fuel standard in the Energy Independence and Security Act of 2007 (EISA2007), which will require 36-billion gal of biofuels to be produced by 2022. ■

David Nakamura

STAYING ALIVE

Repeatability, flexibility and visibility via automated control systems can help batch processors make it through the recession


Honeywell

FIGURE 1. Many batch automation vendors are enabling batch functionality at the controller level

As it is with all chemical processors, the current economic climate is forcing batch processors to produce more saleable product at a better profit margin from the same assets. Increasing flexibility, reliability and visibility while decreasing batch cycle times via integrated automation systems can help increase throughput and the chance of survival.

Staying afloat

Undoubtedly it's difficult to get more product from a process, especially in the wake of staff reductions and facility shutdowns. However it is possible to improve batches in an effort to ensure longevity even during an economic crisis. To do so, experts recommend the following:

Increase reliability. Since the product from many batch processes is immensely valuable and any loss of a batch due to failure will result in a large financial setback, ensuring reliability is especially important during the current economic downturn

Reduce batch cycle time. Like other chemical processors, batch processors need to get more from less. Getting a batch cycle down from 12 h to 11 h and 45 min translates into additional revenue from the same assets, so it is prudent to find ways to reduce batch cycle times

Increase flexibility. Flexibility, too, is crucial at this time as processors are being asked to produce a wider range of products from the same equipment with very little setup-related downtime between batches

Track and trace. In this sagging economy, many batch processors are cutting back on documentation and quality procedures. Experts warn that this is only laying a trap for the future as regulations regarding record keeping are becoming more stringent. Historical batch information can also be used to improve a process. For these reasons, batch processors must begin to step up their game in this area

True batch control

While taking these actions may seem difficult, automation vendors do provide solutions that can help. Increasing reliability, they say, lies in moving sophisticated and intelligent batch automation down the automation hierarchy and into the controller. "In the past there were hierarchical systems where recipe management and other aspects of batch processing and unit control were run in a server and the actual phases and individual building blocks were done in the controller," says Maurice Wilkins, vice president of the Global Strategic Marketing Center with Yokogawa (Newnan, Ga.; www.yokogawa.com) and chairman of the World Batch Forum (Research Triangle Park, N.C.; www.wbf.org). "But now unit supervision can be done in the controller as well."

This means that the unit can stand alone inside the controller, where before a server was needed to manage the operation. "Controllers are becoming more powerful, which lets you run more inside the controllers themselves. This is where batch processing is headed because you can do more with less equipment," says Wilkins.

Chris Morse, product marketing manager for batch with Honeywell (Morris Township, N.J.; www.honeywell.com), agrees that this is the ticket to more successful batch operations. "Moving the procedural levels of batch control into the controller provides a robust environment and reliability," says Morse. "We call it 'bumpless redundancy,' meaning that if one controller fails, the system automatically moves to the back up with no single point of hardware or software failure that will cause the batch to hold, which could be dangerous or involve economic loss."

In addition, this recent move helps with cycle time reduction. In previous generations of batch automation, there was a server involved, which left dead time in communication between that server and the control-

ler. "We have customers who have calculated that by reducing dead time, they can increase their annual throughput by up to 3%," notes Morse. "They can sell that additional product, which means they have successfully reduced cycle time and improved productivity."

Using advanced process control as part of the batch process can also help improve yield by allowing users to make more informed decisions about equipment and processes, says Todd Stauffer, PCS 7 marketing manager with Siemens Energy & Automation (Alpharetta, Ga.; www.siemens.com). "Advanced process control is a way to understand how you're currently running so you can make fine adjustments to the process with ease," he says. "With the distributed control systems of the past, it was difficult and costly to make small changes unless you were knowledgeable in the vendor's programming."

THE HUMAN TOUCH

While automation obviously plays a starring role in successful batch processing, both processors and automation system suppliers realize there will always be a certain degree of human intervention involved. From that revelation came the advent of several solutions designed to embrace and enhance the human touch.

"Along with the economic woes faced by chemical and batch processors comes the problem with reduced engineering staffs and the graying workforce," says Fred Ungerer, chief operating officer with Performix, Inc. (Houston, Tex.; www.performixinc.com). "This leaves processors with knowledge management and transfer issues. While some say the problem further justifies automation, there will still be a human touch at certain points during the process, so the issue really becomes how do you make the most of the combination of automation and human touch and how do you make the human touch more effective and more consistent?"

He says the idea of consistency in automated processes is especially relevant during this time when facilities are moving overseas and becoming global. "As you move from one facility across the world to another, you need to have as much consistency in the process as is possible because there may be differences in materials due to different sources in various areas around the globe," explains Ungerer. "In these situations, how to take knowledge and move it from one part of the world to another becomes a key issue."

As a result, Performix began offering Manufacturing Execution System solutions, which are built on the SAP framework. The three core components to the solution include xRecipe for recipe editing and management, xMES, a recipe executing engine that includes plant floor user interfaces and xBatch, the execution historian.

The components work together to keep a master document of what needs to be done, which is housed in SAP, yet allows data to be viewed and/or collected on the plant floor. "The solution may include operators with handhelds that allow them to view checklists of the proper

Integrating information

Providing integration at a variety of levels can also help processors boost their batch. At the operator level, it's important to provide a common user interface and concept across all the systems, not just the batch or automation system. Further up the automation pyramid, integration with ERP (enterprise resource planning)

steps to follow, such as what protective equipment is necessary or the steps necessary for startup," says Ungerer. "Laying out step-by-step instructions for a process goes a long way toward increasing consistency and reliability and is an ideal way to transfer knowledge from one location to another or from retiring to next-generation workers."

Performix's solutions can be automated so users don't have to confirm each step or can be set up so they must confirm everything. "It becomes a simple stepped process," says Ungerer. "Rules and electronic work instructions are developed and then put in the hands of the operators so they can execute them. Not only does it improve safety, consistency and reliability of a process, but it can also be used to do analysis of a batch."

Information such as how long a batch took and what steps were taken can provide insight into how to cut cycle time and expand capacity. "If you know there are variations from batch to batch, but know the manual aspects of operations are handled the same each run, you can begin to zero in on the other variables that may be affecting cycle times," says Ungerer.

Yokogawa (Newnan, Ga.; www.yokogawa.com), too, is offering a means to automate procedures for newer members of the workforce. "In industry it's a big deal to be able to do the same thing the same way every time," says Maurice Wilkins, vice president of Yokogawa's Global Strategic Marketing Center. "And having the procedures automated and available to operators helps ensure that the startups and shutdowns are done the same way from shift to shift."

Performix, Inc.

Performix's xMES Next Generation User Interface (UI), displayed on a Panasonic Toughbook Wireless Handheld, is used by plant operators to help facilitate batch manufacturing processes during execution. This particular UI view shows just a few of Performix's capabilities including Electronic Work Instruction, plant floor device integration with a Bar Code scanner and seamless connectivity back to ERP for realtime visibility of the manufacturing enterprise

For this reason, he says, Yokogawa recently enhanced the functions of the Human Interface Station for Centum VP, a new DCS system. The Centum VP HMI (human machine interface) introduces a unified and intuitive operating environment, while facilitating easy access to information. The visualization of operational know how and consideration of information users' mental models enable everyone to work more consistently. The unified and intuitive HMI helps harness the power of an integrated production control system by ensuring that information gets prioritized and providing actionable information.

While Centum VP works in conjunction with Yokogawa's current batch system to ensure repeatability, the company is working on a batch solution that will better take advantage of the HMI features, says Wilkins. ❑

systems allows processors to seamlessly move from order to order input, to planning and inventory management and then into kicking off the batch process.

Vendors are tackling this in a variety of ways. Honeywell is more deeply integrating the batch automation functions into the system, so "it does batch right out of the box rather than being an installed application on top of the automation system," says Morse. "This provides the user consistency in look and feel, which reduces the training requirements for main-

taining and operating a system."

One of the newest developments in the area of integration is with Honeywell's Experion Process Knowledge System (PKS), which offers new integrated batch functionality through the new Experion Batch Manager. "Every item of batch automation can be changed online with this system," explains Morse. "We're taking measures to be able to manage large numbers of recipes and integrate with ERP systems. A batch can be kicked off by an external system, usually an ERP, without paper or manual handling between the ERP and automation system." He says this provides flexibility and ease of change between orders and batches.

Siemens is handling the integration challenge through its Simatic IT product, which bridges the gap between its PCS 7 control system and Simatic Batch. While Simatic Batch is a graphical tool that allows users to make recipe changes in a drag-and-drop environment, there was still difficulty in getting the information for those changes from the IT people to the process control folks. "We are providing Simatic IT to make those two worlds talk in an effort to increase flexibility," says Robert Purvy, PCS 7 technical consultant with Siemens.

"Typically there are IT guys and process control guys, but batch processors need to make that line blur if they want to increase productivity via flexibility," he says. "The information and data regarding scheduling, warehousing and material management that is normally in the scope of IT has got to make it to the process control people so they have information on the quality of the raw materials if it differs from the information in the ERP system."

"Having integration between these normally disparate entities will also enable batch processors to quickly change from one product to another if something comes up," says Purvy. "Quite simply, integration provides batch processors with information in real time, which enables them to produce more products with the same equipment, make changes on the fly, optimize production runs and keep track of it all."

Track and trace

And keeping track of it all is especially important as regulations regarding documentation and record keeping grow tougher every day. Not only does tracking and tracing keep batch processors in compliance, it also helps them understand the process, enabling process improvements.

Most suppliers of automation solutions provide some sort of track-and-trace, documentation and historical analysis functionality in their offerings. Rockwell Automation (Milwaukee, Wis.; www.rockwellautomation.com), for example, offers its Plant PAx Process System and, within that, a

Honeywell

FIGURE 2. **Honeywell introduced the Experion LS control system as part of it's Experion PKS line to provide the power and reliability of a distributed control system in a small and flexible solution. Experion LS manages all continuous process control applications and optimizes batch and sequence-oriented applications typically found in smaller batch processing sites**

batch management and control function focused on batch and sequence management, which leverages Integrated Architecture and Factory Talk. Factory-Talk Batch software provides modules for batch management, manual work instructions, materials management and material usage tracking, forward/backward track and trace, regulatory compliance, validation and other tracking activities.

"Not only does this help with regulatory compliance and product recalls, it also turns data into usable information, which helps batch processors truly understand and optimize the process," says Andy Stump, segment manager for Rockwell Automation's Process Systems Team.

He says the Factory-Talk Batch product provides web-based reporting, which offers a range of standard out-of-the-box reports for track and trace, material usage, electronic batch reporting and exception reporting. "The system takes all that data, collects it and gives the user a report that can be used to fine tune the process," he says. What it boils down to is that batch processors are using modern and reliable batch control systems to gather and study the information collected by track and trace functions. This enables the user to make informed decisions to achieve the levels of flexibility and increased productivity necessary to stay alive during the economic downturn. ■

Joy LePree

FOCUS ON

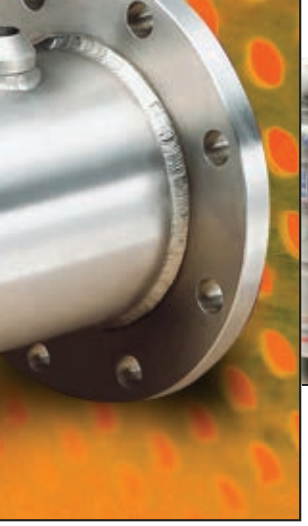
Heat Transfer

Chemineer

New line of blown film coolers are designed for warm climates
The BFC Series of Blown Film Air Coolers offer an increase in blown film productivity, especially in warmer climates or other environments where ambient air temperature rises during the summer. The Series boosts productivity by eliminating production variables in air ring supply, including air temperature, pressure and volume. A modulated chilled-water supply provides a constant exit-air temperature to the process, and the air inlet diffuser ensures that the air stream covers the full face of the cooling coil. The exit-air chamber is insulated to reduce condensation while providing the coldest air possible to the air ring. Units are available in 600–7500 ft/min sizes. — *Mokon, Buffalo, N.Y.*
www.mokon.com

These heat exchangers offer high heat transfer coefficients
Equipped with streamlined Kenics Static Mixer elements, Kenics heat exchangers (photo) offer maximum transfer rates, even with highly viscous, difficult-to-process materials. Kenics Static Mixer technology offers the highest available heat-transfer coefficients, providing heat-transfer rates of three to seven times greater than conventional empty tubes, says the firm. The product offers design pressures to 10,000 psi. The unit, constructed from all metals and alloys and offered with special connections and fittings, is ASME/TEMA compliant. — *Chemineer, Inc., Dayton, Ohio*
chemineer.com

Withstand harsh outdoor conditions with this heat exchanger
The Climaguard Outdoor Heat Exchanger removes up to 3,000 W of enclosure heat and features a double-



Unifin International

crimped and dip-sealed core, for efficient thermal transfer in harsh outdoor environments. Units can easily be surface- or recess-mounted to an enclosure. Climaguard units are designed to seal out harsh environments, including temperature extremes, corrosive environments and wind-driven rain. Robust Climaguard Heat Exchangers are compatible with 48 Vd.c. and 115 Va.c. power supplies. A maximum 2,000-W heater option is available on d.c. and a.c. volt heaters, and variable-speed blowers come standard on d.c.-powered units for quiet running. — *Hoffman, Anoka, Minn.*
www.hoffmanonline.com

Mobile coolers designed for demanding oil applications

The ForZair line of mobile coolers (photo) feature this firm's Mono-Aluminum Extruded Fin-Tubes and plate fin technology for optimal heat-transfer efficiency and exceptional durability. ForZair mobile coolers are designed to work with Cardinal transformer oil pumps, which utilize a glandless design to prevent leaks. ForZair units are available with a performance range of 125–750 kW for oil flows of 200–650 gal/min and a top oil rise (TOR) of 35–63ºC. A galvanized finish is standard, with other surface treatments optional. A two-part epoxy paint option is available for chemically-aggressive environments, and a durable three-part system is available for marine environments. — *Unifin International, London, Ont., Canada*
www.unifin.com

This Series of thermal fluid heaters includes new sizes

With the addition of the ASME Code 16-mil. and 20-mil. Btu/h thermal-fluid heaters, these Btu fuel-fired horizontal heaters are now available from 2.4-mil. to 20-mil. Btu/h output. In addition, the firm offer fuel-fired vertical heaters from 0.2-mil. to 14-mil. Btu/h output and electric heaters to 1.7-mil. Btu/h output. Thermal-fluid heaters are available as stand-alone products, or they can be skid mounted with circulation pumps and expansion tanks. Heaters can be customized upon request, and can reach 750ºF. — *Fulton Thermal Corp., Pulaski, N.Y.*
www.hoffmanonline.com ■

Kate Torzewski

People

WHO'S WHO


Clements


Murray


Davidson


McCarty


Rummel

John Paterson becomes vice-president of **Ross Mixing, Inc.** (Port St. Lucie, Fla.), a division of Charles Ross and Son Co. (Hauppauge, N.Y.).

Paratherm Corp. (West Conshohocken, Pa.) promotes *Rich Clements* to COO and vice-president of operations.

Cherry Murray of Lawrence Livermore Laboratory is named dean of the **School of Engineering and Applied Science at Harvard University** (Cambridge, Mass.), and becomes Harvard's John A. and Elizabeth S. Armstrong Professor of Engineering and Applied Science.

KBC Advanced Technologies plc (Houston) names *John Dosher* senior vice-president of strategic consulting.

Heidi Davidson is named technical development engineer for the SOLVAir Products Group of **Solvay Chemicals** (Houston).

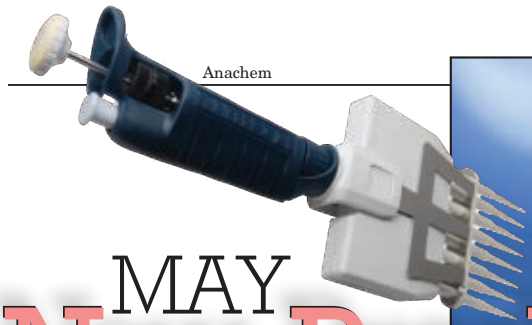
ITT Corp. (Seneca Falls, N.Y.) promotes *Charles Cappellino* to vice-president of research, development and engineering.

Malek Jalel is appointed president of the biodiesel company **Innovation Fuels** (Albany, N.Y.).

Patrick McCarty becomes president of separations company **KMPT USA** (Florence, Ky.).

Ric Rummel is now director of global sales at **Hardy Instruments** (San Diego, Calif.). ■

Suzanne Shelley



Anachem

Brooks Instrument

MAY New Products

Splice Detection Technologies

Exact Flow

Splice detection system for paper and packaging

Sentinel Splice (Joint) Detection Technology (photo) is designed to monitor 1–16 webs of material and will detect any splice or joint that may exist within the web-based process. It is applicable to manufacturing processes that require the culling out of splices or joints prior to shipment. Unaffected by printed surfaces, material color, grade changes and process speeds, the Sentinel is a self-calibrating system that is powered by 24 Vd.c. It provides an opto-isolated, digital electronic output with a pulse width selectable for 1, 10 or 100 ms. The Sentinel can be connected directly to PLC control devices or interfaced into existing marking systems or directly control devices. — *Splice Detection Technologies, Syracuse, N.Y.*
www.splicedetector.net

Flow calibrator with extended range dual manifold capability

Utilizing a two-meter manifold control system, the portable, automated Flow Gator calibrator (photo) operates in single viscosity fluids from 0.1 to 310 gal/min. Calibrations in multiple viscosities can be achieved from 0.35 to 310 gal/min. Instead of removing flowmeters from service for recalibration, the Flow Gator flow-transfer standard allows users to bring the calibrator to the flowmeter. This flow calibrator is intended for inline calibration and validation of meters using the actual process liquid. Rugged, lightweight and compact, the Flow Gator incorporates handheld electronics. Two dual-rotor turbine flowmeters, which provide exceptional repeatability of ±0.02%, enable the Flow Transfer Standard system uncertainty to be <±0.25% of reading. The Flow Gator system's intuitive, menu-driven calibration software enables end users to create calibration data files, which can be up loaded to a PC for storing historical calibration data. — *Exact Flow, Scottsdale, Ariz.*
www.exactflow.com

Achieve consistent dispensing over 8 or 12 pipette channels

The Pipetman Neo Multi 8- and 12-channel pipettes have recent design changes, including a reengineered spring that reduces pipetting forces. The unique design of the tip-holder, with successive sealing rings, offers the widest compatibility with a full range of the most commonly used tips. A dispenser spacer distributes dispensing forces equally. Plus, a patented mechanism distributes the pipetting forces equally over each channel, for consistent aspiration and dispensing of samples and identical performance across the pipette. Pipetman Neo Multi is available with nominal volumes of 20 µL or 200 µL. Accuracy and precision specifications are more stringent than ISO 8655-2 recommendations. — *Anachem, Bedfordshire, U.K.*
www.anachem.co.uk

This flow controller is unaffected by temperature and pressure

The family of B-Series mass flow controllers (photo) is designed to be insensitive to fluctuations in pressure and temperature. Each flow controller is built on a standard 1.125-in.-wide platform with a powerful user interface and local digital display. The mass flow controller actively measures line pressure and adjusts the control valve to virtu-

Note: For more information, circle the 3-digit number on p. 70, or use the website designation.

LumaSense Technologies

ally eliminate actual flow and flow-signal changes as caused by pressure fluctuations. In addition, the output of every B-Series mass flow controller is characterized over the full operating temperature range. The B-Series incorporates internal self-diagnostic routines that continuously check the health of the device. In the event of a diagnostic fault, an alarm code flashes on the user interface. An easy-to-use service port provides additional diagnostic capability, minimizing the need to remove the mass flow controller from process service. — *Brooks Instrument, LLC, Hatfield, Penn.*
www.brooksinstrument.com

This thermal-imaging camera is portable

The Mikron MikroSHOT (photo) is the latest offering from this firms' Mikron Infrared thermal imaging product line. The MikroSHOT's Thermal-on-Visible mode allows for radiometric temperature data (from –20–350°C) to be displayed directly on the visible image. The pocket-sized MikroSHOT is lightweight (10.5 oz.) and uses off-the-shelf batteries (an a.c. adapter is also included). Its large 2.7-in. display and 160 X 120 pixel image resolution allow easy viewing of images. The SD card, USB and video output capability allow for analysis of the data on a laptop. MikroSpec 4.0 software is included for image analysis and reporting. — *LumaSense Technologies, Santa Clara, Calif.*
www.lumasenseinc.com

Communication blocks for field devices into control systems

The PCS7 to IEC 61850 TCP/IP communication blocks have enabled problem-free integration of IEC-61850-capable field devices into instrumentation and control systems based on Simatic PCS7 or S7. The plant operator thus has an integral automation and control solution that can also be used in heterogeneous system landscapes. This facilitates the gradual and therefore inexpensive expansion or modernization of existing plants and equipment. All the subsystems are interconnected by means of Industrial Ethernet. The new "PCS7 to IEC 61850" communication blocks are intended not only for use in process-engineering installations, where a connection is to be established between the process control system and the power system control equipment, but also for small to medium switchgear, which are au-

Tharo Systems

tomated with Simatic PCS7 or S7. — *Siemens AG, Erlangen, Germany*
www.siemens.com

These thermal-transfer printers feature internal memory

H-427 and H-436 Series Thermal Transfer Label Printers (photo), suited for high-volume printing, are available in 203 or 300 dpi resolution. These all-metal printers feature a full backlit LCD display; standard real-time clock; ink-in or ink-out ribbon use, 450-m capacity; serial, parallel, PS/2 and USB interfaces; and stripper sensor for strip-and-peel or tear-off applications. In addition, the H-Series contains internal memory for storing downloaded label formats, graphics and fonts, allowing the printers to be operated without being connected to a computer. The units come with this firm's Easylabel Start software for custom designing and printing bar code labels. — *Tharo Systems, Inc., Brunswick, Ohio*
www.tharo.com

An interface tool is now offered to all Micro Motion customers

A complimentary support utility is now offered for all Micro Motion customers who use Modbus protocol to interact with their Coriolis meters. The Modbus Interface Tool is a PC-based data-delivery system that replaces more than fifty pages of Modbus register data in tabular form with a simple point-and-click spreadsheet presentation. The Modbus Interface Tool allows users to select, sort and group register data by Coriolis device, Modbus address, datatype or keyword. Control systems based on digital protocols, such as Modbus, are typically more accurate and provide faster response than analog control systems. The Modbus digital interface provides a complete window into the Coriolis device, including configuration, operations, maintenance and troubleshooting. — *Emerson Process Management, Boulder, Colo.*
www.emerson.com

This microphone measures sound based on light variations

The MO 2000 optical microphone (photo, p. 28D-4) utilizes a new type of transducer that processes acoustic signals on the basis of variations in light intensity. In the optical microphone, light from an LED is directed onto a reflective diaphragm via a transmitter fiber-optic cable. The diaphragm

New Products

Sennheiser Electronic

reflects part of the light into a receiver fiber-optic cable. If the diaphragm is moved by sound signals, the reflected light beam is deflected, with the result that more or less light is coupled into the receiver fiber-optic cable, and then converted into electrical signals. The current- and metal-free design allows the microphone to be uninfluenced by magnetic fields. — *Sennheiser Electronic Corp., Old Lyme, Conn.*
www.sennheiserusa.com

A viable alternative to control VOC emissions

The design of this new wet electrostatic precipitator for sulfuric-acid-emissions control makes it easier to fabricate and significantly less expensive to install. Economical alloys are used to make the system significantly more cost effective while exceeding process requirements. The system's alloy construction allows shop fabrication to a much greater degree, which means significantly less field labor. The resulting project cost savings can be significant, says the firm. — *A. H. Lundberg Associates, Inc., Bellevue, Wash.*
www.lundbergassociates.com

Use this gateway for industrial communication connectivity

The netTAP 100 (photo) is a flexible and cost-effective gateway designed to bridge the gaps between traditional fieldbus, realtime Ethernet-based systems and serial protocols. Based on this firm's netX chip, up to 1,000 protocol combinations are made possible in a modular compact DIN-rail mounted housing. The netTAP 100 is capable of linking any of the major fieldbus, realtime Industrial Ethernet's and serial protocols used in the market today. master and slave protocols for CANopen, DeviceNet, Profibus, CCLink, EtherCAT, Ethernet/IP, Modbus TCP, Powerlink, Profinet, Sercos III, MB/RTU, MB ASCII RS232-, RS422, and RS485 are included for realtime I/O data exchange. A standard USB port is used for configuration along with loading network firmware and diagnostics. — *Hilscher North America, Inc. Lisle, Ill.*
www.hilscher.com

Hilscher North America

This laboratory-scale centrifuge is designed for clean processes

The sanitary design of this laboratory filtering centrifuge is ideal for solid/liquid separation, washing and extractions of food ingredients, polysaccharides, crystals, botanical extracts and pharmaceuticals. The unit is rugged enough to handle dense products, including powdered metals. Separate feed and wash lines allows approximation of a production-scale centrifugation process. The basket, machined from a solid block of 316 stainless steel, has a 6-in. dia. and is 3.6-in. high with a 1-in. cap. It has a solids-holding capacity of 0.68 L, and is able to reach speeds of 4,000 rpm. The unit features a NEMA-4X electrical enclosure and base frame, a 1/2 h.p., totally enclosed, non-ventilated motor and a 110-V power supply. — *The Western States machine Co., Hamilton, Ohio*
www.westernstates.com

Omega Engineering

Build this paperless data acquisition system into a network

The RD8300 paperless recording system (photo) has features a high contrast 142 mm color Active Matrix TFT LCD with a rugged touch screen that can be operated by a finger or the onboard stylus. It has a built-in OPC server and email client, 6 to 12 universal and relay outputs, multiple media drives, and locking media access door. This CE-compliant product needs no additional equipment for harsh environments and is NEMA 4 rated. The unit can be used in a range of idnustries that require rugged equipment, as well as food processing and chemical laboratory applications. — *Omega Engineering Inc., Stamford, Conn.*
www.omega.com

Manage energy use with this software

The IndustrialIT cpmPlus Energy Manager software is offered to help users monitor, manage and optimize energy usage for maximum efficiency and cost savings. Energy Manager includes tools for planning and scheduling, energy-balance management, and reporting for overall electricity cost savings of 2–5%, says the firm. Energy Manager clearly indicates the cost of electricity and provides support to schedule electricity consumption for off-peak hours. It coordinates electricity purchases and sales with its own generation capacity, then schedules this generation during on-peak hours, when purchased electricity is most expensive, to provide additional cost savings. Energy Manager also includes reporting and analysis tools that evaluate the energy use patterns of all processes and pinpoint areas for improvement. — *ABB, Baden, Switzerland*
www.abb.com

This indoor air-quality monitor senses carbon dioxide

The Model CO200 checks for carbon dioxide concentrations in indoor environments where high levels of CO_2 are generated. The CO200 features a maintenance-free NDIR (non-dispersive infrared) CO_2 sensor, as well as a visible and audible CO_2 warning alarm with relay output for ventilation control. Indoor air quality is displayed in ppm as Good (380–420 ppm), Normal (≤1,000 ppm) or Poor (≥ 1,000 ppm). The unit

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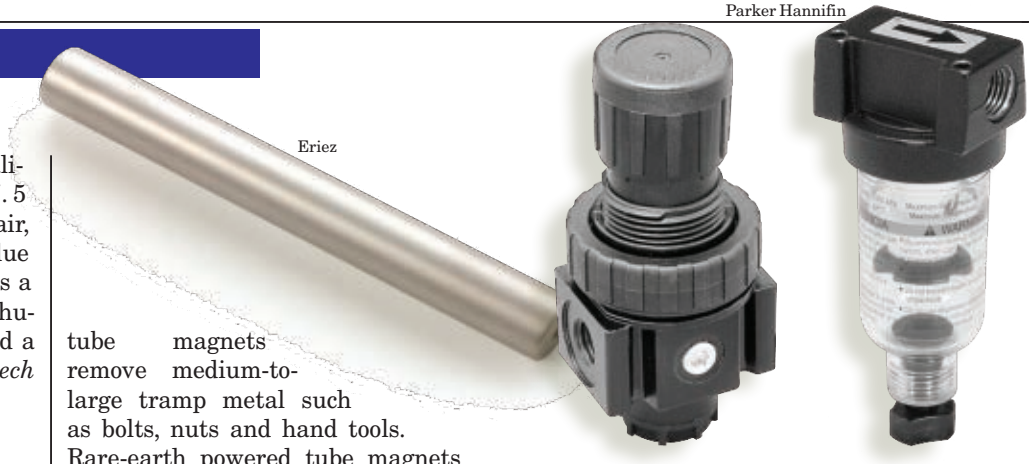
Parker Hannifin

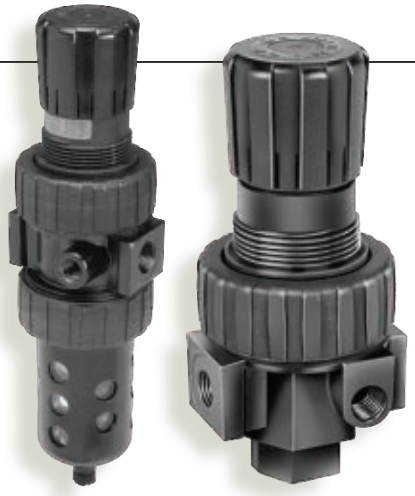


Eriez

contains an Automatic Baseline Calibration (minimum CO_2 level over 7. 5 d) or a manual calibration in fresh air, and features a Max/Min CO_2 value recall function. Extech's CO200 has a temperature range of –4–140ºF, a humidity range of 0.1–99.9% RH, and a CO_2 range of 0 to 9,999 ppm. — *Extech Instruments, Waltham, Mass.*
www.prestolifts.com

Magnets separate contaminants from dry and liquid products
The 1-in. dia. ProGrade Tube Magnets are available in lengths of 4–24-in. and are primarily used to remove ferrous contaminants from liquids in tanks, as a quality control check of dry bulk materials, or in various other application settings where a powerful, portable magnet is needed. ProGrade Tube Magnets are offered in three strengths, enabling customers to select the right degree of magnetic strength for their application. Ceramic powered tube magnets remove medium-to-large tramp metal such as bolts, nuts and hand tools. Rare-earth powered tube magnets remove small ferrous contaminants such as pins, staples and clips. Xtreme Rare Earth powered tube magnets are best at separating out weakly magnetic fine ferrous contaminants. — *Eriez, Erie, Pa.*
www.eriez.com

For pneumatic instrumentation requiring special air preparation
This firm now offers a new line of filter regulators, regulators and mini filters (photo). The four filter regulators are offered with flowrates from 16 to 72 ft/min. The filter regulators are designed with a rolling diaphragm for extended life with quick response and accurate pressure regulation regardless of changing flow or inlet pressure. Four mini filters, offered with high-efficiency coalescing filter media, are ideal for harsh-environment applications, such as chemical washdown areas. Five regulator models are offered in ¼ to 1 ½-in. ports with a maximum pressure capacity of up to 300 psig and flowrates to 300 ft/min. These products are ideal for pneumatic equipment and



instrumentation requiring special air preparation. — *Parker Hannifin Corp, Haverhill, Mass.*
www.parker.com

Alternative flurosurfactants that are environmentally preferred
The anionic, short perfluoroalkyl chain PolyFox fluorosurfactants are formulated to meet the goals of the U.S. Environmental Protection Agency's (EPA) Design for the Environment (DfE) program. The new products are formulated using dipropylene glycol monomethyl ether (DPM) solvent instead of diethylene glycol monobutyl ether (butyl carbitol), the solvent used previously. Some consider DPM to be an environmentally preferred formulating agent. The PolyFox technology platform is based on an oligomeric poly (oxetane) backbone with short perfluoroalkyl groups. PolyFox materials are neither prepared from PFOA, PFOS or telomer-based fluorochemicals of concern, nor can they degrade into such materials. Consequently, PolyFox fluorosurfactants and fluorochemicals by regulatory agencies globally, including the EPA and the EU's REACH program. — *Omnova Solutions, Inc., Fairlawn, Ohio*
www.omnova.com

Use this rupture disc in clean applications
Designed specifically for the pharmaceutical, biotech and food and beverage industries, the Sanitrx MP rupture disc features severe service application capabilities. This rupture disc offers reliable performance from full vacuum to the recommended operating pressure in excess of 100,000 cycles. Precision scoring on the vent side of the dome assures optimum cleanability and improves rupture disc performance. The Sanitrx MP scored reverse-acting rupture disc complies with ASME BPE criteria. — *Continental Disc Corp., Liberty, Mo.*
www.contdisc.com

Realtime viscosity monitoring, even at high pressure
The new XL7-HT2 high-temperature viscometer provides continuous realtime viscometry measurement of fluids at up to 450°C without special cooling. The device has no moving parts, and the sensor is an all-welded construction that can be mounted at any location and in any orientation using any process fittings. Calibration is unaffected by installation or environment. The standard sensor

Circle 41 on p. 70 or go to adlinks.che.com/23014-41

is made of 316 stainless steel, but if necessary, other materials of construction can be used. High-pressure models are rated at 20,000 psi (1,380 bars) or greater. Viscosities of up to 1,000,000,000 cP can be measured. — *Hydramotion Ltd., York, England*
www.hydramotion.com

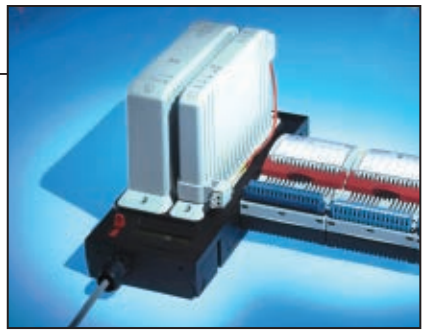
For light duty, use this power-driven stacker

This line of fully powered stackers has a lifting height of 62 in. and a capacity of 1,500 lb. The Power Stak Lite line of light-duty stackers (photo) features a narrow mast design and an offset control handle to improve ease of use and comfort, while eliminate blind spots. An auto-reversing belly switch protects operators when walking the unit backwards, while an automatic brake immediately halts travel when reversed. The Power Stacker is built on an stable, yet short wheel base to provide maximum maneuverability, even in tight quarters. Units are available in fork-over design for use with open-bottom pallets or adjustable straddle design for use with closed-bottom pallets. — *Presto Lifts, Inc., Attleboro, Mass.*
www.prestolifts.com

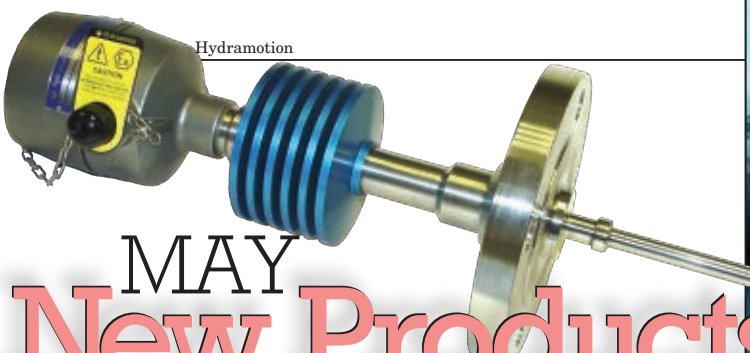
Presto Lifts

The IS1 remote I/O interface now comes in a FF HSE version

A market-leading remote I/O system for Zone 1, Div. 1 applications, the IS1 (photo) has now been extended to feature its first operational communication interface for Foundation Fieldbus High Speed Ethernet (FF HSE). The system has already supported the Modbus TCP protocol for basic Ethernet performance. This new FF HSE version now provides users with a more advanced and considerably more powerful Industrial Ethernet protocol implementation. Remote I/O technology allows users to deploy consistent plant communication networks integrating conventional HART-capable and Foundation Fieldbus H1 devices. — *R. Stahl Schaltgeräte GmbH, Waldenburg, Germany*
www.stahl.de ■


R. Stahl Schaltgeräte

Kate Torzewski and Gerald Ondrey



Hydramotion

Siemens

MAY New Products

Realtime viscosity monitoring, even at high pressure
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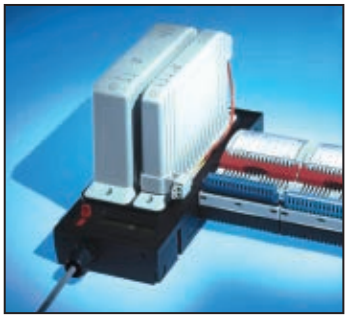
www.hydramotion.com



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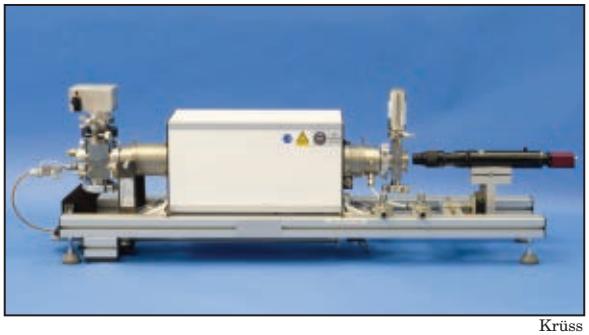


Krüss

Samson

The IS1 remote I/O interface now comes in a FF HSE version
A market-leading remote I/O system for Zone 1, Div. 1 applications, the IS1 (photo) has now been extended to feature its first operational communication interface for Foundation Fieldbus High Speed Ethernet (FF HSE). The system has already supported the Modbus TCP protocol for basic Ethernet performance. This new FF HSE version now provides users with a more advanced and considerably more powerful Industrial Ethernet protocol implementation. Remote I/O technology allows users to deploy consistent plant communication networks integrating conventional HART-capable and Foundation Fieldbus H1 devices. — *R. Stahl Schaltgeräte GmbH, Waldenburg, Germany*
www.stahl.de

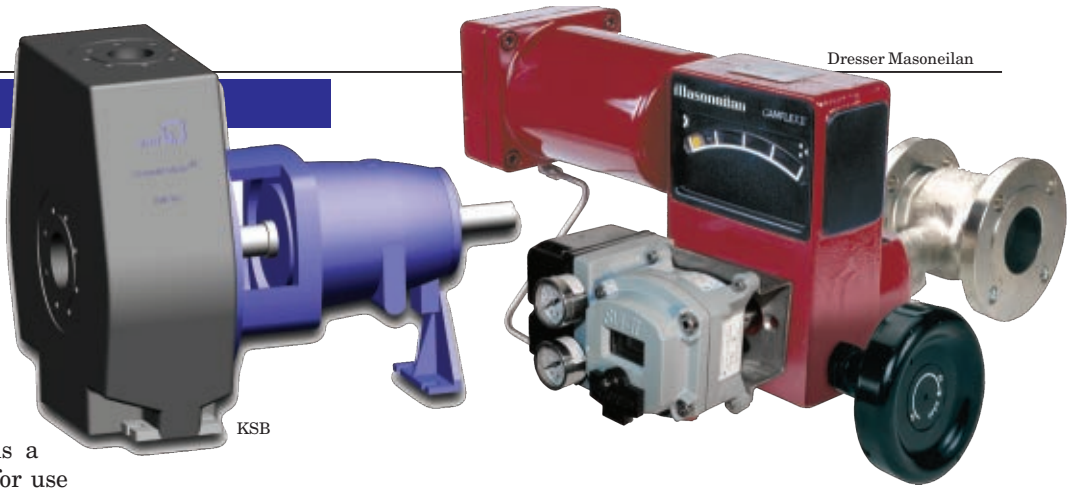
A versatile level switch for monitoring bins, silos and hoppers
The Sitrans LVS100 (photo) is the latest addition to this firm's line of vibrating point level switches for high, low or demand levels of dry bulk solids in bins, silos or hoppers. The new device detects the presence of material with bulk densities starting at 60 g/L (3.8 lb/ft^3) in mining, food, plastics, chemical and pharmaceutical industries, even in hazardous applications. The device is used primarily for high- or low-level indication, and for redundancy of continuous level systems as overfill or dry-run protection. Sitrans LVS100 is impervious to external vibrations, and the vibrating fork design ensures the sensing tines are kept clean for reduced maintenance. — *Siemens Industry Automation Division, Nuremberg, Germany*
www.siemens.com

This booster allows fast control, even with high flowrates
Thanks to its precisely manufactured bypass restriction, the new Type 3755 Booster (photo) can be adjusted exactly and lead-sealed in this setup. Because the Booster is completely pressure balanced, it provides a stable output, even under changing pressure conditions. The signal pressure is transmitted with defined hysteresis, without loss and emitting little noise. The Booster is designed so that the functional parts only come into contact with instrument air. Its exhaust-air port can be protected against weather or environmental influence, or the exhaust air can be routed through a pipeline. When combined with a positioner, the booster allows control valves with large pneumatic actuators to be controlled quickly and precisely, even with high flowrates or pressure drops. — *Samson AG, Frankfurt, Germany*
www.samson.de

Analyze molten liquids at very high temperatures
The Drop Shape Analysis System with Tube Furnace (DSAHT; photo) can perform optical drop studies at temperatures up to 1,750°C, making it suitable for studying liquid metals and slag, molten glass and ceramics at their firing temperature. The clear shadow image of the sample provides information about the melting behavior (for example, flyash fusibility according to ASTM D1857). The shape of a molten drop on a solid sample makes wetting visible. Versions up to 1,200, 1,500 or 1,750°C, for oxidizing, reducing or inert atmospheres, or for mea-

Note: For more information, circle the 3-digit number on p. 70, or use the website designation.

New Products



KSB

Dresser Masoneilan

surement under vacuum cover a wide range of applications. — *Krüss GmbH, Hamburg, Germany*
www.kruss.de

Process pumps for FDS units

KWPKC-Monobloc (photo) is a new pump series designed for use in secondary circuits of fluegas desulfurization (FDS) plants. The main application of these pumps is to transport limestone slurry and circulating water, to remove gypsum and to thicken solutions. The pump series covers flowrates up to 3,000 m^3/h and discharge heads up to 120 m. The pumps feature a pull-out design for the radially split casing to make maintenance quick and easy. An adjustable clearance gap is provided on the suction side to keep the pump's efficiency high. The impellers are made of this firm's wear-resistant Noridur Das, and the wetted components (such as casing and discharge cover) are lined with wear-resistant CeramikPolySiC — a specially developed composite material of ceramic and polymer that is proven to be abrasion and corrosion resistant. — *KSB AG, Frankenthal, Germany*
www.ksb.com

This valves seal keeps emissions at bay without excessive friction

The Camflex II rotary globe valve (photo) can help users meet environmental emissions standards. Featuring a specially developed Emissions Free (EF) Seal and many other innovative design characteristics, the Camflex II valve reduces equipment emissions that can occur at the valve shaft sealing or packing, particularly after long-term operation. The EF combines a double O-ring sealed packing follower with low-friction tetrafluoroethylene- (TFE) based packing materials for long-term service that complies with low-emissions standards. In addition, the small-range rotary motion of the Camflex II valve shaft provides benefits, such as preventing contaminants from entering the packing sys-

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Heinen Drying

tem from atmospheric exposure, which can accelerate corrosion. Another feature of the Camflex II valve is an integrated extension bonnet that enables the standard TFE packing material to withstand its full temperature range — up to 400°C. — *Dresser Masoneilan, Courbevoie, France*
www.dresser.com

These membranes enable higher pressure operation of RO plants
This firm has modified its spiral-wound membrane elements in a way that enables reverse osmosis (RO) desalination plants to operate at pressures of up to 120 bars — considerably higher than the 80 bars used in conventionally driven, high-pressure RO plants. As a result, a significantly higher concentration of salts can be achieved, thereby reducing the investment and operating costs needed for downstream evaporation. In addition, the capacity of an existing evaporation plant can be increased "enormously" by an upstream, high-pressure RO plant. Pilot and test plants (photo) are also available. — *OSMO Membrane Systems GmbH, Korntal-Münchingen, Germany*
www.osmo-membrane.de

This FB dryer incorporates a filter for fines
One feature of the Heinen fluidized-bed (FB) systems is the high-performance filter cartridges integrated in the dryer's hood (photo), separating and recycling the fine dust particles that are produced during the process. No material is lost with the exhaust air, nor pollutes the ambient air. The filters are directly cleaned via cleaning nozzles integrated in the dryer's hood. The filter types (stainless steel, PTFE or PP) are selected according to the process (drying, cooling, agglomeration and so on) and product (coarse and fine-grained powders; granules, pellets or extrudates; suspensions, solutions or slurries). — *Heinen Drying GmbH, Varel, Germany*
www.heinen.biz

Ceramic bearings enable dry running without lubrication
This manufacturer provides different kinds of bearing solutions for the chemical process industries (CPI).

Jamesbury Emission-Pak® valves keep your emissions under control

Many process streams encourage fugitive losses. Metso Automation's Emission-Pak provides a quick, easy way of assuring compliance with emissions standards.

Mounted on Jamesbury® valves, Emission-Pak combines a PTFE/graphite body seal and gasket, which maintains a leak-free joint at the valve bonnet, with a double-packed, live-loaded V-ring steam seal mechanism that maintains a constant packing force without over-compression.

Emission-Pak is available in a wide range of corrosion resistant trim materials, and is suitable for use in extreme pressure and temperature situations.

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New Products

Cerobear

Full ceramic bearings consist of rings and balls made of ceramic, whereas the rings of a hybrid bearing system are made of high-value bearing steel (photo). Both bearing types have a variety of advantages over standard bearings. In particular, seizing — one of the main failure modes in standard steel bearings due to poor lubrication — is virtually impossible in full ceramic and hybrid bearings, says the manufacturer. This makes it possible to use these bearings without lubricants, and dry-running bearings drastically reduce friction and particle emissions. — *Cerobear GmbH, Herzogenrath, Germany*
www.cerobear.de

This multimotion dryer offers a number of advantages

The Planex System is a patented, multi-product dryer for vacuum drying of wet powders obtained from a centrifuge or filter press. The system consists of a fixed cylindrical chamber with an eccentric agitator inside that undergoes two independent movements; it can rotate on its own axis as well as tangential to the cylinder. This combined double rotation allows optimal mixing of the product, continuously renewing the surface of the mass exposed to evaporation, covering the entire volume of the vessel. As a result, solvent release is facilitated and drying times are significantly reduced, says the manufacturer. The Planex System is available with volumes from 300 to 4,800 L, with loading capacities from 15 to 80% of the vessel volumes. — *Italvacuum S.r.l., Borgaro (Turin), Italy*
www.italvacuum.it

E. Begerow

A new, mineral-free depth filter medium

This firm has developed the bepure process, in which different types of high-purity cellulose are crosslinked to form a structure that does not require the addition of any inorganic material, even for sterile filtration duties. BecoPad P (photo) is characterized by unparalleled purity, with ion and endotoxin contents hardly detectible, says the manufacturer. The new range is available as a low or high cationic version. The filters are said to have a lifetime up to 20% longer than conventional sheets. Rinse volume is reduced by 50%, which results in significant cost and time savings, says the firm. — *E. Begerow GmbH & Co., Langenlonsheim, Germany*
www.begerow.com ■

Gerald Ondrey

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CHEMICAL ENGINEERING
FACTS AT YOUR FINGERTIPS
Department Editor: Kate Torzewski

Choosing a Control System

TECHNOLOGY REQUIREMENTS [1]

1. Control architecture

Does the solution provide an integrated automation platform?

New systems should manage process knowledge through a combination of advanced technologies, industrial domain expertise, and Six Sigma methodologies.

Choose an open, scalable control system that is fully redundant, includes robust control algorithms and provides on-process upgrades to minimize plant downtime. The system should be embedded with best-in-class applications for advanced control, asset management and control monitoring, and include a human interface integrating plant-wide information and delivering realtime process data. Additionally, the system should comply with open industry standards.

2. Field instrumentation

Does the solution integrate "smart" devices?

Control solutions should support digital integration of field instruments, allowing processes to be linked with monitoring and control equipment, and providing the platform needed to operate plants more profitably. An automation provider should offer a maintenance-management program incorporating all of field assets — traditional and fieldbus alike — and providing tools for integrating all device information in a single database.

3. User interface

Does the solution support complex human-machine interface (HMI) requirements?

Instead of requiring customers to support an outdated HMI platform or abandon it entirely, control-system suppliers should provide the means to leverage existing investments and intellectual property, and at the same time migrate plant control rooms and engineering stations to newer, more robust technology. This can include field upgrade "kits" allowing users to retain their existing hardware and industrial-class furniture, while expediting the transition to the latest operator environment.

4. Networks

Does the solution employ open or proprietary protocols?

Control systems employing open network protocols provide process plants with new levels of connectivity. Users have the freedom to select the best control and instrumentation solutions for a given task. Be sure the control system you choose makes full use of recognized open standards, and is equipped to integrate the industry-leading field network protocols. These include Foundation Fieldbus, Profibus, HART, DeviceNet and ControlNet, among others.

5. Optimization

Does the solution support redesigned work processes?

When selecting a new control system, it is important that the vendor offer a solution tightly integrating optimization, multivariable control and advanced process control (APC). Moreover, these tools should be embedded in a system architecture that captures and leverages process knowledge over time. A methodology will also be in place for continuous improvement.

6. Asset management

Does the solution focus on the entire process?

A supplier's asset-management solution should be "process centric." Users have an enterprise-wide view of the relationships between all installed assets, and as such, can make informed decisions affecting plant availability. This approach allows the user to determine: 1) the impact of equipment problems on the process; 2) the association between these problems and the business; and 3) the priority of needed repairs.

CHOOSING A DCS OR A PLC [2]

When choosing a control system for a particular process application, there are many considerations that can help influence the decision. Remember that a DCS is optimally designed for process control with refinery control origins and a PLC is optimally designed for machine or motion control with car factory relay panel origins. While PLCs are sometimes used for process-control applications, there are some trade-offs in terms of degree of programming, robustness and operational suitability. This is most often attempted with small or non-hazardous processes where the loss of benefits is less visible. Below, each type of system and those areas where it typically performs best are listed.

References

1. Gregg, J., Control System Selection, *Chem. Eng.*, August 2002, pp. 62–66.
2. Bohan, J., Industry Solutions Manager, Honeywell Process Solutions (Phoenix, Ariz.), personal communication, Apr. 6, 2009.

DISTRIBUTED CONTROL SYSTEM (DCS)

Should be used when:

- A fair amount of continuous control is required — DCS systems typically have more built-in capability in this area, such as selectors, calculators, stepped outputs and initialization
- The application will be changing frequently (several times a year or more — adding new feed lines, tanks, and so on). Tools in the DCS are fool-proof and make changes quickly
- You have a batch process — sequence capability and handling is built into the DCS
- You want to assign specific areas of the process to operators. Again, this is built-in
- The system must be integrated with other applications and/or systems. DCS systems have a number of open protocols built-in for integration
- Loss of control or operational view during production is unacceptable. DCS systems are robust due to their refinery heritage, and robustness is built-in because it is expected
- You anticipate having multiple controllers that need to "talk" to each other in a peer-to-peer fashion (sharing a lot of data throughout the application). This is built-in to a DCS system
- You need a highly available production system (controller, HMI, server, network, etc). A DCS system is pre-built ready to go out of the box
- Historical data about your application is important to your company. History collection is built-in and very robust

PROGRAMMABLE LOGIC CONTROLLER (PLC)

Should be used when/for:

- High speed processing (faster than 1 ms). This is the hallmark of PLC systems
- 90%+ discrete application (digital inputs/outputs). PLCs are optimized for discrete applications, due to their packing line heritage
- Your application is predominantly machine/motion control. The nature of ladder-logic processing is ideal for machine/motion control applications
- The application will not change frequently, or if so, the changes are small. PLCs are very flexible for making small changes, but lack integrity checks and built-in functionality for making large-scale changes to an automation strategy
- You need to control single pieces of equipment or single workstations that are loosely integrated at a higher level. Many end users deploy SCADA architectures with PLCs that are effective for capturing data across the systems, while preserving autonomy for each controller
- Operators of the application have responsibility over a piece of equipment only. PLCs offer many options for closely coupled operator touch panels
- You anticipate that the controllers for various pieces of equipment have minimal communication between them, and the communication will not change much. Building messaging in the PLC system is costly and must be maintained
- You will require valve line-up logic for numerous (close to 100), multi-position valves. Ladder logic is a very clean, effective way to handle this requirement
- Your application has many areas, separated by distance, that each require only a small amount of I/O (less than 100). PLCs can be scaled to cost-effectively handle tens of I/O at multiple locations

Designing and Operating Gravity Dryers

Properly designed, bulk solids bins or silos offer numerous advantages in slow, diffusion-limited drying operations

Greg J. Mehos, Jenike & Johanson

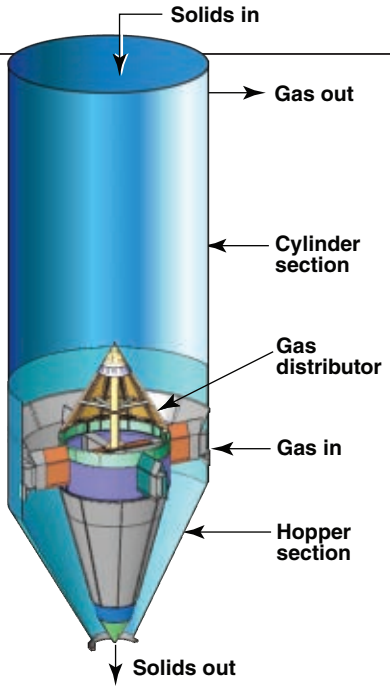


FIGURE 1. In a gravity dryer, gas (usually air or nitrogen) is injected via a distributor typically located near the cylinder-hopper junction. The gas passes upward, stripping volatile components from the solids, which flow downward

Evaporation of moisture or volatile organic compounds (VOCs) from bulk solids usually takes place in two stages: one in which the drying rate is constant, and the second in which the rate decreases over time. Devolatilization during the first stage is rapid and can be readily accomplished in flash, spray, or fluidized bed dryers. In the second stage, however, the VOC or moisture removal rate is diffusion limited, and several hours of residence time are often necessary. To meet low moisture or VOC targets, two unit operations may be required.

An economical way to provide the extended residence time required for slow, diffusion-limited drying is to use a bin or silo that has been modified to allow injection of a sweeping gas and, in some cases, to provide heating. These unit operations have a variety of names, including gravity dryers, purge or conditioning columns, moving bed columns, and silo or bin dryers. Relative to other methods — such as heated screws, paddles or disks, fluidized bed processors and tray dryers — modified bins or silos offer the following advantages:

1. The capital cost of a gravity dryer is generally much lower than that of a fluid-bed processing unit or of heated screws.
2. Gravity dryers have no mechanical agitators or other moving parts, eliminating the maintenance costs associated with such devices.
3. Gravity dryers provide a longer residence time than most other technologies do.
4. Gravity dryers also provide storage or surge capacity, which is desirable when interruptions in production take place.

A schematic of a gravity dryer is shown in Figure 1. Gas, usually air or nitrogen, is injected via a distributor typically located near the cylinder-hopper junction. When polyolefins are processed, steam is also introduced to neutralize the catalyst. The gas passes upward, stripping volatile components from the solids, which flow downward. A rotary valve or other feeding device at the hopper outlet modulates the solids discharge rate.

The keys to successful design and operation of a gravity dryer include the following:

- ***Uniform solids flow.*** A non-uniform solids-velocity profile will impact the quality of the final product since exposure time of the solids to the gas will be variable. In the worst case, there may be no motion along the walls, and the solids will only flow in a channel above the vessel's outlet. The residence time of the solids will be dramatically less than intended and may not allow the desired degree of volatiles removal
- ***Uniform gas flow.*** The distribution system used to inject the gas must result in a constant gas velocity throughout the cross-section of the dryer. Channeling of the gas will not only cause the gas to bypass an appreciable portion of the solids, but it may cause flow instabilities
- ***Non-zero solids stress.*** Unless the region where the gas is introduced is properly designed, the local solids stress can approach zero. In other words, the solid particles in the vicinity of the gas distributor may become fluidized due to high gas velocities. As a consequence, instabilities can occur throughout much of the vessel
- ***Sufficient gas injection rate.*** The composition of the gas stream inside the dryer will vary with position inside the vessel. As volatiles are stripped from the solids stream, the concentration of volatile components in the gas stream will increase as it travels upstream in the vessel. If the gas injection rate is too low, the driving force for devolatilization may vanish in the upper portion of the vessel
- ***Adequate residence time.*** The volume of the gravity dryer must be large enough to provide the residence time necessary for the volatiles or moisture targets to be met. A residence time on the order of hours may be required when drying is diffusion limited

Gravity dryers that function as desired are those whose designs are based on the fundamental flow properties of bulk solids and the diffusional and phase-equilibrium properties of the volatile species. Obtaining purposeful data is critical. At a minimum, the following properties should be obtained:

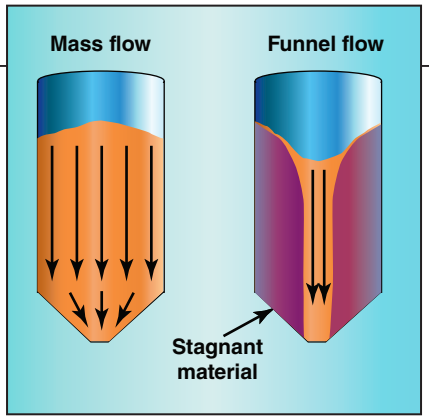


FIGURE 2. In general, there are two types of flow patterns in a vessel: funnel flow and mass flow. The preferred flow pattern in a gravity dryer is mass flow

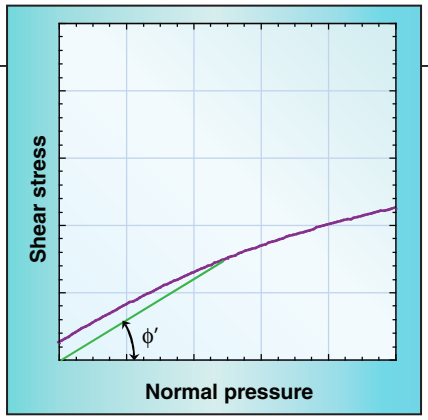


FIGURE 3. The angle of wall friction is the angle that is formed when a line is drawn from the origin to a point on the wall yield locus

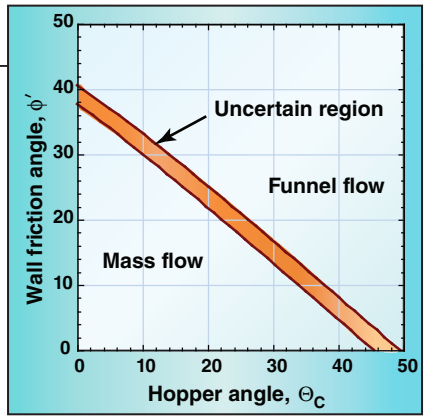


FIGURE 4. Design charts are useful in determining combinations of wall friction angle and hopper angle that provide mass flow

- ***Cohesive strength.*** Used to determine outlet dimensions that prevent a cohesive arch from developing
- ***Wall friction.*** Needed to calculate hopper angles that ensure flow of the bulk material along the vessel walls at an appropriate velocity to maintain overall residence-time-distribution goals
- ***Compressibility.*** Provides the relationship between solids pressure and bulk density
- ***Permeability.*** Used to specify operating conditions that circumvent flooding, to determine outlet dimensions that allow the desired solids discharge rate, and to determine the gas pressure profile in the column
- ***Phase equilibria.*** Used to calculate the minimum gas-injection rate
- ***Kinetic information.*** Used to calculate the required solids residence time.

Modified bins or silos can also be used to remove undesirable components of a gas stream. Here, a zeolite or other suitable bulk material flows downward in the vessel and selectively adsorbs unwanted species from a countercurrent gas stream. Although the focus of this paper is devolatilization, the same concepts can be applied to moving bed adsorbers.

Achieving mass flow

In general, there are two types of flow patterns in a vessel: funnel flow and mass flow. These flow patterns are illustrated in Figure 2. In funnel flow, an active flow channel forms above the outlet, with stagnant material remaining at the periphery. This pattern leads to a non-uniform velocity profile inside the vessel, a dramatic reduction in solids residence time, and gas flowing preferentially in the central channel due to the decreased permeability of the moving solids. Funnel flow occurs when the walls of the hopper section of the vessel are not steep enough or its friction is not low enough for the bulk material to flow along them.

The preferred flow pattern in a gravity dryer is mass flow. In mass flow, the entire bed of solids is in motion when material is discharged from the outlet. This behavior eliminates stagnant regions in the vessel, which provides a more uniform velocity profile. In addition, mass flow minimizes the transition time during grade changes when more than one product is processed in the vessel [*1*]. Hence, in order for a gravity dryer to operate properly, mass flow is vital.

The first step in designing vessels for mass flow is to measure the wall friction between the bulk material and the wall material. Wall friction is measured by a method described in ASTM D-6128 [*2*]. A sample of bulk material is placed inside a retaining ring on a coupon of wall material, and various normal loads are applied. Material in the ring is forced to slide on the stationary coupon, and the resulting shear force is measured as a function of the applied normal force. The wall yield locus is constructed by plotting shear force against normal force.

Design charts originally developed by Jenike [*3*] provide allowable hopper angles for mass flow given values of the wall friction angle (ϕ'). The angle of wall friction is the angle that is formed when a line is drawn from the origin to a point on the wall yield locus. A representative wall yield locus is shown in Figure 3.

An example design chart is shown in Figure 4. Values of the allowable hopper angle (Θ_c, measured from vertical) are on the horizontal axis, and values of the wall friction angle (ϕ') are on the vertical axis. Any combination of ϕ' and Θ_c that falls within the mass flow region of the chart will provide mass flow.

Designing right to the limit of the mass flow region is not recommended for conical hoppers. Figure 4 shows a region of uncertainty where the flow pattern cannot be predicted with confidence. In actuality, this region represents a margin of safety to account for slight differences in material flow properties and wall surfaces. If the combination of wall friction angle and hopper angle lies too close to the funnel-flow line, a switch to funnel flow can occur. Hence, a 4–5-deg. margin of safety is used with respect to the mass flow boundary.

The uniformity of the solids velocity in a vessel depends on how close the hopper angle is to the mass flow boundary. As the hopper angle is steepened, the velocity profile in the hopper section becomes more uniform. In a mass flow hopper, the velocity differences diminish in the cylinder section and the solids velocity becomes nearly uniform unless the solids level is very low.

Outlet size

The outlet of the dryer must be large enough to prevent a flow obstruction from developing. If the cohesive strength of the bulk material that develops as a result of its consolidation in a vessel is greater than the stresses imparted onto it at the outlet, a cohesive arch will develop.

The cohesive strength of a bulk solid is a function of consolidation pressure and is determined by the method described in ASTM D-6128 [*2*], where a direct shear tester is used to measure the shear strength of a material under varying consolidation pressures. A sample of powder is placed in a split

cell and then pre-sheared (consolidated by exerting a normal compacting load and then shearing it until the measured shear stress is steady). Next, the shear step is conducted, in which the vertical load is replaced with a smaller load, and the sample is again sheared until it fails. The pre-shear and shear steps are repeated for a number of normal stresses, and a yield locus is then determined by plotting the failure shear stress against normal stress. From the yield locus, the major consolidation pressure and cohesive strength are determined [*3*]. By conducting the test over a range of consolidations, the relationship between consolidation pressure and the cohesive strength of the bulk material can be determined. The relationship between strength and pressure is called the *flow function*. An example flow function is given in Figure 5.

The greater the material's cohesive strength, the greater will be the tendency for the formation of a stable obstruction, such as an arch or dome at the vessel outlet. A stable cohesive arch is formed when the strength of the bulk solid is greater than the stresses acting upon it. Jenike [*3*] showed that the magnitude of these stresses depends on a material's bulk density, the outlet dimension, and the geometry of the hopper. The stresses acting to overcome a cohesive arch and cause flow are described by a hopper's flow factor (*ff*), which is a function of the internal friction of the bulk solid, the hopper angle, and the wall friction. The flow factor can be obtained from design charts given by Jenike [*3*] or formulas given by Arnold and McLean [*4, 5*]. By comparing the flow factor and flow function and ensuring that the stresses at the outlet are greater than a critical value, the minimum opening size required to prevent a cohesive arch from forming can be calculated.

Since the flow factor is a constant for a given material and bin, a plot of the arch stress against consolidation pressure is a straight line through the origin. Superimposing the material's flow function on the same graph allows the cohesive strength and arch stress to be compared (see Figure 5). There are three possible results of such a comparison:

1. The flow function lies below the flow factor and the two curves do not intersect. When this is the case, the stress imparted on the arch is always greater than the material's cohesive strength, and there is no minimum outlet dimension.
2. The flow function lies above the flow factor and the curves do not intersect. The bulk solid will not flow due to gravity alone.
3. The flow function and flow factor intersect, as shown in Figure 5. At the point where the two lines intersect, the arch stress is equal to the strength of the bulk solid. The value of the stress or strength is equal to the critical stress $\sigma_{critical}$. The minimum outlet diameter to prevent a cohesive arch from developing in a cone, B_{min}, can then be calculated from Equation (1):

$$B_{\min} = \frac{H(\Theta_c)\sigma_{critical}}{\gamma} \qquad (1)$$

Where the function $H(\Theta_c)$ is approximately equal to 2 and is given by Jenike [*3*], and γ is the material's weight bulk density.

While an outlet diameter greater than the minimum will prevent cohesive arching, it may not necessarily be large enough to allow the desired discharge rate when fine powders are processed. The maximum flowrate of a fine powder can in fact be several orders of magnitude lower than that of coarser materials. Two-phase flow effects are significant due to the movement of interstitial gas as the powder compresses or expands during flow. A limiting condition occurs when the compaction in the cylinder section forces too much gas out through the material top surface. When the bulk material dilates in the converging section of the vessel, a slight vacuum forms, resulting in gas counter flow through the outlet. At a critical solids discharge rate, the solids contact pressure drops to zero, and efforts to exceed this limiting discharge rate will result in erratic flow [*6*]. For fine powders, permeability testing is recommended to determine the outlet size required to achieve the desired discharge rate. Calculation of limiting flowrates is described by Johanson [*7*].

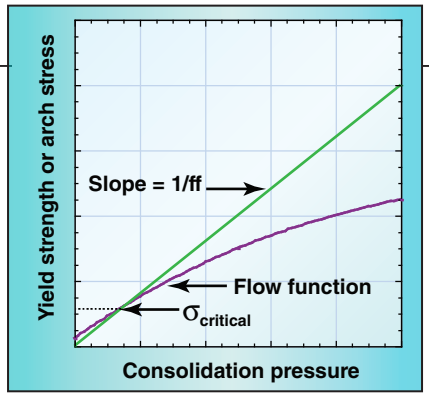


FIGURE 5. The relationship between strength and pressure is known as the flow function

Gas distribution

Uniform distribution of the stripping gas is essential. Otherwise, the bulk solid's exposure time to the gas can be non-uniform, severely impacting uniformity of purging. If the distributor is not properly designed, the gas may bypass a significant portion of the solids. If introduced at a point where the solid's stresses are low, the gas is likely to cause localized fluidization of the solids.

Localized fluidization frequently occurs when gas is introduced at high velocities via nozzles or perforated plates, which can lead to flow instabilities propagating throughout the dryer. If gas is introduced through screens in the converging section of the vessel, only a relatively small amount of gas can be injected in the lower portion of the cone, since at higher injection rates, the minimum fluidization velocity will be readily exceeded due to its small cross-sectional area.

To avoid fluidization, a gas distributor may be accompanied by an inverted conical insert. Gas is introduced underneath the inverted cone, directly into the material through the free surface that forms. Gas may also be introduced through screens around the perimeter of the inverted cone or through the outer hopper section or both. If properly designed, an insert will expand the flow channel and eliminate stagnant regions of bulk solids in the vessel.

An improperly designed gas distributor, however, can cause non-uniformities to occur in gas or solids flow or to result in unstable flow. An insert that is too small or too large, or is placed too high or too low relative to some critical size and position, will expand the flow channel very little, if at all. Even if optimally located, an inverted conical insert is unlikely to convert a funnel flow pattern to mass flow, since simple

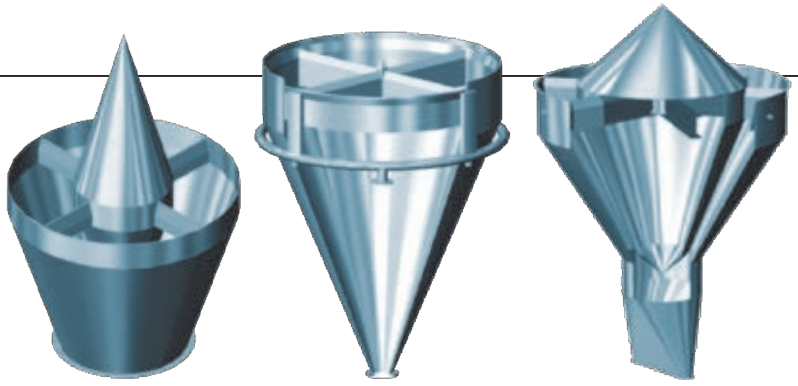


FIGURE 6. Notable improvements in gas uniformity can be achieved by injecting gas via an annulus and a set of crossbeams located at the intersection of the cone and cylinder [9]

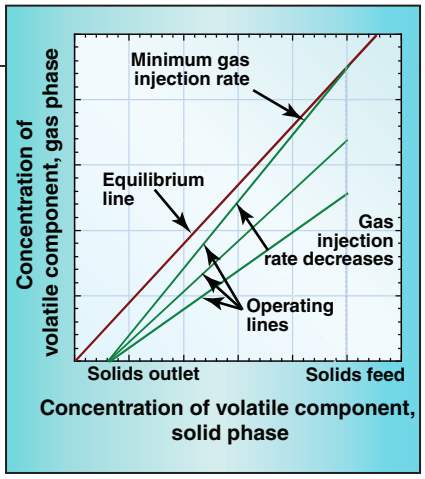


FIGURE 7. The minimum gas-injection rate is such that the concentration of the volatile component in the gas leaving the column is in equilibrium with the solids feedstream. The gas injection rate should be set safely above the minimum, and the column diameter must be sized to ensure stable operation of the dryer

inverted cones have little effect on the flow pattern below their base [*8*].

Notable improvements in gas uniformity can be achieved by injecting gas via an annulus and a set of crossbeams located at the intersection of the cone and cylinder [*9*]. By properly sizing the annulus and crossbeam components of the distributor, high gas injection rates can be achieved with gas velocities low enough to prevent localized fluidization. The crossbeams can also be used to support a conical insert. By properly choosing the dimensions and material of construction of the inner cone, mass flow can be achieved with a hopper angle that is twice as large as would be required if an inner cone were not present. This results in a substantial saving of headroom compared to mass flow designs without inserts. Distributor designs that employ crossbeams are shown in Figure 6.

Minimum gas-injection rate

As the solids travel countercurrent to the stripping gas inside the dryer, the driving force for mass transfer of the volatile species is not constant, since the compositions of both the solids and gas streams vary along the vessel height. For a specified solids feedrate, a minimum required gas injection rate exists. If an injection rate less than the minimum is used, the driving force will vanish in a portion of the column, and the desired level of devolatilization cannot be reached.

To determine the minimum gas requirements, a relationship is needed to describe the phase equilibrium between the solids and gas phases. In the case of polymers, the equilibrium relationship can be determined from Flory-Huggins theory. Flory-Huggins parameters are tabulated for several solvents and polymers [*10*]. In the absence of published data, a bulk material with a known volatiles concentration can be placed in a sealed container, and the vapor phase composition can be determined by gas chromatography or other analytical methods.

The minimum required gas injection rate is determined by plotting the equilibrium line and an operating line on the same graph. The operating line is determined as follows. First, the target volatiles level of the solids and the concentration of volatile species in the inlet gas are located on the graph. Next, a gas injection rate is assumed, and points on the operating line are calculated using a material balance. If the gas and solids streams are lean in volatiles, the solids and gas rates are nearly constant throughout the cylinder, and the slope of the operating line is constant and equal to the ratio of the solids-to-gas, mass flowrates.

Example equilibrium and operating lines are given in Figure 7. The horizontal axis represents the solids volatiles content; the vertical axis denotes the volatiles content of the gas stream. Note that for a constant solids feedrate, the slope of the operating line increases as the gas injection rate is reduced. The minimum gas-injection rate is such that the concentration of the volatile component in the gas leaving the column is in equilibrium with the solids feedstream (see Figure 7). The gas injection rate should be set safely above the minimum, and the column diameter must be sized to ensure stable operation of the dryer.

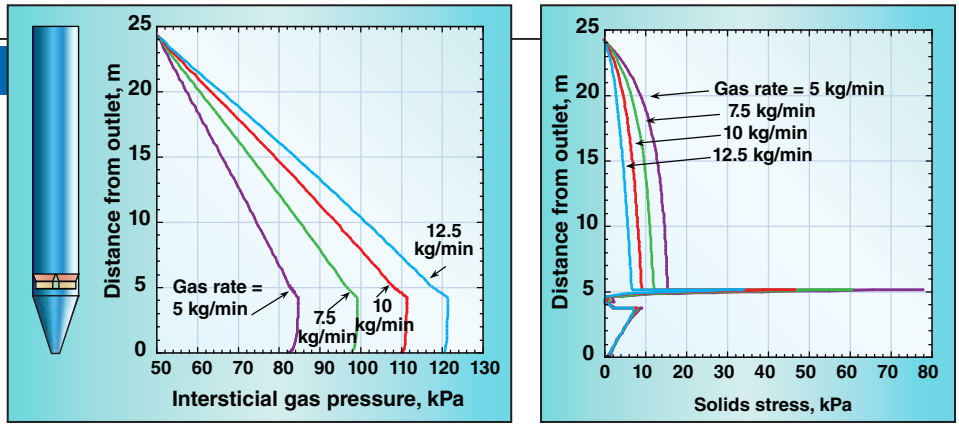
Cylinder diameter

There is a trade-off between gas injection rate and required solids-residence time. Higher gas rates allow a shorter residence time, since at high rates, the volatiles in the gas phase are more dilute, the driving force for mass transfer is greater, and hence drying rates are higher. At high gas flows, however, vessels with greater diameters are required, since otherwise, unacceptably high gas velocities will result, causing fluidization and unstable operation.

The cross sectional area of the column must be large enough to prevent the solids stresses from approaching too close to zero. Solids stress and gas pressure profiles can be determined by an analysis given by Johanson [7]. Expected gas-interstitial pressure and solids stresses in a 3-m dia. dryer having a 20-m tall cylinder are shown in Figure 8 and 9, respectively. (See Table 1 for other parameters used in the calculations.) Note that there is a significant increase in the solids stress at the cylinder-hopper junction, and therefore, a load analysis should be performed during the structural design of the dryer. The interstitial gas pressure increases and solids stress decreases with increasing injection rate. The gas-pressure and solids-stress profiles depend on the bulk solid's permeability and compressibility and the feedrates of the solids and sweeping gas.

As the gas injection rate is increased, the particle-to-particle contact stresses decrease. The reduction in solids stress is most severe where the gas is injected into the vessel. In Figure 10, the minimum solids stress is plotted against gas injection rate. The analysis illustrates the importance of properly sizing the vessel, as the solids stress decreases with increasing gas rate. If solids stress is low enough, the solids may become fluidized, resulting in severe flow instabilities throughout the vessel.

Note that the gas rate in the purg-



FIGURES 8 AND 9. Expected gas interstitial pressure (left) and solids stresses (right) are illustrated for a 3-m-dia. dryer having a 20-m-tall cylinder

ing section of the vessel (the cylinder) does not necessarily equal the gas injection rate. Usually, the outlet of the dryer is equipped with a rotary valve or other feeding device. Depending on the pressure downstream of the feeder and the pressure buildup that results from injecting gas into the column, additional gas may leak through the vessel outlet or a fraction of the injected gas may flow cocurrently with the solids stream out the outlet. This addition or reduction of gas flow in the cylinder must be taken into account when determining gas injection rate and solids residence time requirements.

Required residence time

The required residence time, which directly determines the cylinder height, depends on the relative rates of the bulk solid and gas streams, the phase behavior of the volatile species, and the local rate of mass transfer of the species. To describe the transport of a trace volatile species in a particle, the diffusion equation written in spherical coordinates is used:

$$\frac{\partial x}{\partial t} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(D_{eff}\, r^2 \frac{\partial x}{\partial r}\right) \quad (2)$$

Where x is the concentration (wt.%) volatile species in the solid, r is the radial coordinate, t denotes time, and D_{eff} is the effective diffusivity. The initial and boundary conditions are:

$$t = 0, \quad x = x_0$$

$$r = 0, \quad \frac{\partial x}{\partial r} = 0$$

$$r = R_P, \; x = x_S$$

where R_P is the Sauter mean-particle radius, x_0 is the initial concentration of the volatile component and x_s is the surface concentration. The first boundary condition signifies symmetry of the intraparticle volatile-component concentration profile. The second boundary condition describes equilibrium at the interface of the solid and gas and assumes that the devolatilization process is diffusion limited (that is, there is negligible resistance to mass transfer in the gas phase).

For batch stripping, where the conditions at the particle surface are constant, the diffusion equation has an analytical solution, which can be integrated to give the average concentration of the volatile component, $\bar{x}$, as a function of time [*11*]:

$$\frac{\bar{x} - x_s}{x_0 - x_s} = \frac{6}{\pi^2}\sum_{n=1}^{\infty}\frac{1}{n^2}\exp\left(\frac{-n^2\pi^2 D_{eff}\, t}{R_P^2}\right) \quad (3)$$

In the case of a gravity dryer, however, where the gas passes countercurrently to the solids stream, the surface volatiles content is not constant. The concentration of volatiles in the vapor stream, and hence the equilibrium concentration at the particle surface, varies with axial position in the column. Hence, Equation (3) cannot be applied to moving beds unless the volatiles content of the gas stream is negligible, such as when large amounts of purge gas are used. In most cases, having a low volatiles level in the gas stream exiting the dryer is undesirable, since recovering volatiles from a lean gas stream can be difficult. The diffusion equation must therefore be solved numerically, using an overall mass balance to track the volatiles level in the gas stream.

One should note that not all particles are spherical or can be approximated as spheres. Powders have many shapes, and engineering judgment must be used to assess the results of analyses that assume a spherical symmetry.

To determine the required residence time, the diffusion and mass-balance equations are solved iteratively. The gas injection rate is specified, one that is safely greater than the minimum, and a dryer diameter that ensures that the superficial gas velocity is low enough to prevent fluidization is determined. Next, an estimate of the required bed height is made, and the diffusion and mass-balance equations are solved to determine the volatiles content of the solids leaving the dryer. Adjustments in the bed height are then made until solving the system of equations gives the target solids-volatiles content at the outlet. Usually, additional height is specified to allow surge capability.

In the analysis, the Sauter mean radius is used. Sauter mean radius is defined as the radius of a sphere that has the same volume-to-surface-area ratio as a particle of interest. Because the average volatiles concentration of a solid particle is based on its volume while devolatilization takes place at its surface, the Sauter mean is appropriate for tackling transport phenomena problems.

The temperature of the solids is usually set by upstream process conditions, such as the temperature of the bulk solids leaving the flash dryer, fluidized dryer or other process unit. The gas may be preheated, but considering its small thermal mass compared to that of the bulk solids stream, the gas and solids temperatures are usually approximately equal in most of the cylinder [*12*]. If temperatures are expected to vary greatly inside the dryer, the solids- and gas-phase temperature profiles can be estimated using a procedure described by Munjal and Kao [*13*].

When specifying the height of the cylinder section, the designer should account for the length required for the injected gas to become uniform. The height at which the gas velocity is considered uniform is typically on the order of either one vessel diameter, if gas is injected through or near the cylinder walls, or one half the diameter, if the gas injected near the centerline

TABLE 1. SIMULATION INPUTS	
Column Diameter, m	3
Height of solids above gas distributor, m	20
Height of solids above cylinder-cone junction, m	20
Hopper angle from vertical, deg.	20
Outlet dia., m	3.0
Angle of wall friction, deg.	15
Bulk density, kg/m^3	450–525
Permeability, m/s	0.05–0.17
Design pressure (gauge), kPa	50
Design temperature, °C	80
Solids feed rate, metric ton/h	25
Gas (air) rate, kg/min	10
Effective diffusivity, m^2/s	1.9E–11
Particle Sauter mean dia., mm	1.0
Volatile component-vapor pressure, kPa	316
Flory-Huggins interaction coefficient	1.5
Initial solids volatiles content, mass fraction	0.001

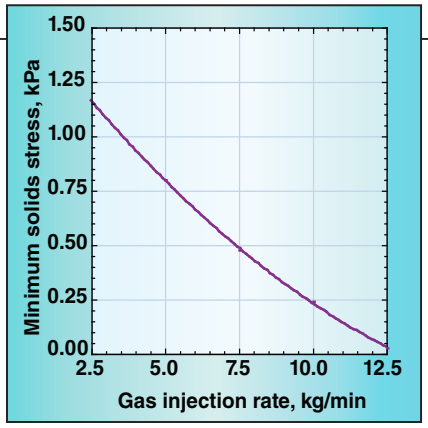


FIGURE 10. Solids stress decreases with increasing gas rate and can become too low, causing solids to become fluidized and resulting in severe flow instabilities throughout the vessel

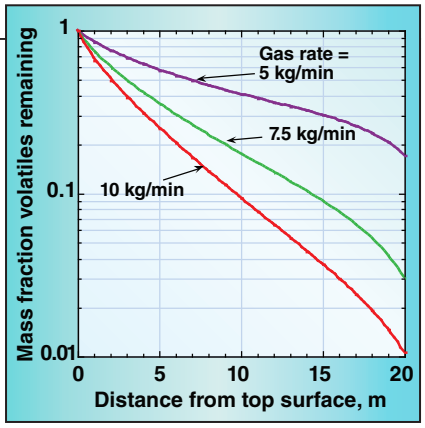


FIGURE 11. In this case, if 25 m.t./h of solids are fed to a gravity dryer having a 3-m-dia., 20-m-tall cylinder, a 10 kg/min gas injection rate is necessary to achieve a 99% reduction in volatile components

and near the cylinder walls. If crossbeams are used, most of the cylinder section is available for solids purging.

Finding an appropriate value for the effective diffusivity may be challenging. Using published values of diffusion coefficients and adjusting them by accounting for porosity and tortuosity will not necessarily give results that predict reality. Although the analytical solution to the diffusion equation in most cases cannot be used to calculate the required residence time in a continuous purge vessel, it can be used to determine the effective diffusivity from batch stripping data. Gas is passed through a fluidized bed or a thin, fixed layer of bulk material, and the volatiles concentration of the solids is measured over time. A least-squares fit of the data to the analytical solution to the diffusion equation provides the diffusion coefficient used in the design of continuous dryers [*14*].

Figure 11 shows the effect of gas injection rate on the performance of a gravity dryer. (See Table 1 for design parameters.) In this case, if 25 metric tons per hour (m.t./h) solids are fed into a gravity dryer having a 3-m-dia., 20-m-tall cylinder, a 10 kg/min gas injection rate is necessary to achieve a 99% reduction in volatile component level. If a greater degree of devolatilization is desired, a dryer with a larger diameter may be required to keep gas velocities low enough to prevent fluidization and to provide additional residence time. The height of the cylinder may also need to be increased to provide the required residence time.

Summary

Silos or bins used to handle bulk solids can also be used for devolatilization provided that they are properly designed. The vessel must allow uniform flow of the solids and gas, and the vessel dimensions must ensure flow instabilities do not occur due to high gas velocities. Gas must be injected at a rate high enough to provide a driving force for purging throughout the vessel, and the volume of the vessel must be large enough to afford the necessary residence time. Obtaining fundamental, bulk-solid flow properties — including cohesive strength, wall friction, compressibility, and permeability, along with phase equilibrium and kinetic data — is necessary to ensure that the gravity dryer will operate as desired. ■

Edited by Rebekkah Marshall

Author

Greg J. Mehos is a project engineer at Jenike & Johanson, Inc. (400 Business Park Drive, Tyngsboro, MA 01879; Phone: (978-649-3300; Email: gmehos@jenike.com), an engineering consulting firm specializing in the storage, flow, and processing of powder and bulk solids. He has been involved in a wide range of bulk solids handling projects including flow property testing, hopper and feeder design, and the design and analysis of purge and conditioning columns. Mehos is a member of AIChE and currently serves on the executive committee of AIChE's Particle Technology Forum. He received B.S. and Ph.D. degrees in chemical engineering from the University of Colorado and a masters degree from the University of Delaware. He is a registered professional engineer.

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Feature Report

Fire & Gas in Safety Systems

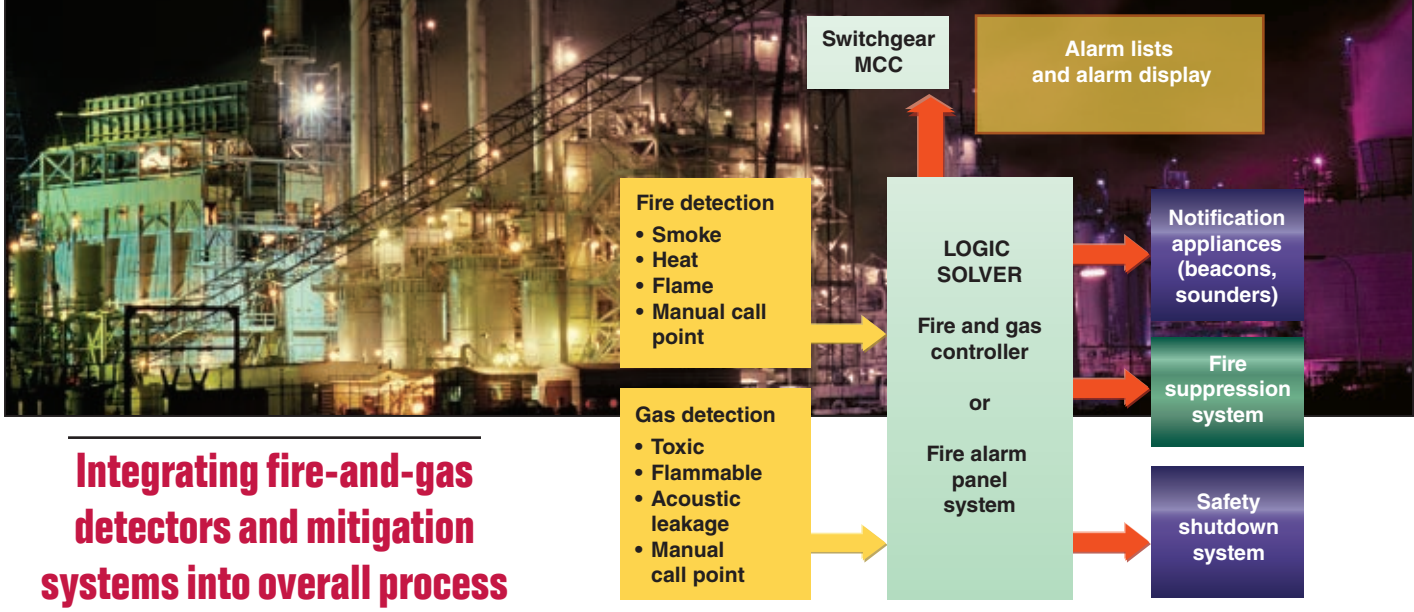

FIGURE 1. A typical F&G safety system comprises detection, logic control, and alarm and mitigation functions. The logic solver is the central control unit of the overall F&G detection and control system. The controller receives alarm and status or analog signals from field monitoring devices required for fire and gas detection. The controller handles the required actions to initiate alarms and mitigate the hazard

Integrating fire-and-gas detectors and mitigation systems into overall process safety control can help ensure fast responses to emergencies

Scott Hillman
Honeywell

By continuously monitoring for abnormal situations, such as a fire, and combustible or toxic gas releases, fire and gas (F&G) detection and mitigation systems are the linchpins to maintaining overall safety and operation of industrial facilities. The premise of these systems is to protect processes and the environment by providing early warning of incidents and enabling actions that prevent them from escalating. Also, implementing an integrated F&G strategy based on the latest automation technology, the chemical process industries (CPI) not only meet protection requirements, but also have potential to enhance business success.

F&G safety awareness

In December 2005, an explosion at the Buncefield fuel terminal in Hertfordshire, U.K. ignited millions of gallons of fuel. Water and land quality were adversely affected across southern England, resulting in a clean-up effort that cost hundreds of millions of pounds. Such incidents illustrate the potential threats to the world's oil-and-gas supply chain and other vital process industry resources. They also serve as a critical reminder that, due to the very nature of the business and the products associated with it, the CPI is inherently fraught with risks.

These risks range from raw material and intermediate toxicity and reactivity, to energy release from chemical reactions, high temperatures and high pressures. With all too frequent news reports of catastrophic incidents occurring at manufacturing facilities across the globe, safety has never been a more scrutinized issue than it is today. Compounding the already high visibility of this issue is the state of the global economy; manufacturers simply cannot afford the monetary losses commonly associated with plant safety incidents.

Amid this backdrop, integrated process control and safety systems have emerged over the last few years as effective solutions for providing safer working conditions in plants. In providing operators better visibility across process and safety, CPI companies are realizing that integrated systems can reduce costs by minimizing equipment damage and incidents that impact people and the environment. At the same time, the reflection on corporate image is positive.

Elements and integration

International standards organize safety implementation under a series of six protection layers:

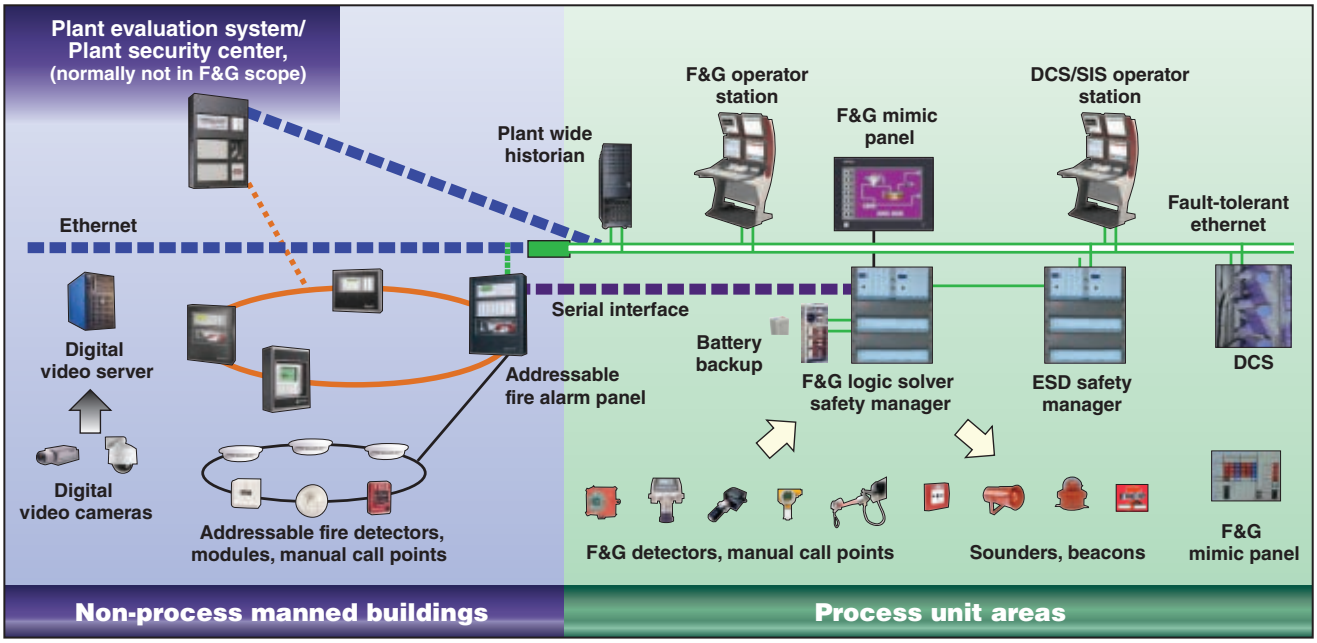

FIGURE 2. A good F&G system combines state-of-the-art fire and gas detectors, conventional and analog addressable fire panels, clean-agent and inert-gas fire suppression systems, and an SIL 3 certified fire-and-gas logic solver into a consistently designed and executed solution. An integrated system provides common tools, operating interface and networking, resulting in a common platform with independent systems

- Inherently safe plant design
- Process control systems that are safe and secure
- Automatic safety, security and mitigation systems
- Work procedures
- Alarm systems
- Mechanical protection systems

Acting as the prevention safety layer, the safety shutdown system takes automatic and independent action to prevent a hazardous incident from occurring and to protect personnel and plant equipment against serious harm. Still, in reality, incidents unfortunately escalate far beyond this layer.

This problem is the main reason that F&G systems should remain at the core of any integrated solution. Used for automating emergency actions with high-integrity safety and control solutions, F&G systems act as the mitigation safety layer that takes action to lessen the consequences of hazardous events. They are also critical to resuming full production when recovering from these incidents.

A good F&G system combines state-of-the-art detectors, conventional and analog addressable fire panels, clean-agent and inert-gas fire suppression systems, and a safety integrity level (SIL) certified logic solver (Figure 2). The logic solver acts as the central control unit (Figure 1), which receives alarm and status or analog signals from field monitoring devices such as detectors or manual pull stations, initiates alarms and mitigates the hazard. Correct and proven connection of detectors to plant safety systems is an important factor in reliable performance of the F&G system and for establishing the desired SIL.

In the past, a proprietary F&G system was standalone or a hardwired mimic overview panel that was linked to a control system. With these older systems, fire-control measures had to be manually activated, which was far from an ideal practice. Today, however, F&G detection systems are generally programmable electronic systems (PES) with high safety availability and mitigation effectiveness. As modern F&G systems are tightly integrated with the overall process safety strategy, mitigation is either enacted through an emergency shutdown (ESD) system or directly by the F&G system itself. Using these new techniques and adding intelligence to instruments to reduce the number of spurious alarms has greatly improved detection rates.

Thanks to these advances in F&G detectors, the systems can detect early warnings of explosive and health hazards, including combustible and toxic gas releases, thermal radiation from fires and minute traces of smoke in sensitive equipment enclosures. They also provide audible and visual alarm indications to ensure that operators and personnel are informed of hazardous situations. With these improved detection capabilities, F&G systems automatically initiate executive actions, such as deluge systems and evacuation procedures. This minimizes the escalation of safety incidents and protects personnel, property and the environment.

Further value can be realized an F&G solution is plugged into an integrated system that provides common tools, operating interface and networking, resulting in independent systems that are tied together on a common platform. A recommended approach is integration at the controller level, which provides: plant-wide safety instrumented system (SIS) point data; diagnostics and system information; alarms and events, operator displays; and sequence of event information to any station. This minimizes manual intervention and drastic plant shutdowns, reduces hardware costs, and allows plants to recover more quickly

and easily from process upsets and abnormal situations.

Modern safety systems, when seamlessly integrated with the plant automation system through a secure communication network, will transfer alarm signals, fault and trip signals and system diagnostics. Information from all related systems can be managed from the same location, enabling that additional layer to monitor the status and operability of the total F&G detection and control system.

Overall SIS technology integrates safety measures dispersed throughout a plant to reduce risk to employees and assets, increase process availability, and improve regulatory compliance. SIS solutions can be integrated with F&G detectors for increased protection, and unified with third-party systems to reduce validation and acceptance testing costs.

Combined with the new generation of F&G solutions, an integrated system provides alerts of abnormal situations in a fast, accurate and structured way, giving personnel time to decide upon the correct course of action. These solutions, which include new integration capabilities with process-simulation tools, F&G detectors and control communication protocols, enable safety engineers to design large integrated and distributed plant-wide safety strategies. With innovative simulation solutions, safety engineers can easily test the impact of safety strategies on the overall plant design and operations before implementation. This reduces overall risk and the impact of system modifications and ultimately increases profitability by bringing new plants into full production much faster.

In addition, new field-device configuration tools allow plant personnel to automatically configure intelligent safety devices and integrate them into the control system database. Facilities subsequently save money by using a single tool to manage all equipment assets.

Toward integrated systems

As more plant owners move toward highly integrated plant-production systems, appropriate integration with multiple interdependent yet interrelated layers of protection (Figure 3) plays an important role in improving safety and efficiency.

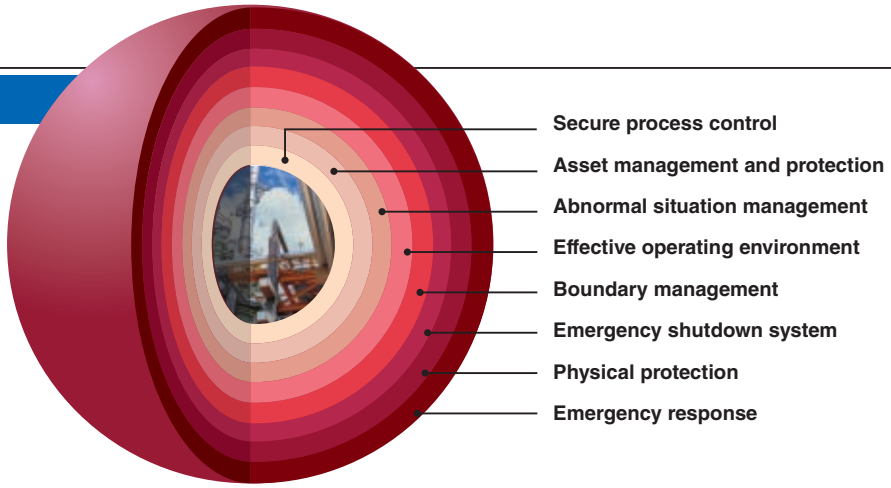

FIGURE 3. Industrial operations benefit from a holistic approach to safety that supports a secure process control network to the perimeter of the plant to protect people, assets and profitability. A layered safety strategy encompasses process and system technology — and the people who interact with that technology — to help plants achieve their safety objectives

The F&G system should have communications integration with the plant distributed control system (DCS) in order to have F&G graphics and alarms displayed to the operator. However, there also should be independent displays, such as independent human-machine interfaces (HMIs), for plant operators to respond to F&G excursions when the DCS HMIs are not available. The plant F&G system, with a fire system for occupied buildings, should also be integrated with the plant evacuation and site security center for efficient plant-evacuation procedures. This enables plant managers to keep better tabs on personnel and efficiently coordinate with first responders during emergencies.

As part of an overall plant-safety strategy, end users need a unified platform for emergency shutdown and F&G detection. A single window for operators and a common tool for engineering and maintenance drives down operational risk and costs.

Integrated control and safety systems (ICSS) provide multiple benefits to process plants. They help operators minimize intervention and shutdowns, and recover more easily from process upsets. They also allow facilities to reduce hardware and installation costs, and ensure easier system configuration with preconfigured function block selections.

Plants implementing an ICSS platform for F&G, ESD and DCS systems can significantly lower their operation and maintenance costs, and in many cases, reduce overall wall-to-wall project costs by 25%. Seamless integration with the ESD and DCS through a common network protocol provides a safe landing in case of emergencies and eliminates the need for additional equipment or engineering. Integration of fire detection and security systems for offsites and utilities with the plant automation infrastructure further improves operator efficiency, through single-window access for alarm visualization, diagnostics, and events and historians.

These truly integrated safety systems deliver several benefits, including the following.

- Integrated operational interface
- Integrated peer control
- Integrated diagnostics
- Integrated postmortem analysis
- Integrated F&G system
- Integrated power supplies
- Integrated modifications
- Integrated simulation and optimization

Operational integration provides a seamless interface to the process under control, and at the same time, maintains safe separation. From an operational perspective, it makes no difference where the application is running. All required information is available to the operator. This allows applications ranging from rotating equipment and compressor-protective systems, to emergency shutdown systems and large plant-wide F&G applications to be monitored from any operator console.

Additionally, industrial operations benefit from a holistic approach to safety that supports everything from a

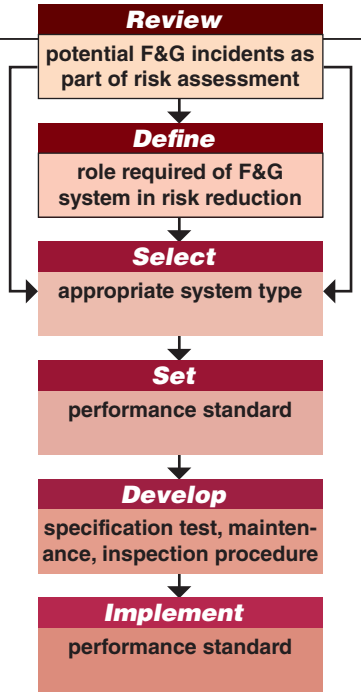

FIGURE 4. An effective project strategy starts with an assessment of future or existing fire and gas performance according to functional safety standards. Based on this assessment, end users have a detailed roadmap for installing new equipment or updating obsolete infrastructure to an optimal level of safety. The main automation contractor can help to identify F&G hazard points and possible risks, and develop basic design packages and related acceptance test criteria to meet safety requirements

INTEGRATED SAFETY IN OIL AND GAS

Like other process industry operations, oil and gas terminals present difficult challenges for automation and safety technology. Tank farms, storage areas, and loading and unloading operations all require F&G and safety systems to protect personnel, assets and the environment. The consequences of incidents at oil and gas terminals, as illustrated at the Buncefield fuel terminal, can be enormous (Figure 5).

In oil and gas terminal applications, operators not only need overfill protection but also an integrated fire and life safety system allowing proactive response to alarms and events and a single realtime view to any potential threat. Industrial plants have procedures and safety systems designed to bring operations to a safe state in the event of equipment malfunctions and other operational problems. In the case of a significant security incident, an integrated system can activate these same procedures and systems. An integrated system also leads to less expensive implementation and maintenance, since all components work together.

An integrated fire-and-life safety solution for terminals typically includes high-high tank alarms and loading system interlocks (compliant with IEC 61511) that prevent overflow through shutdown of pumps. Likewise, it incorporates the latest-technology gas and vapor detectors, integrated with the overfill shutdown system, to detect incidents before they escalate. The system will mitigate safety incidents by ensuring that all personnel are informed of hazardous situations in a clear and unambiguous manner, and providing fast and efficient response to associated risks.

An effective terminal automation safety and security solution will not only include overfill protection, but will also integrate security access control, personnel mustering systems and video monitoring to reduce the possibility of unauthorized access or intrusion. Integration of technologies such as security biometrics and wireless mesh networks enhance the operation and the lower cost of implementation of these systems. ❑

secure process control network (PCN) to the perimeter of the plant. This layered safety strategy encompasses process and system technology — and the people who interact with that technology — to help plants achieve their safety objectives.

A layered safety strategy unifies all plant protection layers (including basic control, prevention and mitigation, as outlined in IEC 61511 standard) required for achieving optimum functional safety. It also provides the required functional safety with a high SIL. This includes superior visualization and logging facilities enabling optimal operator response and accurate evaluations. By integrating basic control, prevention and mitigation components, a CPI company can vastly reduce its overall project costs and ongoing maintenance expenses.

At the core of a layered safety strategy is process design — the embodiment of the business, safety and production considerations necessary for effective operations. At the next layer, the layered approach implements tools and procedures for managing abnormal situations and reducing incidents. When an abnormal situation occurs, alarm management, early event detection, and abnormal situation management (ASM)-designed displays ensure operators have the information available in the context they need it. This enables faster reaction to hazardous situations.

Next, properly designed emergency-shutdown systems and automated procedures can move a plant to a safe state in the event that an incident escalates beyond the inner sphere of protection. Should an incident occur, F&G detection solutions, coupled with rapid location of individuals and a carefully designed emergency response procedure, will help contain the impact.

Finally, a layered approach to safety protects the perimeter of the plant using physical security that safeguards access to structures and monitors traffic approaching the facility.

When designing a truly integrated system, an effective project strategy starts with an assessment of future or existing F&G performance according to functional safety standards (Figure 4). Based on this assessment, end users have a detailed roadmap for installing new equipment or updating obsolete infrastructure to an optimal level of safety. This process begins with a hazard and risk assessment (such as HAZOP) and then continues through the various steps of the safety lifecycle as outlined in safety standards such as IEC 61511. An integrated main automation contractor (I-MAC) can help identify F&G hazard points and possible risks, and then develop basic design packages and related acceptance test criteria to meet safety requirements. This results in optimized risk reduction and operational performance, better compliance with safety standards, and increased lifecycle sustainability.

Supplier assistance can extend to implementing SIS solutions; live hot cutover, implementation and execution of revamps; and installation, commissioning and safety validation. To sustain the end user's F&G system performance, leading automation contractors also provide lifecycle support services that include periodic proof testing; system maintenance; training programs on safety, code and standard compliance; and spare parts management.

Challenges and the road ahead

Industrial standards such as IEC 61511 (ANSI/ISA S84.01 in the U.S.) play a large role in developing, implementing and installing F&G systems. The overall safety lifecycle model described in the IEC standard lists all of the necessary project activities, from the concept (definition) phase to the decommissioning phase, necessary to ensure the functional safety of equipment under control (EUC). These ac-

tivities can be divided over a wide range of categories, such as procedures, documentation, testing and validation, planning, hardware and software development, and risk assessment.

The IEC 61511 standard concerns the determination and development of risk-reduction measures (RRMs) required as the outcome of an EUC risk assessment. The basic principle of risk assessment is that all potential risks to the EUC are identified and analyzed. This includes calculating the probability of each potential EUC hazard and determining the risk reduction measures required to achieve an acceptable SIL. This is defined by the following expression.

Risk = Probability x Consequences

The prescribed reduction measures either decrease the risk probability (for example, ESD systems), or mitigate their consequences (for example, F&G systems). The risk of EUC hazards can be reduced by a combination of several RRMs, where each measure handles one part of the total required risk reduction factor (RRF).

Recently, there have been discussions regarding whether F&G detection systems should contribute to risk reduction, or be considered only as a protection for the installation. The ISA technical report TR84.00.07, providing guidance on the evaluation of fire-and-gas system effectiveness, is currently in draft review.

Additionally, a growing number of regulations have drawn more attention to process safety and the role played by F&G systems. Manufacturing plants must cope with business challenges ranging from increased accident, incident and insurance costs, to compliance with strict standards and codes, such as NFPA, API and OSHA in the U.S., and BS EN and SEVESO II in Europe. Also, issues related to corporate image and environmental stewardship have growing implications in the global market.

To help address these issues, industrial plants need effective solutions for improving a wide range of process-safeguarding practices. This requires a control-system architecture that allows engineers to design and build stand-alone safety applications and distributed plant-wide safety topologies.

FIGURE 5. Like other process industry operations, oil & gas terminals present difficult challenges for automation and safety technology. Tank farms, storage areas, and loading/unloading operations all require fire and gas and safety systems to protect personnel, assets and the environment. The consequences of incidents at oil and gas terminals can be enormous

Plants must find ways to improve F&G system effectiveness through optimization of F&G detector coverage, system safety availability and mitigation effectiveness. At the same time, they must reduce the cost of ownership for safety equipment. Many facilities are also dealing with the cost of upgrading and refurbishing existing, non-integrated F&G systems. Compounding this issue is the fact that plants must meet their safety needs while ensuring operational and business readiness at project startup. Faced with this reality, they seek the lowest risk and highest value protection from their safety system and F&G technology. ■

Edited by Kate Torzewski

Author

Scott Hillman is the global solutions director for Honeywell's New Construction Solutions (2500 West Union Hills Drive, Phoenix, AZ 85027 Phone: 602-313-4138; Fax: 602-313-4040; Email: scott.hillman@honeywell.com). In his 20 years with Honeywell, Hillman has held project engineering, training, consulting and a variety of product manager positions. He also is a Certified Safety Functional Safety Expert (CFSE) and a member of the CFSE Governance Board.

Optimal Cooling Systems For Coastal Plants

When all economic and environmental factors are considered, a cooling tower may be the best option

Mahdi Gougol and **Jamshid Pouresfandiary Cham**
Research Institute of Petroleum Industry

Hassan Dezvareh Resnani
Kaviyan Petrochemical Co.

Because temperature control is important in any process, a water-cooling system is a common component in chemical processing plants. For facilities located near coastal areas, the tendency is toward the use of seawater instead of river water for cooling purposes. Seawater has the advantage of having nearly a constant quality (chemical analysis), nearly a constant temperature and is available in large amounts. This option is not without its challenges, though.

Presented here is an economic-environmental approach for selecting the best cooling system for operation at the sea shore. An actual facility, located in the Persian Gulf, is used as an example.

Cooling system options

Air and water are the least expensive, most available and accessible fluids for removing heat from equipment and processes. When cooling is achieved directly with ambient air (air-cooled systems), the minimum temperature difference between the ambient air and the warm outlet media — the so-called approach temperature — is about 10–15°C.

Air cooling is typically used in processes such as condensation of low-pressure steam, where the temperature of condensation does not necessarily need to be low. But in many, if not most, processes, the air supply is not sufficient for cooling, so a continuous flow of water is used as a cooling medium. Water-cooling systems can be classified as two main types: once through, and recirculating [*1*].

Once-through cooling systems. This type of cooling system is usually available near large, natural sources of cold water. In once-through cooling, there is no equipment or facility for recirculating, cooling and reusing the cooling water. The water is entirely supplied from the sea, and after flowing through the heat exchangers it leaves the system and is discharged back to the sea (Figure 1).

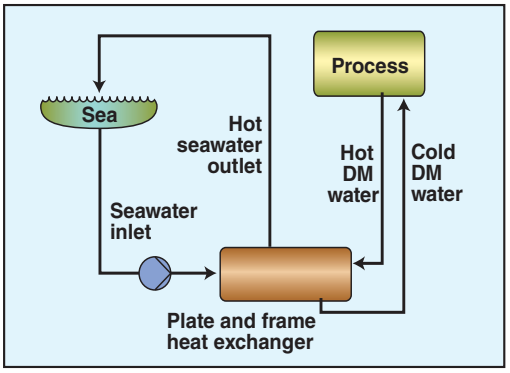

FIGURE 1. In the once-through cooling system, seawater makes a single pass through the system before returning to the sea

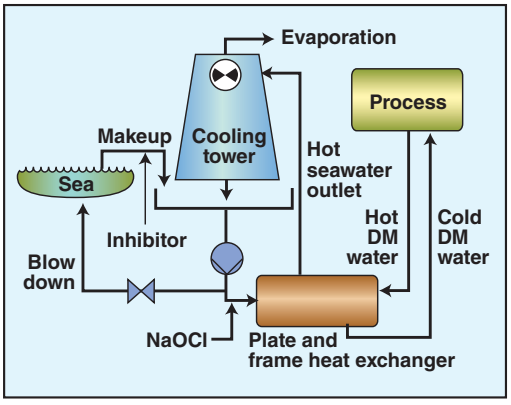

FIGURE 2. In the recirculating cooling-water system, a cooling tower is used to recycle the seawater. Such systems have significantly smaller investment costs than once-through systems, and a smaller environmental impact

When seawater is used, the most important problems in the process heat exchangers are corrosion, scaling, deposition, and microbiological growth. Because the equipment is in direct contact with seawater, these problems are more severe than in systems that use other sources of water (rivers, lakes or groundwater).

To prevent the above-mentioned problems and reduce the damages, an indirect method of heat transfer is applied. That means desalinated or demineralized (DM) water is used to cool hot process fluids. Then, the warm DM water is collected and sent to a number of seawater/DM heat exchangers in which the construction material is resistant to corrosive seawater.

For this reason, plate-and-frame type heat exchangers are typically used. This type has some advantages over shell-and-tube heat exchangers, such as high turbulent streams, high velocity, low approach temperature, low scale deposition, and so on.

Microbiological growth in heat exchangers and associated equipment in contact with seawater is controlled by injection of sodium hypochlorite solution or other chlorine solutions.

Recirculating cooling systems. In this type, water after the heat adsorp-

tion is sent directly to a cooling tower where it is cooled through simultaneous heat and mass transfer to the air (Figure 2).

The hot water is sprayed at the top, then trickles through the cooling fills while the air is drawn or forced through the cooling fill from the bottom. The unsaturated air absorbs humidity and will saturate to the equilibrium state (namely, the wet bulb temperature). The energy required for water evaporation is supplied by the remaining bulk of warm water.

When seawater is the cooling source, the cooling system is called a seawater-cooling tower. Apart from sources of makeup water, there are significant differences between seawater cooling towers and other types of cooling towers.

As with once-through systems, indirect heat transfer is preferred in recirculating systems to prevent the corrosion, scaling, deposition, and microbiological growth problems.

Cooling tower types

Cooling towers are categorized according to the flow directions of air and water — that is, either counter current or cross flow types. Airflow in the tower is supplied through two main mechanisms: mechanical draft and natural draft. Mechanical draft can be either forced or induced.

In the forced-draft type, motor driven fans located at bottom periphery of the tower cause the air to flow through the tower. This type of cooling tower is used for capacities exceeding 30,000 m^3/h. For capacities below 30,000 m^3/h, the induced-draft type is used [*1, 2*]. In this case, the fans are installed at the top of the tower (Figure 3).

Seawater cooling towers

Throughout most of the year, coastal areas have high relative humidity (*RH*), which is defined by Equation (1).

$$RH = \frac{P^{\wedge}_{water}}{P^{sat}_{water}} \quad (1)$$

where

$P^{\wedge}_{water}$ = Partial pressure of water at air in ambient temperature

P^{sat}_{water} = Saturation pressure of water at air in ambient temperature

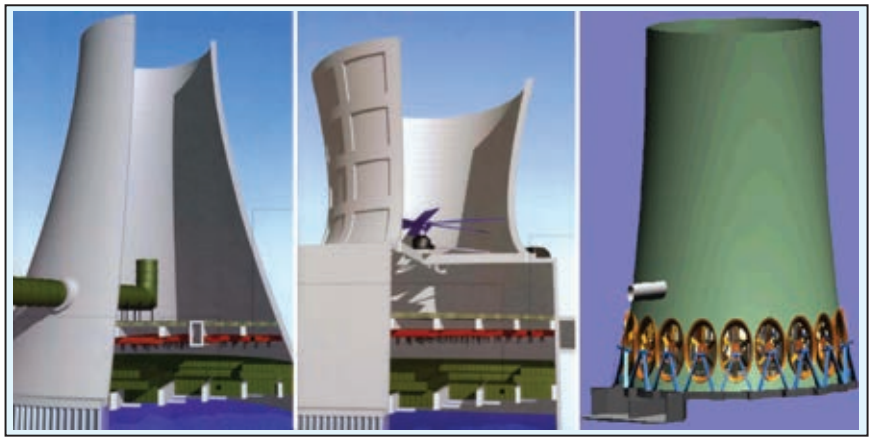

FIGURE 3. Seawater cooling towers can use natural draught (left), induced draught (middle) and forced draught (right)

As mentioned before, the major cooling effect of a cooling tower is due to water evaporation. When designing a cooling-tower system, the question to ask is, will the tower operate properly in the local ambient conditions? The most important parameter in the design and selection of a cooling tower is ambient wet-bulb temperature. In theory, this is the lowest water temperature that can be reached in a cooling tower. However, due to very high investment costs, achieving such temperatures is usually not practical. Instead, the minimum water temperature that is normally reached in a cooling tower is 3 to 5°C higher than the ambient wet-bulb temperature [*1, 2*]. As a consequence, an engineer should decide on the operation of a cooling tower, after analyzing the wet-bulb temperature variation.

Up to dew-point temperature, the water content of air is not changed although the relative humidity varies.

During daytime, the dry-bulb temperature is going to increase. In this condition, if water content of air remains constant, the relative humidity reduces [Equation (1)]. At the same time, the wet-bulb temperature is going to increase, although its rate of variation is less than that of the dry-bulb temperature. This difference can be observed by examining Scenario 1 on the psychrometric chart shown in Figure 4.

Consider a situation where air with a constant absolute humidity of 0.02 kg water per kilogram of dry air, and the four dry bulb temperatures of 35, 40, 45 and 50°C. The verticle lines at these four temperatures have the same length (same absolute humidity), but cross different constant enthalpy lines. To determine the corresponding wet bulb temperature, the constant enthalpy line for each temperature is followed to where it crosses the 100% relative humidity curve, and a verticle line extended downwards. So, for dry bulb temperatures for 35°C and 50°C, the corresponding wet bulb temperatures derived from Figure 4 are 27.4°C and 30.6°C, respectively. This shows that for a 15°C difference in dry bulb temperature, a nearly 3°C difference in wet bulb temperature is observed.

However, the assumption of constant absolute humidity in Scenario 1 is not realistic, because an increase in dry-bulb temperature will cause some seawater to evaporate. In this case, the water content of air does not remain constant. Therefore, the relative humidity as well as wet bulb temperature increases so slightly that it does not have an effect on the operation of the cooling tower. This can be observed in Scenario 2 of Figure 4.

During nighttime, both the dry-bulb and the wet-bulb temperature are going to decrease though relative humidity increases. In this condition the cooling tower operates through the following mechanism.

When the hot water comes in contact with cold/saturated air, the air is getting a little warm due to the transfer of sensible heat from hot water to the air. Thereafter, the air is not saturated and it can take up some water

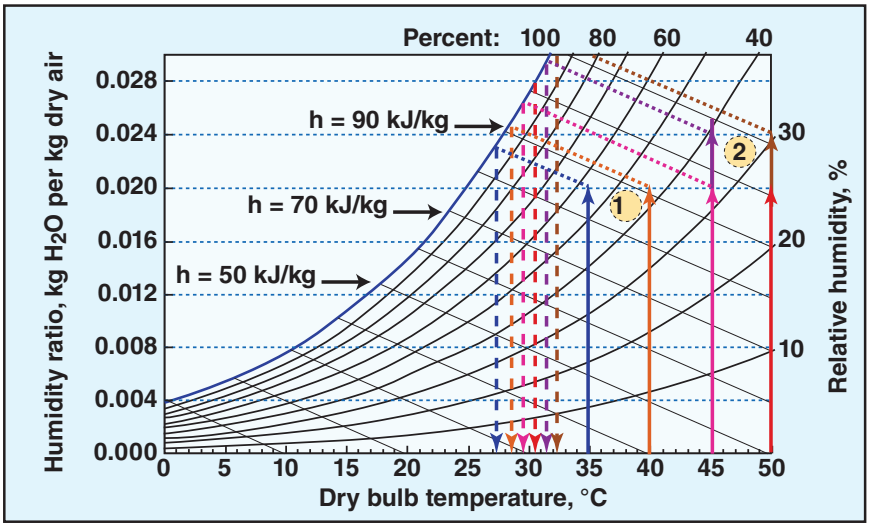

FIGURE 4. A psychrometric chart is a graph of the physical properties of moist air at constant pressure

vapor. As the cold air rises upward through the tower, its temperature increases more and more because of its long contact time with warmer water moving downward.

In contrast, hot water that moves downward becomes colder and colder due to simultaneous heat and mass transfer to the air. As a result, the cooling tower maintains its water-cooling ability, not only during the day but also at night.

Environmental impact

In a cooling system, hot water discharged to the sea has the most important environmental impact. The temperature of discharged seawater should be controlled, and limited to an acceptable value that usually is specified by environmental protection organizations and regulatory bodies.

As an example, let us consider an olefins plant located in Assaluyeh near the Persian Gulf. Two cooling systems are compared: a forced-draft, round cooling tower, and a once-through system. The cooling water flowrate is 100,000 m^3/h with an inlet (outlet) temperature of 35°C (43°C). The wet-bulb temperature of the Assaluyeh region is 31°C and the maximum dry-bulb temperature is 48°C.

Assume that the maximum-admissible, total-dissolve solid (TDS) of the recirculating cooling water is 55,000 ppm to prevent scaling (with this TDS, scaling cannot occur due to the low temperature of the seawater and the high turbulent flow in the plate-and-frame heat exchangers) [2].

According to material balance of the cooling tower,

$$Q_{MU} = Q_{BD} + Q_{EV} \quad (2)$$

And for salts,

$$C_{BD} \times Q_{BD} + C_{EV}(0) \times Q_{EV} = C_{MU} \times Q_{MU}$$

$$CC = \frac{C_{BD}}{C_{MU}} = \frac{Q_{MU}}{Q_{BD}} \quad (3)$$

Where

CC = concentration cycle.
C_{BD} = TDS of recirculating seawater in the cooling tower that is the same as blow down
C_{MU} = TDS of fresh seawater that is used as makeup water
Q_{MU} = flowrate of makeup
QBD = flowrate of blow down

In the Persian Gulf, the TDS of water is 38,000 ppm. From Equation (3) we find that the concentration cycle of seawater cooling tower is 1.45 [3].

We want to know how much makeup water and blow-down water is needed to maintain the concentration cycle at 1.45. Therefore:

$$CC = \frac{Q_{BD} + Q_{EV}}{Q_{BD}}$$

$$CC - 1 = \frac{Q_{EV}}{Q_{BD}} = 1.45 - 1 \rightarrow Q_{EV} = 0.45 \times Q_{BD} \quad (4)$$

$$Q_{BD} = \frac{1}{1.45} \times Q_{MU}$$

If the temperature difference between hot-water inlet (43°C) and cold-water outlet (35°C) of the cooling tower is 8°C, and if it is assumed that all of the heat load is removed by evaporation, the process heat balance is:

$$Q_{EV} \times \lambda_{EV} = Q_{R.R} \times C_P \times \Delta T \quad (5)$$

where

$Q_{R.R}$ = Recirculating rate of cooling water
λ_{EV} = Latent heat of evaporation
ΔT = Range (difference between hot inlet water and cold outlet water from the cooling tower)
C_P = Specific heat capacity of sea-water

Substitution of λ_{EV} and C_P for an average recirculating seawater temperature of 39°C and ΔT = 8°C results in:

$$Q_{EV} = 1.44\% \times Q_{R.R} \quad (6)$$

From Equations (4–6) it is seen that blow-down and makeup water are 3.2% and 4.6% of $Q_{R.R}$, respectively.

Comparing these two flowrates with a once-through cooling system in which $Q_{MU} = Q_{BD} = Q_{R.R}$ reveals that a once-through system, with the same heat load as a forced-draft type cooling tower, has a flowrate of hot water discharged to the sea that is 31 times higher than that of the recirculating system, and the makeup water is 21 times higher.

This means that, for the example above, the flowrate of discharged hot water to the sea is 100,000 m^3/h for a once-through cooling system and 3,200 m^3/h for a cooling tower. Besides the problems caused by local heating due to the larger volume of water discharged, other problems associated with the once through system are the larger amount of chemicals present in the discharged water, such as chlorine, dispersants, anti-corrosion additives and non-oxidizing biocides.

Accordingly, the environmental impact of a once through cooling system is so extensive that it can affect irreversibly the seawater ecology and destroys the seawater eco-system.

Economic comparison

For the economical assessment of the same example, three main parameters are considered, the benefits and

the operating and investment costs. The investment costs include all three phases of engineering, procurement and construction.

All equipment considered under procurement (water pumps and drives, filters, chlorinator, piping, electrical work, instrumentation, spare parts and steel structure), and the corresponding construction phase for the seawater cooling tower are also used in the once-through system. However, the equipment sizes, and amount of time and labor required for construction are mostly different.

If the required temperature of supplied water in the once-through system is lower than the surface water near the coastline, especially in the hot seasons, the user should install a pipeline on the seabed and proceed through the sea to achieve required water temperature.

As the seawater is transferred from the seabed by gravity, the onshore basin shall be constructed in a depth lower than the point of seabed water intake. It is these parts of the once-through system (that is, offshore piping and basin) that dominate the cost of a project. In cases where the intake point to reach water with sufficiently low temperature is far from the coast, the investment cost of a system could drastically increase.

Operating costs include operating materials, labor (to operate the system), maintenance, and electricity. (For this example, one of the chemicals produced in the plant is NaOCl, so it is not included in the calculation for the operating costs.) The maintenance cost associated with a once-through system is higher than that of seawater cooling tower, while the cost for inhibitors is lower for the once-through system. Because fans are used in the forced-draft, round-type cooling tower, electricity demand is almost the same as for a once-through system. When all these different factors are considered, the total operating cost is almost equal for both systems. Also, the total amount of supplied cooling water is the same for both systems.

The results of the cost-comparison calculation is presented in Table 1. One can see that, although commissioning and operating costs are almost the same, the investment cost for a once-through system is 45% more than that of the seawater cooling-tower system, or $42 million more. Therefore, all the economical factors are considered, such as payback period and net present value, the seawater cooling tower is the better option.

TABLE 1. A COMPARISON BETWEEN ECONOMIC PARAMETERS IN THE STUDIED CASE

Seawater cooling tower (million $)	Once through (million $)	
3.9	4	Engineering cost
32.5	53.6	Procurement cost
13	33.8	Construction cost
49.4	91.4	Investment cost
0.61	0.57	Commissioning cost
14.72	14.02	Operating cost per year

Salt emissions

For seawater applications, today's cooling technologies are now able to guarantee a maximum drift of 0.0005% of the total cooling water flowrate — a rate that is the measurement limit of existing test equipment. This salt becomes mixed with the fan air flow released from the selected seawater cooling tower. Therefore, the maximum concentration of salts (in the drift) traveling with the plume is several times lower than the concentration of salts in the air that originates from seawater spray and aerosol [*4*].

Final remarks

From both economical and environmental points of view, a seawater cooling tower has noteworthy advantages compared to a once-through system. The once-through option should only be considered in the case where the yearly average wet-bulb temperature is so high that the required cooled water temperature cannot be provided by a cooling tower.

If the process designer does not consider all aspects in the design of a cooling system, he or she might select the once-through system simply on the basis of high air humidity. This can waste millions of dollars and cause extensive damage to the marine environment. ■

Edited by Gerald Ondrey

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Authors

Mahdi Gougol is a senior process engineer with the Research Institute of Petroleum Industry (P. O. Box 14665-1998, Tehran, Iran. Phone: +98-21-4473-9768; Fax:+98-21-4473-9779; Email: gougolm@ripi.ir), where he is responsible for water optimization and cooling tower modeling projects. His key projects include: water optimization in Kahngiran gas refining co., Razi Petrochemical Co., Tehran Oil Refining Co., Ilam Petrochemical Co., and Bidboland Gas Refining Co. Gougol has a M.S.ChE from the Mazandaran University of Science and Technology, Babol, Iran. He is currently responsible for preparation of cooling tower simulation and optimization software.

Hassan Dezvareh Resnani is utility project manager at Kaviyan Petrochemical Co. (4th floor, Engineering Department, No.54, Karimkhan St., 7'th Tir Square, Tehran, Iran; Phone: +98-21-8884-6125; Email: hdezvareh@bpc.co.ir). He has over 15 years experience in operation and design of utility units. Dezvareh has a B.S.ChE from Sharif University of Technology, and a M.S.ChE from Tehran Polytechnic University, Iran.

Jamshid Pouresfandiary Cham is the CFD specialist at the Research Institute of petroleum industry (same address as Gougol; Phone: +98-21-4473-9554; Email: pouresfandiarij@ripi.ir). His current research interests include CDM and energy management. Pouresfandiary has a Ph.D. degree in mechanical engineering from the Shinshu University, Japan.

EPC CONTRACTORS Selecting an ERP Package

The goal of any Engineer-Procure-Construct (EPC) arrangement is to manage risk, prevent cost overruns, and deliver the project on time. The right enterprise resource planning (ERP) system can help

FIGURE 1. Successful completion of complex projects at petrochemical complexes, oil refineries and other CPI facilities requires close collaboration between engineering, fabrication and construction disciplines. Under an EPC contract, such collaboration must be optimized to avoid waste and errors that can result when the design attributes change after fabrication has already begun. Properly structured ERP systems can help streamline and automate the data- and project-management needs of these complex projects

Magne Halvorsen, IFS AB

In recent years, a growing number of projects throughout the chemical process industries (CPI) have been carried out using Engineer-Procure-Construct (EPC) contracts. Because such contracts typically involve the work of numerous subcontractor parties, they tend to be complex. As such, specialized tools are required to manage their information- and project-management needs.

In general, operating companies throughout the CPI enjoy working with EPC contractors because they can expect a greater degree of predictability on the costs associated with the finished project; this predictability comes from the fact that EPC contracts typically put much of the risk of discipline integration on the contractor's side. Such centralization gives an owner a single point of responsibility — as the saying goes, "one throat to choke" — which can help to avoid the finger-pointing and buck-passing that often results when engineering, fabrication and construction activities are handled by separate entities.

While such a setup often sounds ideal, in real life, EPC contractors routinely face significant challenges when it comes to ensuring that the project will be completed at the agreed-upon price — despite any contingencies that may or may not arise. Uncertainty arises whenever design changes are needed, especially after the project has already commenced, and these changes must be managed not only across the EPC's internal processes, but across the entire network of subcontractors and suppliers, as well.

Imagine the cascading series of events that result when flow line pressure requirements are changed on a project. First, the project engineers must change the design accordingly. Such changes will affect not only the purchasing of pipes, valves, pumps and other items associated with the line, but the work of many subcontractors, as well. For instance, EPC contractors need to ensure that the contractual responsibilities for how these changes are to be handled are honored. In this way, EPC contractors are one part engineer, one part fabricator, one part contractor, one part construction manager and one part insurance broker. The risk that the EPC contractor must assume to ensure firm contract terms must be monetized during contract negotiation.

Lacking an adequate enterprise resource planning (ERP) system to handle the information- and project-management, EPC contractors will have a hard time delivering the project as promised. When this occurs, project owners may be forced into costly and time-consuming litigation, whereby the various contract participants — engineering firms, fabricators and subcontractors — may find themselves in civil court, trying to sort out the ramifications of cost overruns and claims of inadequate project execution.

This article provides guidance for the evaluation and selection of ERP systems, for both EPC contractors and the project owners throughout the CPI who engage them. It also reviews how different the EPC model is from the traditional Design-Bid-Build model, and discusses how existing business technology must change to accommodate EPC work, from the perspective of both the EPC contractor and project owner. The article reviews how both integrated, point source software products and traditional ERP software often fail to deliver all of the capabilities that an EPC contractor needs to turnkey a complex project, and provides recommendations for EPC contractors to consider when evaluating ERP packages.

Centralizing risk management

Perhaps the single most important word that can be used to describe the world of the EPC contractor is "risk." With each contract, the EPC contractor must manage numerous variables, confronting a variety of unknowns, all

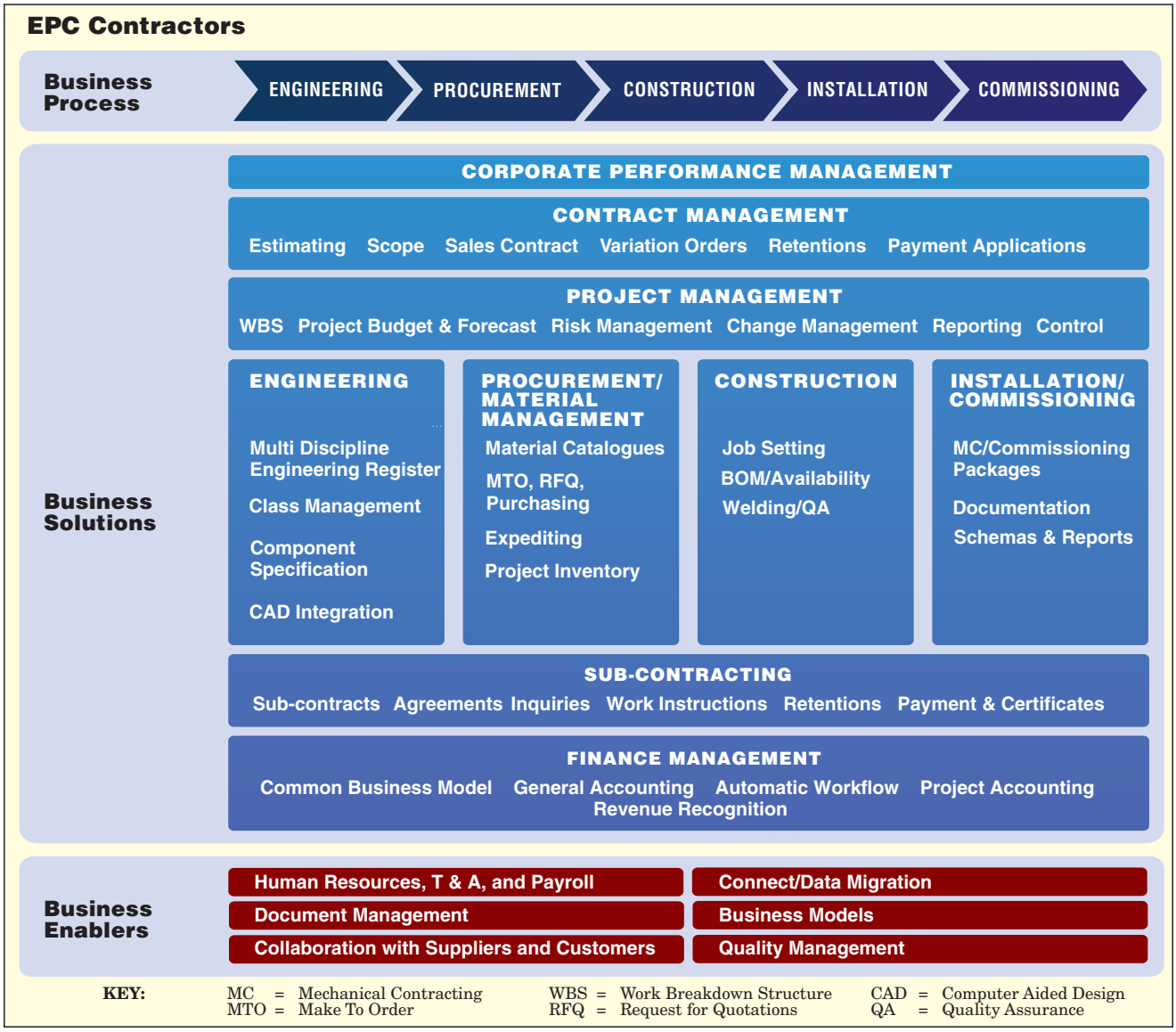

FIGURE 2. The key elements of an ERP solution for EPC contractors are shown here

the while remaining fiscally responsible for delivering a fixed outcome to the customer, in accordance with the predetermined contract price. Managing risk must remain a top priority as the project is being bid, planned and executed, and comes to what is hopefully a successful conclusion.

Unfortunately, on any EPC contract, risk is not a static factor that can simply be determined during the design process. Rather, the risk profile of any project changes as information about design changes filters through the purchasing and fabrication departments and beyond the company's four walls to become disseminated to the EPC contractors and their various subcontractors. To achieve a successful outcome, project managers must ensure successful communication in real time with both different internal departments, and with subcontractors and clients, as well.

This very demanding business environment is a key reason why ERP software should be appealing to EPC contractors. When project and corporate managers are able to bring the entire project lifecycle into a single enterprise-wide information- and project-management application, they are able to gain visibility into the supply chain, streamline communication among all parties, and keep closer tabs on the live costs of all aspects of the project, as it unfolds.

Unfortunately, most commercial ERP packages are too limited or segmented in their functionality to give the EPC contractors the true project lifecycle management capabilities they need. A truly functional enterprise software tool for EPC contractors must not only provide functionality for engineering, procurement, construction, installation and commissioning, but must also allow all information to flow easily back and forth between these different disciplines, so that risk can be managed dynamically as the project progresses.

ERP systems are also useful in this era of mergers and acquisitions, consolidation, and increasing globalization in the CPI. As various fabrication and engineering shops merge to form

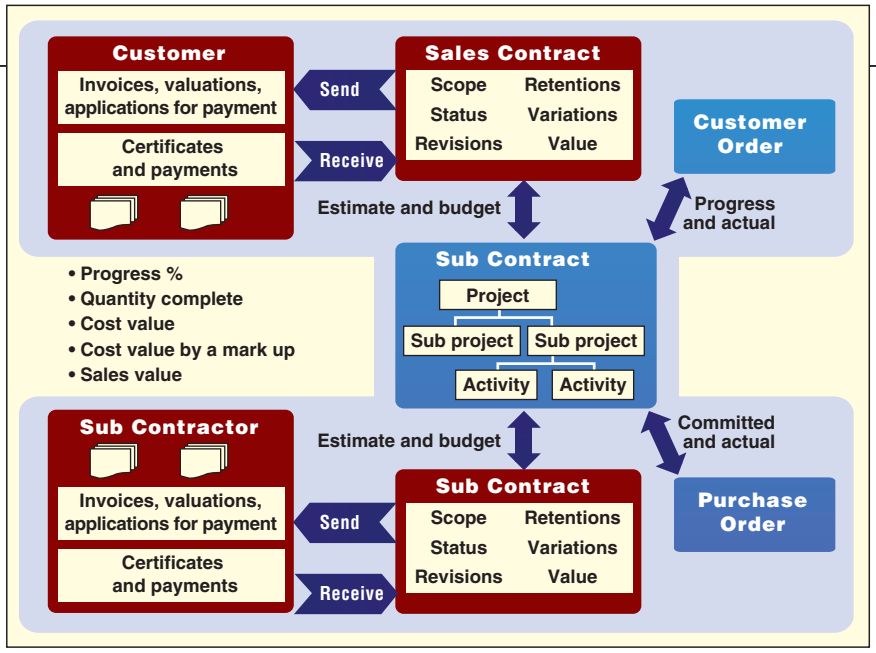

FIGURE 3. The right ERP system can help EPC contractors to manage aspects of the contract itself. Key aspects of these contract-management capabilities are shown here

EPC contracting businesses, and as EPC contractors purchase relevant operations to build localized presence around the world, modern ERP systems can provide the continuity the merged organizations need.

Similarly, as the markets served by today's EPC contractors become less geographically restricted, and companies extend themselves into more foreign markets, the ability for the entire project team to remain connected in real-time via a properly structured enterprise application — one that can operate in a number of languages, units of measure and currencies — also becomes desirable. This globe-spanning capability also helps to overcome language and other communication barriers in the supply chain as local engineering and other disciplines are sourced from around the world.

The need for ERP

As a general rule, EPC contractors often run discrete software tools to carry out a number of point solutions in different parts of their business, each designed to manage specific elements — related to, for instance, planning, engineering, procurement, document management and finance functions — within the overall project continuum. However, such a patchwork approach to project and data management has its drawbacks.

Consider the process of transferring a bill of materials (BOM) from the engineering application into the production/procurement applications. Essentially, you are exporting a parts list from the CAD tool, to support efforts related to purchasing the items on that list. But well after that initial data transfer, engineers are often called upon to revise the design.

When this happens, the risk of an information mismatch arises, because as design revisions are made, corresponding changes might not be made to the part numbers released to the purchasing department. From the standpoint of the procurement and fabrication departments, it might then appear that the original design is still active and money and resources are still being spent executing it. Only later will they realize that the materials they have on hand no longer conform to the project's requirements.

The use of separate point solutions for planning, engineering, procurement, document management and finance are often not well-equipped to provide needed visibility between departments, and they are even less well-suited to provide visibility beyond the four walls of the company into the operations of subcontractors who are retained to execute portions of the project. This presents a problem. For instance, as changes occur to the design, there are implications for the subcontractors, as well. Oftentimes, EPC subcontractor agreements include clauses that specify how changes are to be handled — clauses that can have budgetary implications.

For instance, if a team of project engineers is working from Excel spreadsheets, they likely do not have immediate access to information on how subcontractors are to be paid, and changes made to their documentation often are not communicated effectively into the project or general ledger accounting systems. This means that substantial subcontractor fees can accumulate without showing up in the project accounting system until it is too late to adjust the budget to accommodate the added expenses.

The ability to ensure that subcontractor agreements are followed, to convey up-to-date information to the subcontractor, and to reintroduce cost and activity information from the subcontractor back into your main project accounting system are vital aspects for maintaining control of the project and capturing live costs as they are incurred. A properly structured ERP system provides these capabilities.

Unfortunately, most commercial ERP products and other packaged enterprise software systems are ill-equipped to deal with the complexities that are particular to EPC contracting. Because ERP has its roots in manufacturing, many of these tools are better adapted to environments that have a sharper delineation between the design and manufacturing processes. That is probably why so many EPC contractors are still using a patchwork of point solutions to manage their finances, human resources and purchasing needs, and perhaps using in-house or self-developed solutions for materials management, fabrication, engineering and other core technical and business processes.

For instance, many ERP systems developed during the 1980s and 1990s were based on the concepts of Manufacturing Resources Planning (MRP) and similar systems (called MRP2), which add capacity and product in addition to materials management. Both of these methodologies assume certain standard business and manufacturing structures. But EPC contractors often face a non-standard, project-driven structure — one that has less emphasis on materials management and more emphasis on project management — and EPC contracts change with each project, and change throughout the course of the project, as well.

What to look for

Unfortunately, today's EPC contractors have very few options in packaged software that truly satisfies all of

their requirements, from pre-bid to design to project completion. Thus, identifying a standardized IT platform that will meet all these needs can be a challenge. But when such a solution can be found, it can deliver better results and be a lot less expensive compared to the need for heavy customization of a standard manufacturing ERP package or efforts to integrate a number of discrete point solutions.

Perhaps the single most difficult aspect of the EPC contractor's requirements is the need for tight integration between the CAD solution used in the design phase, and the rest of the project support systems. As noted earlier, any changes made to the design will affect the budget, purchasing and fabrication requirements, and thus must be communicated efficiently to all subcontractors (Figure 2).

Other crucial elements to look for in an EPC software package include the ability to do the following:

- ***Handle collaboration in engineering and procurement with external fabrication contractors***. Project participants need to dynamically share design and other project data in real time; proper integration allows these subcontractors to work more like an integral part of the project team
- ***See beyond a materials list***. Historically, ERP systems transfer a materials list, consisting of simple quantitative data (such as part numbers and quantities), from the engineering department into a purchasing module. However, as noted earlier, while changes that take place in an EPC project might not affect the purchase part numbers at all, they are likely to affect descriptive information about the parts and the relationships between the parts and other documentation. Such changes are common when design and fabrication processes overlap, and must be easily visible to other project team members in procurement and construction functions and to all subcontractors. This highlights the need for tight, transparent integration between engineering and procurement

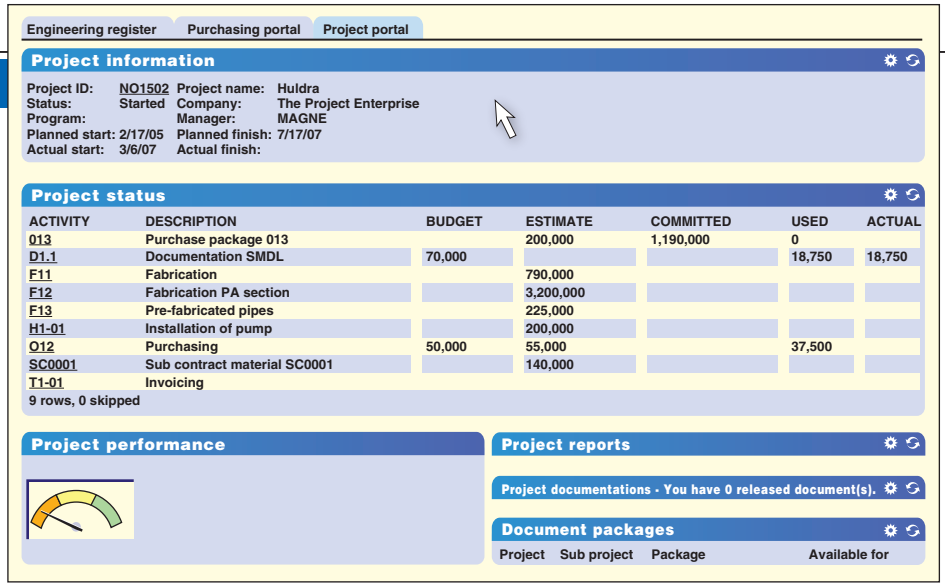

FIGURE 4. Enterprise applications designed for the EPC environment need to include a "project portal" that shows both project budget details and actual costs from the general ledger on an activity-by-activity level. This will provide realtime visibility into costs as the project evolves

- ***Ensure visibility of project financials.*** When it comes to project accounting, reliance on the general ledger is similar to "reading it in the newspaper" — by the time you've seen it, you learn what has happened, but it is certainly too late to do anything about it. In order to change any activities that will impact project financials in the general ledger, you need to see where the project is going — not where it has been. That's why a system that ensures visibility with regard to project cost and progress is so important. After all, if your enterprise software allows you to see deviations from the budget as they occur, you can then look forward and make alterations or manage the project in such a way as to remain within budget parameters and constraints. As software-based tools continue to advance, more and more EPC contractors will be making this move from general ledger to project management and control

EPC contractors should also realize that the ability to implement the right enterprise application can provide an important upside — competitive advantage — by helping them to get the technology side of their business in order. A contractor with better cost controls — for instance, one who can anticipate real costs and avoid hidden ones by correctly allocating expenses to specific contract tasks — can confidently submit a more-competitive bid.

With the right measures in place to both avoid unbudgeted expenditures and identify cost over-runs early-enough to make adjustments, a well-equipped EPC contractor will then avoid the unpleasant fiscal surprises that can crop up toward the project's conclusion. The ability to tender a more competitive bid and to prevent budgetary overruns will translate into a greater number of projects that can be completed profitably.

What to look for

Today, the number of packaged software options that are available to meet the unique needs of the EPC contractor is limited, and vendors may attempt to sell suboptimal products to EPC contractors. Thus, a certain amount of due diligence is required to ensure that any multi-faceted enterprise software tool will do what the vendor says it will do.

There is no substitute for asking a lot of questions of a vendor, and requiring the vendor to show you how *your* business processes would be executed within the software environment itself — rather than trying to demonstrate the system capabilities through a more generalized PowerPoint sales presentation.

Do your best to look beyond the outward appearance of the solution, to see how the application is able to cope with changes and risks. Make a vendor run the solution with actual project data, ask them to change something in engineering or in the project structure and see how the technology deals with the changes and disseminates the information accordingly through

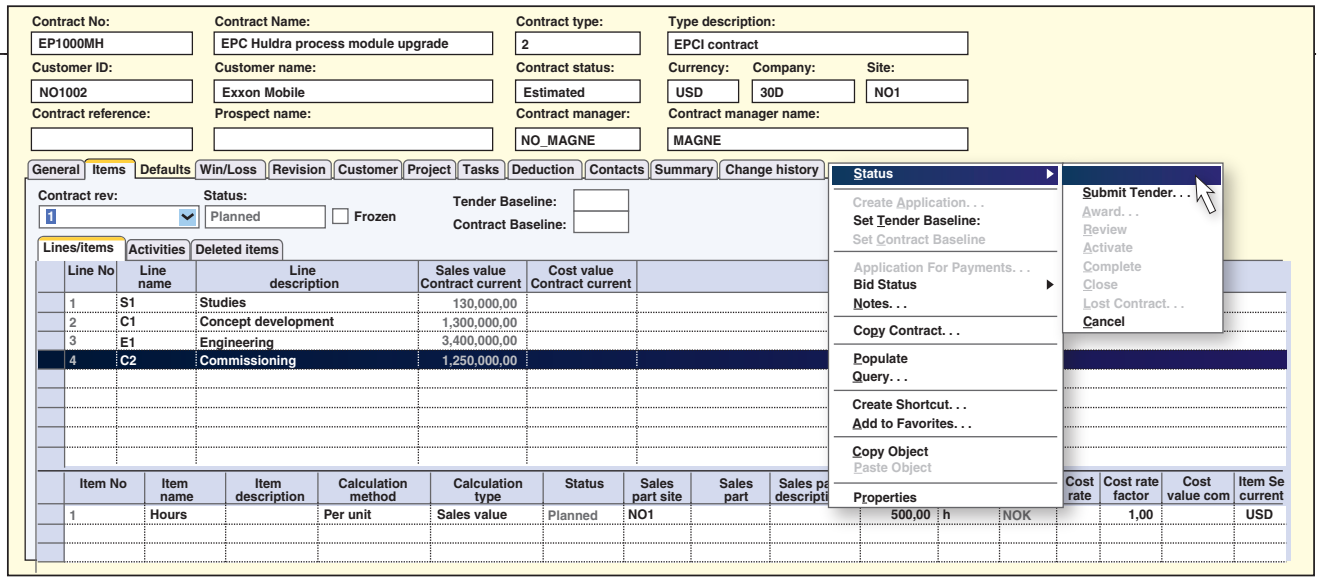

FIGURE 5. The "contract management" functionality of any ERP system must allow an EPC contractor to manage contracts throughout the entire lifecycle of a project, from bid to application for payment, to commissioning

the enterprise-wide application.

Similarly, in the application and product documentation, watch for verbiage that indicates that the product is actually an EPC solution and not a just repackaged manufacturing solution. Terms like *project, contract, subcontract, engineering* and *fabrication* should be present in abundance in the sales and training documentation provided from the vendor. If those phrases are not there, it might be best to consider another vendor.

Similarly, the flexibility of any solution is important, in terms of how it can be reconfigured to meet your changing needs. Such adjustments might take place on an individual project and require on-the-fly changes in the work breakdown structure as represented in the application. As noted above, it is important to consider how the application adjusts to all changes that transpire in the course of a project.

Certain types of project changes have implications for the way the company does business in general. For instance, as regulations and customer requirements change, and as you enter new markets, add new disciplines, identify new competitors, how easy is it to configure the application or add functionality to meet your needs? Some applications can handle change over time more easily than others, while others may require a complete reconfiguration, which could bring a heavy penalty, in terms of financial implications and potential business disruptions.

During the selection of any ERP system, contractors should consider whether the system provides the functionality needed to do the following:

- ***Manage and control complex contracts.*** An application should let you record all invitations to tender, respond to tenders, monitor negotiation processes, and track the conversion from tender to contract. It should also allow you to record work progression, and allow for revisions of contract baselines at the same time as you manage cash-collection activities like application for payment (Figure 3)
- ***Provide project-driven capabilities.*** Make sure that the project plan is the central engine that drives progress, procurement, off-site manufacturing, construction and installation. When all business processes are working within the same planning document, team members can easily drill down into details or view information and progress on aggregated levels. The application should also support two-way integration with leading planning tools such as Primavera, Microsoft Project and Safran. This means that information should not only be exportable to these project-management tools, but that changes made in the third-party program should flow back into the enterprise application
- ***Designate risk-management capabilities.*** An ERP package that is designed explicitly for EPC contractors should be able to create a list of potential problems and constraints that could add risk to a project, and lets users review and correct for any incidents that occur during a project. The information should be structured and presented in such a way as to help an EPC contractor understand all risks — related to, for instance, unpredictable materials supply, weather, exposure to risk by subcontractors — and then mitigate or avoid any impact
- ***Support engineering and design activities.*** An ERP package for EPC contractors must include a comprehensive multidisciplinary engineering register for process-, electrical-,

instrumentation-, and AEC/piping engineering — in short, a central repository for all design data accessible to all project participants in real time. The system should also include integrated document management and support both the design of new projects, as well as the modification of projects that involve assets in operation

- ***Provide support for material, inventory and supplier catalogs, to streamline the material management process.*** All drawings of parts should belong to a specific aspect of the project, and all parts should have a scheduled (required) date. When you calculate the material take-off (MTO), the application should generate a complete overview of the total material requirements and work effort for your EPC project, including the required dates. Planners should be able to monitor the progress of fabrication efforts and track details for all materials issued to different fabrication processes. These progress details should be rolled back to the overall project to ensure total control
- ***Ensure visibility of work done by suppliers.*** Specific aspects of the fabrication operations and the cost of the work that has been outsourced to suppliers should also be visible within the ERP application. This helps project managers to verify whether suppliers are delivering their aspects of the project according to plan — from within the enterprise application — and evaluate the consequences of any specific delays or failures. Ideally, the ERP package should allow for a number of types of arrangements with subcontractors. One approach would be a contract that allows the EPC contractor to control payments by percentage of work completed. This approach can offer greater control over systems and prices (Figure 4)
- ***Ensure dynamic connection between projects and the general ledger.*** An appropriate ERP package will automatically allow financial transactions to be created automatically at the source event within the project, and updated to the company's central financial records, to ensure that cost and revenue are correctly posted on the work breakdown structure and entered into the general ledger (Figure 5)

Closing thoughts

For any EPC contractor, the pressure is on to manage risk and prevent negative outcomes, such as cost overruns or failure to deliver project elements on time and as specified by the project owner. The ability to manage engineering and construction, along with any subcontracted construction, in order to deliver a project within time and budget parameters requires an ongoing process of managing risk as project variables continue to change over the life of the project.

Contractors who take on EPC work must have the tools in place to deliver on the project, not only within the time and budget allowed, but in a way that ensures their profitability. The ability to identify and mitigate risk in complex turnkey projects, and the ability to identify deviations from the timeline and budget early enough to make corrections, are key criteria EPC contractors should look for when evaluating competing ERP options. ■

Edited by Suzanne Shelley

Author

Magne Halvorsen is senior business analyst with IFS AB, the global enterprise software company (200 S. Executive Dr., Suite 100, Brookfield, WI 53005; Phone: 262-317-7419; Email: Magne Halvorsen@ifs.no; www.ifsworld.com). In this capacity, he helps companies involved in engineer, procure, construct (EPC) activities and other complex business models to meet their enterprise software needs. Halvorsen has career experience in the petrochemical and offshore industries, and has held multiple technology advisory positions with IFS' global and Scandinavian operations. Halvorsen holds an M.S. degree in production engineering from Narvik University College, Norway. Prior to joining IFS, he worked as manager of IT Planning for Kongsberg Maritime, a supplier of electronics to the shipping, offshore, oil & gas, subsea, navy, coastal marine and fisheries, maritime training, port and harbor surveillance industries.

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Access Intelligence

Multistage centrifugal pumps are gaining ground

Multistage centrifugal pumps originally developed for downhole applications find favor in the chemical and petrochemical industries, says Wood Group

Long view: these multistage pumps can replace other high-pressure types

Electric submersible pump (ESP) systems are now providing specific solutions to a wide range of surface fluid-movement applications, says **Wood Group Surface Pumps**, a unit of Wood Group ESP. These systems feature a direct-drive, multistage centrifugal design ideally suited for most high-pressure, low to medium volume and environmentally sensitive applications. Building on rugged oilfield ESP technology and first used as produced water injection pumps, the versatile SPS Surface Pumping System is the right choice to replace positive-displacement plunger, split-case and vertical-turbine centrifugal pumps in many applications. SPS systems feature a quiet, low-vibration, environmentally friendly and energy-efficient design that is adaptable to changing flow conditions. They include API 682 mechanical seal and API 610 flush/quench options. Multiple units can be combined in parallel systems for higher capacities and flexible operation. The pumps are available with short delivery times. They can be electric, gas or diesel-powered; and can typically handle up to 2000 gpm (64,000 BFPD) with discharge pressures ranging up to 6,000 psi.

Issue	SPS	PD	SC
Capital cost	Low	Low	High
Whole life cost	Low	High	Moderate
Up time	High %	Low %	High %
Down time	Low %	High %	Low %
Daily/weekly maintenance	No	Yes	No
Downtime per repair	Low	Moderate	High
Cost of repair	Low	Moderate	High
Noise level	Low	High	Low
Vibration	Low	High	Low
Pulsation	Nil	High	Nil
Sealing (number of seals)	Mechanical seal (1)	Packing (3 or 5)	Mechanical seal (2)
Environmental leakage	Virtually nil	High	Virtually nil
Flexibility to changing flow/pressure	High	Moderate	Low

The table above compares the SPS to positive-displacement (PD) reciprocating and centrifugal split-case (SC) pumps.

www.woodgroup-esp.com/prodsurfpump.asp

A customer enthuses over this heat transfer fluid

Petro-Canada's CALFLO HTF heat transfer fluid solved a serious and long-standing problem for a major Swedish plastics products manufacturer

CALFLO HTF (above) means no more black sludge for Sweden's Arla Plast

As one of Europe's leading suppliers of extruded plastic sheets, Arla Plast AB constantly strives to find effective solutions that improve its production and ultimately its product offering. In operation since 1969, the Swedish company produces 12,000 t/y of high-quality transparent polycarbonate sheets. The sheets are used for machine protection, safety glazing and hockey rinks. Many of Arla Plast's customers are in Europe and approximately 80% of the company's products are exported from Sweden.

"The problem we had in our machine is that the oil degraded very quickly and got very black," said Gerry Christensen, Technical Chief responsible for maintaining all the lines and equipment in the factory. "That hurt the pumps, and inside the rollers we had a lot of black sludge from the oil, which led to many problems."

When the oil broke down, it created a chain reaction of consequences. "After six months we had to put new bearings in the pumps," says Christensen. "We had to repair them and it costs a lot of money to stop a line like this. We had one or two days to repair the pumps, then we could run for six months again."

Over the years Arla Plast experimented with various heat transfer fluids to try and find a solution. "We tried at least 10 different products and we had the same problem with all of them," explains Christensen. Then he came across Petro-Canada's CALFLO HTF heat transfer fluid.

"After we changed to Petro-Canada's CALFLO HTF heat transfer fluid, we have been running for three years without problems," says Christensen. "It solved a lot of problems, not just the short oil life. The pumps are working — we haven't repaired any pumps since three years ago."

"Petro-Canada's oil solved all of the problems, so we are very happy," Christensen continues. "We changed all of our lines, so now we are just running CALFLO HTF."

After trying a variety of different products, Arla Plast found Petro-Canada's CALFLO HTF heat transfer fluid to be an effective solution to its problems. By solving the numerous operating issues, short oil life and equipment damage, CALFLO HTF dramatically decreased the costly downtime caused by previous oils. It allows the company to operate efficiently and maintain its edge as one of Europe's leading suppliers of extruded plastic sheets.

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Automation and information at every project stage

From concept to commissioning, Emerson Process Management provides premier engineering, system integration and field services for process control and automation

Smooth performer: Emerson excels in project management and technology

Throughout its history, **Emerson Process Management** has remained focused on providing quality industrial automation and information systems that benefit process manufacturers. This has allowed Emerson to develop into the premier automation engineering, system integration and field services provider in the oil and gas industry. Unlike other automation engineering firms, Emerson has the internal knowledge and skilled resources to offer turnkey project implementation, from concept to commissioning and startup.

Industry-leading technologies like the PlantWeb digital plant architecture reduce project costs substantially. Typical savings have been documented at over 30% on new installations. And the architecture's built-in predictive intelligence can improve plant efficiency by 2% or more.

Emerson's Main Automation Contractor (MAC) approach, with early involvement, can identify and mitigate risk and establish alignment with project expectations. Emerson minimizes change orders throughout the project by ensuring key decisions are made early in the process related to technology requirements, operating objectives, and total life cycle costs.

Emerson project managers are trained, and kept current with the latest best practices in project management, working with the world-renowned Project Management Institute. Using a global resource and skills database, Emerson's project managers can quickly locate and mobilize the talent needed for any project. No matter the size and complexity, Emerson project managers can successfully deliver on schedule, budget, and quality.

Managing large, multi-faceted projects requires a proven methodology to assure success. With experience gained through hundreds of thousands of project service and engineering hours, Emerson's methodology helps customers manage projects efficiently.

Faster time-to-market and early positive cash flow are often key measures of a project's success. To help achieve these outcomes, Emerson has developed a comprehensive library of standards and tools that can reduce implementation time and minimize ongoing maintenance costs. Emerson's proven design basis provides a standard, modular core design that can be customized to any specific needs, without additional project risk.

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A powerful simulation resource for refiners

ProMax is powerful simulation software backed by excellent customer service from developer Bryan Research & Engineering

For over 30 years, **Bryan Research & Engineering Inc.** (BR&E) has been committed to providing the energy industry with process simulation software that accurately and efficiently predicts the performance of gas processing, refining and petrochemical processes. Today, BR&E's ProMax simulator is used by engineers around the world to design and optimize processing facilities. Totally integrated with Microsoft Visio, Excel and Word, ProMax is a comprehensive tool that offers incomparable flexibility.

A few of the commonly used features of ProMax include:

- crude oil characterization;
- gas and liquid sweetening;
- glycol dehydration / hydrate inhibition;
- sulfur recovery;
- LPG recovery and fractionation;
- sour water stripping;
- exchanger rating/sizing;
- exchanger network performance monitoring;
- pipeline systems;
- vessel sizing; and
- parametric studies.

The latest version of ProMax contains a complete reactor suite for modeling kinetic (plug-flow and stirred-tank), equilibrium, conversion, and Gibbs minimization schemes. ProMax is also widely known for its ability to model many aspects of a refinery. For instance, ProMax may be used to:

- model atmospheric and vacuum towers;
- investigate preheat exchange and fouling;
- study refinery changes on sour treating systems;
- model FCC and coker main fractionators;
- define custom reactors;
- define custom reports;
- simulate caustic treaters; and
- predict optimal exchanger performance with active rating during simulation.

A ProMax license also includes much more than just software. BR&E is committed to providing unrivaled customer support. The company offers free training sessions around the world, provides timely customer support from a staff of knowledgeable and experienced engineers, and sets up free initial plant models for operating companies.

ProMax's advanced technology, including over 2,500 pure components and 50 thermodynamic package combinations, along with BR&E's exceptional client services unite to make ProMax the "must have" simulation resource. **www.bre.com**

Lean times demand faster returns

Honeywell's plant optimization technology can cut plant operating costs significantly, increase productivity, and improve product quality

With the current economic situation, it is more important than ever for refineries and petrochemical producers to operate more efficiently.

Honeywell can help manufacturers reduce costs and increase efficiency during these challenging times. The company's website at TheOptimizedPlant.com shows how Honeywell solutions can reduce energy consumption (5–10%), raw material usage (1–2%), quality variability (up to 50%), transition time (up to 30%), and maintenance costs.

Honeywell addresses all aspects of process optimization, from improving regulatory loop control to optimizing entire processes. Under the name Profit Suite, these technologies create a layered approach to optimization that Honeywell says is unique in the industry.

The layered approach is scalable and benefits-driven. It creates solutions that are sustainable in the long term, based on a skill set that is common across projects from basic advanced control, all the way up to multi-unit and multi-plant optimization. Profit Suite technologies are flexible and applicable to a wide range of industrial processes. They are also easier to implement than competing products.

As the foundation of Honeywell's layered optimization approach, Profit Controller provides the base for improving the economic benefits of processes. Project payback periods of less than a year are typical, with sustained benefits lasting indefinitely. Honeywell's applications:

- increase profitability through increased production, lower operating costs and higher product quality;
- improve plant safety;
- increase employee productivity through improved operator effectiveness and lower engineering requirements; and
- achieve high returns on investment.

Other Honeywell solutions featured on TheOptimizedPlant.com include wireless, simulation tools, manufacturing execution systems, emissions monitoring and remote services. **TheOptimizedPlant.com**

Plant optimization can provide lasting benefits, Honeywell says

Using rupture discs to safeguard your valves

Fike rupture discs protect the environment, your equipment and your bottom line

Global air quality standards, public health and environmental concerns are increasingly hot topics not only for the politicians, but also for business success. In the US, the Clean Air Act is now requiring industries to implement a leak detection and repair program (LDAR) to control fugitive emissions. And while pressure relief valves (PRVs) can be a vital part of your process, they are expensive to maintain and a major source of process media emissions. By installing **Fike** rupture discs (bursting discs) upstream of your PRV, you not only protect the valve, but greatly decrease emissions, and gain significant cost savings advantages:

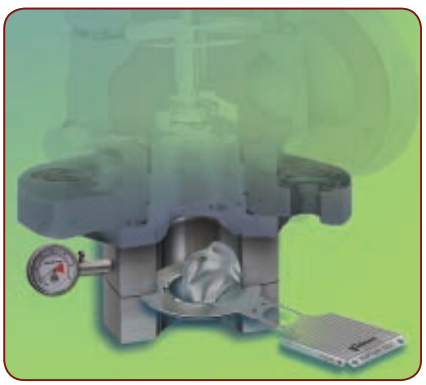
- possible exemption from PRV monitoring requirements;
- zero emissions during normal operation means no collection and disposal costs;
- can significantly reduce possible fugitive emission fines; and
- within the US, zero daily PRV emissions calculations allow you to sell emissions credits for increased profits.

Fike has several rupture discs to choose from when protecting your PRVs, but the Axius offers clear advantages over any other disc on the market. It features a 95% operating ratio (100% of minimum burst pressure according to CEN ISO 4126–2) and a high tolerance to pressure pulsations. The Axius is capable of cycling from full vacuum to 95% operating ratio in excess of 100,000 times—even at the lowest burst pressures available.

Other discs can fatigue and fail much earlier, leaving the PRV exposed to not only the system pressure, but also to—possibly corrosive—process media. In addition, if the valve is forced to operate, when it begins to return to normal or blow down, significant energy must be used to build the pressure back up. With the efficiency and high cyclic ability of the Axius, you can count on the disc operating well beyond the normal range, preserving the valve, reducing emissions, and reducing energy costs.

The Axius, as well as other Fike rupture discs, are invaluable for protecting your expensive pressure relief valves.

www.fike.com

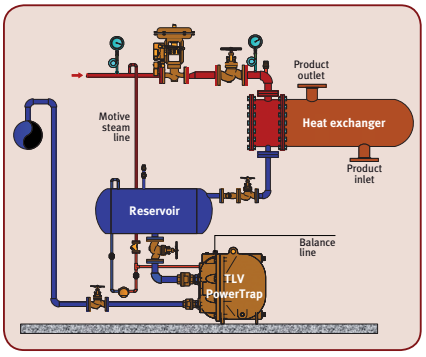


Protecting pressure relief valves: Fike's Axius rupture disc

Stop wasting valuable MP steam for heating duties

Back-pressure often restricts the use of cheap low-pressure steam—a problem solved by the PowerTrap combined steam trap and pump from TLV Corp.

Many refineries and petrochemical plants use costly medium-pressure (MP) steam for low-temperature heating duties, notes **TLV Corp.**, when they could instead be using cheaper and more readily available low-pressure (LP) steam. Alternatively, plants may use LP steam for heating, but waste energy by sending the condensate to drain. TLV's PowerTrap, a combined steam trap and pump, avoids both these problems by returning LP condensate to the boiler house even against significant back-pressure.



Steam power: TLV's PowerTrap works at line pressures up to 200 psig

LP steam is a versatile heat source that is so abundant on many process plants that it is frequently vented to atmosphere, wasting its valuable energy content. MP steam, on the other hand, is scarcer and more expensive to produce, sometimes to the point where MP steam demand is made up by letting down high-pressure steam—a very wasteful operation.

So why is MP steam often used for low-temperature heating duties in reboilers, exchangers, jacketed vessels and preheat coils? A common reason is that if there is significant back-pressure in the condensate return system, the pressure of the LP steam is too low to drive condensate through a steam trap and into the condensate main. Instead, the system stalls: condensate backs up in the equipment and impedes heat transfer.

The typical way around this problem is either to use MP steam for heating, or to use LP steam and dump the condensate to drain. Either way, energy is wasted.

A much better way to use LP steam for heating when back-pressure is high is to install a TLV PowerTrap, a combination of a steam trap and a steam-powered condensate pump.

The PowerTrap optimizes process heating equipment performance by ensuring continuous drainage of condensate from equipment at steam pressures between vacuum and 200 psig.

It reduces energy costs by allowing plentiful LP steam to be used for process heating, avoiding the need to dump condensate or use costly MP steam instead.

The PowerTrap also improves the availability and reliability of process systems. It reduces channel head gasket damage, and eliminates cavitation or seal leakage issues often experienced with electric pumps, says the manufacturer.

www.tlv.com

Pumps are now even more reliable

Griswold 811 Series feature enhanced power frames, resulting in increased performance and longer pump life

Griswold Pump Company, a leading manufacturer of ANSI centrifugal pumps and an operating company within Dover Corporation's Pump Solutions Group (PSG), has given its 811 Series ANSI line of pumps enhanced power frames that not only increase performance and longevity, but also simplify maintenance. The improved strength and rigidity of the 811 Series power frames are an estimated 33% stronger than competing models, making them better-equipped to withstand severe conditions found in many process and transfer applications.

In addition, the large sight glasses and magnetic drain plug provide longer bearing life for the 811 Series. Griswold also uses a fusion bonded epoxy coating on the interior surface of the power frame. This provides a superior barrier between the iron frame and the lubricating oil, and keeps the oil cleaner for longer.

The 811 Series offers a full range of pump sizes, as well as options and upgrades that can be tailored to meet virtually any fluid-processing application with flowrates up to, and including, 908 m^3/h (4,000 gpm). Among the 811's options are low-flow models, heavy-duty power frames, fully open impellers with rear adjustment capability, and a wide variety of mechanical-seal options. 811 Series pumps are available with ductile iron, 316 stainless steel, CD4MCu, and Alloy 20 liquid paths, which make them viable in temperatures as high as 260°C (500°F). All 811 Series pumps undergo extensive hydro testing before delivery.

Knowing that its customers deal in time-sensitive operations, Griswold has developed a manufacturing and inventory system to suit the most critical needs. A ready-to-ship inventory coupled with a worldwide network of stocking distributors means that when a customer orders an 811 ANSI Series pump from Griswold, it is covered by a 36-hour emergency shipping commitment. Griswold also offers value-added services like inventory-optimization programs, technical support for equipment performance, and engineering assistance in pump and component specification.

33% stronger: the Griswold 811 Series now features an uprated power frame

Griswold Pump Company is a full-line pump manufacturer with product lines dating back more than 70 years. Included among its industry-leading pump lines are ANSI, end-suction centrifugal pumps, self-priming pumps and submersible/vertical turbines. **www.griswoldpump.com**

Energy solutions are not just for plant shutdowns

Rental equipment and expertise from Aggreko can boost plant performance during hot weather, as well as covering plant shutdowns and cooling tower maintenance

Aggreko's proven experience and comprehensive expertise has made it the premiere resource for rental energy solutions for the petrochemical and refining industries. Drawing on a team of experts with vast industry-specific knowledge, the company develops custom solutions to meet any challenge.

This innovative approach goes beyond services for turnarounds, shutdowns and general maintenance. Aggreko Process Services (APS)—an experienced process engineering team aimed at addressing process, operational, and environmental constraints—was formed as a response to customers' growing needs for unique solutions to process enhancement.

Aggreko Process Services can design and install a project in a matter of weeks instead of the months required for a typical capital project, enabling customers to capture short-run market opportunities. APS specifically targets process limitations caused by high ambient temperatures and fouled or under-performing equipment.

In hot weather, temporary cooling can keep plants running at full output

Additionally, Aggreko Cooling Tower Services (ACTS) was created to address demands for emergency or supplemental cooling at refineries, factories and other plants. With 24-hour availability and the largest fleet of modular cooling towers in the industry, Aggreko can address emergencies, maximize production, and keep operations running smoothly when the heat is on. Aggreko's experience and capabilities have dramatically reduced the risks inherent in process cooling. ACTS can:

- maximize production during hot summer months or peak demand times;
- maintain production while repairing or maintaining existing cooling tower;
- reduce costly downtimes after disaster strikes; and
- meet or exceed customers' own environmental and safety standards.

Whether providing rapid emergency response to equipment failure for a multinational chemical organization, or vessel cooling services to increase production, Aggreko is committed to delivering the highest performance standards, 24/7/365. Aggreko keeps production and profitability flowing while delivering valuable time and cost savings, thanks to its experience, skill and specialized equipment.

www.aggreko.com/northamerica

Preview the next version of this process simulator

Version 6.2 of CHEMCAD from Chemstations will feature better report generation, easier heat exchanger design, and an updated software licensing system

Chemstations is pleased to announce the upcoming release of its CHEMCAD suite of process simulation software, version 6.2. The highlights of this new version are an improved report generation engine, an overhaul of the CC-THERM heat exchanger design and rating interface, and an updated software licensing system.

Aaron Herrick, the company's Manager of Development (aaronh@chemstations.com), said: "We discovered that our customers were spending quite a bit of time taking our stock reports and customizing them in Microsoft Word and Excel. This new release will make it much simpler and faster to do that individualization from within the CHEMCAD interface, while maintaining the ease of export to Microsoft's tools."

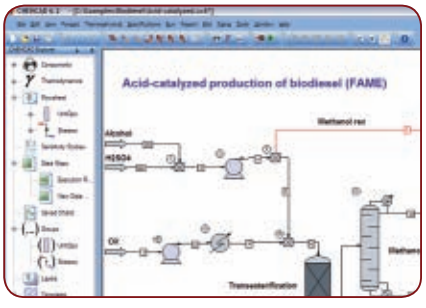
"Our customer discussions turned up some significant opportunities to improve the interface for CC-THERM. We had already made significant technical improvements, but the feedback indicated that we could do more to help users navigate the data input and review. We took a goal-directed approach to the process of generating thermal designs for exchangers, and I think our customers will be very happy with the improvements."

"The ideal licensing system for any software would be totally transparent to the user. The realities of modern computing won't let us get quite that far, but this latest update goes a long way to removing some of the headaches that licensing can cause for our customers."

"We try to be very aware of both the engineering and IT constraints of our customer base, so we publish updates about every six weeks. Those users needing the latest and greatest features can get them quickly. We also package a major, yearly update for those users with stricter IT requirements and/or tighter versioning control for project work."

"Chemstations uses a blend of programming techniques including goal-directed design, agile, and scrum, to ensure that our customers remain in focus throughout the development cycle, and to keep our development cycle times short. These techniques enable us to create upgrade releases throughout the year, even while preparing larger yearly maintenance releases. Our releases are staged such that each version is released as a preview version first, and then as a release version after it undergoes further testing."

www.chemstations.com



On display: improvements in the forthcoming release of CHEMCAD

These tigers specialize in tough tower jobs

Working in 100-degree temperatures, Tiger Tower Services completes a problematic fractionation tower turnaround... just before the big storm

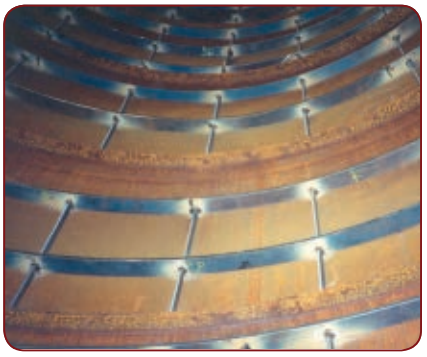
A Louisiana refinery had a major turnaround planned and **Tiger Tower Services** was tapped to perform the fractionation column project. It was a big job in hot weather.

When the Tiger Tower Services team went into the column they found a coking build-up so thick and dense that they needed pneumatic jackhammers to loosen the grid for removal. There were other obstacles along the way but the Tigers' experienced team found solutions to each surprise. They removed all the feed piping and the trough distributor along with the structured packing and bed support. They cleaned the column walls and chimney tray for inspection. Then they re-installed the internals and replaced the packing.

Tiger Tower Services provides all the specialized skills needed for tray and packing installation, tower maintenance and plant turnaround projects

The bottom head had a lot of debris in addition to the heavy coke build-up, and required significant cleaning. Once the original stubborn grid was removed, the new grid was installed, as were the trough distributor and feed piping. The balance of the column required additional work including many tray and nozzle replacements.

The client was so pleased with Tiger Tower Services' performance that they have been invited back to perform other projects. And, not only did the Tigers finish the job successfully and safely just before hurricane Ike struck the coast, but they rushed back to their homes to help their own community's evacuation, relief and clean-up efforts.



The company handles all process column needs involving re-sections or a major internals revamp, such as this one for a large process technology provider

www.tigertowerservices.com

Heat transfer fluids for the oil and gas industry

Therminol heat transfer fluids from Solutia are widely used in refining, gas processing, oil and gas pipeline operations, and reprocessing used lube oils

Therminol heat transfer fluids from **Solutia** are commonly used in offshore and onshore oil and gas processing, fractionation, refining, transportation, and recycling operations. Therminol 55, Therminol 59, Therminol 62, Therminol 66 and Therminol VP1 have successfully demonstrated low-cost, reliable, and safe performance in these applications for decades. Therminol fluids are selected because they provide lower capital and operating costs, and better temperature control, than other heat transfer options.

In gas processing and fractionation, Therminol fluids are frequently used to heat gases for regenerating solid desiccants (such as molecular sieve) in gas dehydration beds; to reboil liquid desiccants (such as glycols) used for gas dehydration; to regenerate liquid solvents (such as amines) used for gas sweetening; to heat gas stabilization and NGL fractionation reboilers; and for other gas processing operations.

In oil processing and refining, Therminol fluids are often used to enhance oil/gas/ water/sediment/salt separation and for other processing and refining operations such as low-sulfur gasoline production, solvent extraction, and sulfur recovery.

Therminol heat transfer fluids have applications in transportation too. Pumping stations along oil and gas pipelines often require heating to control the viscosity of oil streams, and to prevent condensation of components from gas streams. Therminol heat transfer fluids have proven capable of meeting these requirements in virtually any environment.

And the reprocessing of used lubricating oils involves operations at very high temperatures and high vacuum, for which Therminol heat transfer fluids are ideal. A variety of Therminol fluids are available with low vapor pressure, high thermal stability, and good heat transfer performance, supporting process needs at virtually any temperature.

www.therminol.com

Reliable and economical under extreme conditions

The new Pro-Flo X air-operated diaphragm pump from Wilden can be adjusted easily to give either maximum throughput or minimum air consumption

The Advanced bolted Pro-Flo X pump from **Wilden** is a reliable and economical solution for emptying vessels, filling tank cars, and transferring bulk chemicals quickly and safely. This new pump is designed to excel under extreme conditions. The bolted configuration ensures product containment, while the Pro-Flo X air distribution system (ADS) with its Efficiency Management Systems (EMS) allows the pump user to control flow rates and air consumption with the simple turn of a dial.

The Pro-Flo X technology makes the previously restrictive rules for air-operated double-diaphragm pump use obsolete. By adjusting the patent pending EMS dial to your exact process requirements, the Pro-Flo X ADS will exceed your expectations without breaking the bank. The pump performance can either be maximized to achieve a greater flow to get the job done fast, or you can maximize efficiency to reduce the operating cost of the pump.

The Advanced Pro-Flo X pump provides reliability, flexibility and efficiencies needed in today's energy-conscious and performance-driven applications.

www.wildenpump.com

Powerful pumping: Wilden's Pro-Flo X

Project engineering for chemicals and polymers

Mustang provides highly experienced process engineers and project managers for all types of process projects, including control and automation

Mustang has wide-ranging experience on chemical and polymer projects, with a project management team whose members average more than 25 years in the process industries. Similarly, Mustang's process engineers average more than 20 years on these types of projects. Behind the scenes, the company boasts superior support teams and the latest 3D modeling techniques, including laser scanning, to streamline projects and reduce costs.

Mustang can manage projects from conception through to operations. With its proven processes, it can also execute revamp projects that come in on budget, on time and without surprises. Mustang personnel have experience in most of the licensed petrochemical, chemical and polymer processes used today. The company's experience allows Mustang to assist clients with the introduction of "first of a kind" or licensed technologies. Mustang offers technical and economic studies, technology evaluation, experimental program design, pilot plant programs, and acquisition of physical and chemical property data.

Mustang Automation and Control (MAC) adds still another dimension to Mustang's total project capabilities on behalf of its clients. An experienced team with extensive process knowledge provides a vendor-independent approach with cost-effective and workable solutions for complex IT, automation and control projects. Front end definition is a forte of the team, combined with innovative tools and methodologies that allow MAC to be a full service provider of automation integration services, including advanced process control and abnormal condition management.

Mustang supports its projects with planning, established procedures and proven Best Practices. The company uses its own stage gate process (Stage COACH) and a robust proprietary project management tool (PACESETTER) to make sure that projects are successful from start to finish.

Mustang Engineering was founded in 1987 in Houston, Texas. Today the company has more than 4,500 employees, offices throughout the US, and international offices. Mustang has completed over 4,700 projects for more than 350 clients.

www.mustangeng.com

Mustang has now completed more than 4,700 engineering projects

Plug-and-play for tempered water drench showers

Emergency shower and eyewash specialist Haws Corp. ensures that its products match ANSI requirements under real plant operating conditions

Today's industrial emergency showers and eyewashes are mostly certified to exacting ANSI operational standards, notes Casey Hayes, Director of Engineered Solutions at the Engineered Solutions Division of **Haws Corp**.

However, he continues, the standards assume certain circumstances that may not apply to the plant in question. For instance, showers must deliver a flowrate of 20 gpm. But, what happens if the inlet line can't supply 20 gpm? Is that a shower problem or a "system" problem? What about temperature requirements? How is a shower supposed to meet the tempered water requirement, if the water fed into it is at 37°F? This is not going to happen, Hayes says, unless the entire system is designed to accomplish the total task at hand.

The idea of engineered solutions—designing a complete system to address the specific plant's needs—is not new. It has been done for years in circumstances where specifiers collaborated with equipment manufacturers to optimize the design of their entire system. Because manufacturers deal with drench showers and eyewashes every day, they are most familiar with installation and operating requirements, as well as capabilities and limitations. Importantly, they are often better equipped to logically match the various components that might go into a system that could be called upon to provide:

- Real-time cooling or warming of inlet water, to ensure that a victim can stand a 15-min. drench or irrigation cycle without suffering scalding or hypothermia.
- Recirculation and/or booster pumps to ensure that sufficient pressure is available to maintain nominal flowrates and spray pattern heights in the widest variety of circumstances.
- Appropriate temperatures, flows and pressures even if multiple victims are using multiple emergency showers or eyewashes at the same time.

The recent launch of an Engineered Solutions Division at Haws Corp. formalizes a service that the company has provided informally for over 700 clients over the years. The group is staffed with experienced professionals who understand clients' business as well as their own. The result is a unique opportunity for specifiers to get it right the first time, without "over-specing".

www.hawsco.com

Custom engineering (right) ensures that showers (top) perform as designed

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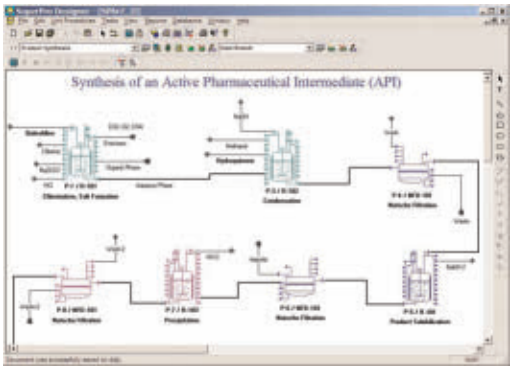
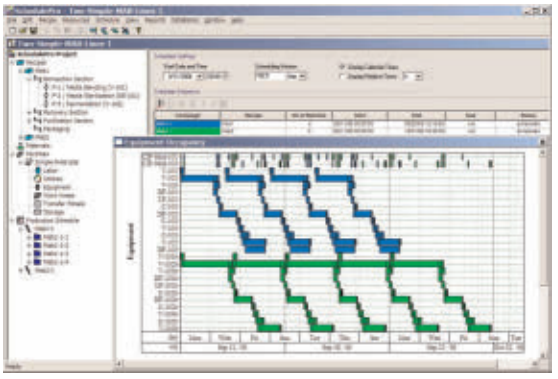


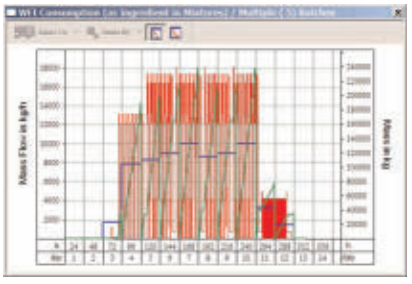
Use SuperPro Designer to model, evaluate, and debottleneck batch and continuous processes

SchedulePro

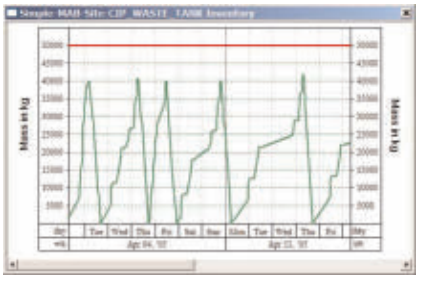


Switch to SchedulePro to schedule, model, and debottleneck multi-product facilities

Tracking of equipment occupancy in multi-product facilities



Tracking demand for resources (e.g., labor, materials, utilities, etc.)



Inventory tracking for raw materials, intermediates, products, and wastes

SuperPro Designer is a comprehensive process simulator that facilitates modeling, cost analysis, debottlenecking, cycle time reduction, and environmental impact assessment of biochemical, specialty chemical, pharmaceutical (bulk & fine), food, consumer product, mineral processing, water purification, wastewater treatment, and related processes. Its development was initiated at the Massachusetts Institute of Technology (MIT). SuperPro is already in use at more than 400 companies and 500 universities around the world (including 18 of the top 20 pharmaceutical companies and 9 of the top 10 biopharmaceutical companies).

SchedulePro is a versatile finite capacity scheduling tool that generates feasible production schedules for multi-product facilities that do not violate constraints related to the limited availability of facilities, equipment, resources and work areas. It can be used in conjunction with SuperPro (by importing its recipes) or independently (by creating recipes directly in SchedulePro). Any industry that manufactures multiple products by sharing production lines and resources can benefit from the use of SchedulePro. Engineering companies use it as a modeling tool to size utilities for batch plants, identify equipment requirements, reduce cycle times, and debottleneck facilities.

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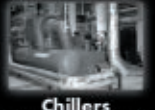

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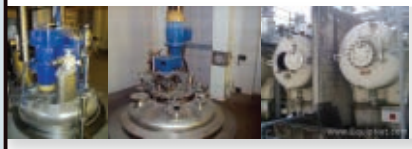
API/Fine Chemical Facilities for Sale!

131481 - Complete API/ Fine Chemicals Processing Facility
Location: Turkey

141514 - Pilot Scale Manufacturing Process Plant
Location: Belgium



Pilot Scale & Production Equipment Available
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83228 - 1991 Summix Bolz 980L Stainless Steel Nauta Style Dryer
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CONTACT
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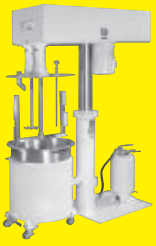

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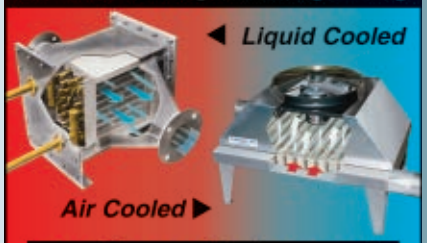

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BUSINESS NEWS

PLANT WATCH

Bayer MaterialScience builds polyurethane raw materials facility

March 27, 2009 — Bayer MaterialScience (Leverkusen, Germany) is to invest 20 million euros in a new aromatic and aliphatic polyisocyanate manufacturing facility in India. The new plant in Ankleshwar, in the northwestern state of Gujurat, is scheduled to start operating in 2011.

Polyethylene plant to be built in India using Ineos technology

March 25, 2009 — Ineos Technologies (Runcorn, U.K.) has reached an agreement with Brahmaputra Cracker and Polymer Ltd. (BCPL) to license the Innovene G process for the manufacture of polyethylene (PE) in a plant to be built at Lepetkata in northeast India. With a production capacity of 220,000 metric tons (m.t.) per year in a single gas-phase reactor, the plant will be able to manufacture a wide range of LLDPE (linear low-density PE) and HDPE (high-density PE) grades. This facility will form part of the Assam Gas Cracker Project, a grassroots integrated petrochemical complex being set up by BCPL.

MERGERS AND ACQUISITIONS

Sud-Chemie acquires BASF catalyst site in China

April 20, 2009 — Sud-Chemie AG (Munich) and BASF SE (Ludwigshafen, both Germany) have come to an agreement about Sud-Chemie's acquisition of a production site for synthesis gas (syngas) catalysts in Nanjing, China. This site is independent from BASF's main production facility in the same city. The parties agreed not to disclose the purchase price. Through this acquisition, Sud-Chemie becomes the largest manufacturer of syngas catalysts in China. The syngas catalysts produced in Nanjing are used primarily in the conversion of coal or natural gas to ammonia for the fertilizer industry or the production of methanol.

Textile companies form a joint venture

April 20, 2009 — Suminoe Textile Co., and Teijin Fibers Ltd. have agreed to establish a joint venture (JV) company that will develop, manufacture and sell fabrics for automotive seats and ceilings. The tentative name of the new firm is Suminoe Teijin Techno Co., Ltd., which will begin operating on Dec. 1, 2009, the date of its official establishment. It will be located in Chuo-ku, Osaka and capitalized at 450 million yen, with Suminoe Textile contributing 50.1% and Teijin Fibers 49.9%.

Kimberly-Clark acquires safety products company

April 14, 2009 – Kimberly-Clark Corp. (Dallas, Tex.) has acquired Jackson Products, Inc., a privately held, safety products company headquartered in Fenton, Mo. Jackson Products, Inc., more commonly known within the industry as Jackson Safety, is a leading provider of welding safety products, personal protective equipment and work zone safety products. Terms of the acquisition were not disclosed.

BASF acquires Ciba and starts integration process

April 9, 2009 – BASF has successfully completed its acquisition of Ciba Holding AG. BASF now holds 95.8% of Ciba. BASF Board member, Dr. Hans-Ulrich Engel, has become chairman of Ciba's Board of Directors, the company's senior supervisory body. BASF intends to fully integrate Ciba into the BASF Group. The integration process will start with a "discovery phase", during which time joint teams consisting of BASF and Ciba employees will analyze the acquired businesses in depth. The actual integration process will start in July 2009 on the basis of these results.

Emerson acquisition expands expertise

April 7, 2009 — Emerson Process Management (St. Louis, Mo.) has acquired epro GmbH (Gronau, Germany). The deal expands Emerson's online machinery-monitoring capability and is expected to speed availability of next generation solutions. Terms of the deal were not announced.

Dow announces divestiture of Morton Salt

April 3, 2009 — The Dow Chemical Co. (Dow; Midland, Mich.) has announced that Rohm and Haas, a wholly owned subsidiary of Dow, has entered into an agreement to sell the stock of Morton International, Inc., the salt business of Rohm and Haas, to K+S AG. The transaction values Morton International at $1.675 billion and is subject to customary closing conditions. The deal is expected to close in mid-2009.

Dow completes its acquisition of Rohm and Haas

April 1, 2009 – Dow has completed its acquisition of Rohm and Haas. Combining the two organizations creates a $14.0-billion diversified business portfolio, which is called Dow's Advanced Materials division. The division is intended to achieve $3.0 billion in additional value growth opportunities, as well as annual cost synergies of $1.3 billion. Rohm and Haas is the key element in Dow's new Advanced Materials division. Pierre Brondeau has been named president and CEO of this division, which includes: coatings, building and construction, specialty materials, adhesives and functional polymers, and electronic materials.

Taylor Chemical Co. rebrands as Siovation

April 1, 2009 — Taylor Chemical Co. (Lawrenceville, Ga.), a formulator and manufacturer of silicone-based technology has announced a name change of the 29-yr-old company. The new name, Siovation is the culmination of a strategic transformation into a highly technical manufacturer and marketer of silicone-based products.

SOCMA becomes 'Society of Chemical Manufacturers and Affiliates'

March 25, 2009 — In an effort to better serve the batch, custom and specialty chemical industry, SOCMA members have voted to change the organization's name from the Synthetic Organic Chemical Manufacturers Association to the Society of Chemical Manufacturers and Affiliates.

UOP and Ensyn offer second-generation biomass technology

March 24, 2009 — UOP LLC (Des Plaines, Ill.), a Honeywell company, has launched Envergent Technologies, LLC, a JV with Ensyn Corp., to offer technology and equipment to convert second-generation biomass into pyrolysis oil for power generation, heating fuel and for conversion into transportation fuels. The new company will offer Ensyn's Rapid Thermal Processing technology to convert second-generation biomass to pyrolysis oil. The JV will also accelerate efforts to commercialize next-generation technology to refine the pyrolysis oil into transportation fuels. ■

Dorothy Lozowski

FOR ADDITIONAL NEWS AS IT DEVELOPS, PLEASE VISIT WWW.CHE.COM

May 2009; VOL. 116; NO. 5
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FOR MORE ECONOMIC INDICATORS, SEE NEXT PAGE

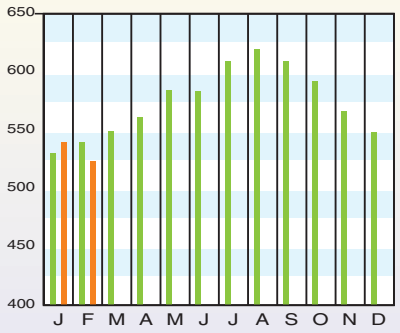
DOWNLOAD THE *CEPCI* TWO WEEKS SOONER AT *WWW.CHE.COM/PCI*

CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957-59 = 100)

	Feb.'09 Prelim.	Jan.'09 Final	Feb.'08 Final
***CE* INDEX**	532.3	539.6	539.8
Equipment	631.9	642.4	645.8
Heat exchangers & tanks	587.0	603.4	618.4
Process machinery	615.3	620.0	610.3
Pipe, valves & fittings	770.6	781.8	768.2
Process instruments	384.5	389.6	420.2
Pumps & compressors	897.0	902.1	850.5
Electrical equipment	458.7	457.9	445.3
Structural supports & misc	660.9	671.5	684.6
Construction labor	323.8	324.5	316.2
Buildings	495.4	500.0	483.0
Engineering & supervision	349.8	350.3	354.5

Annual Index:
2001 = 394.3
2002 = 395.6
2003 = 402.0
2004 = 444.2
2005 = 468.2
2006 = 499.6
2007 = 525.4
2008 = 575.4

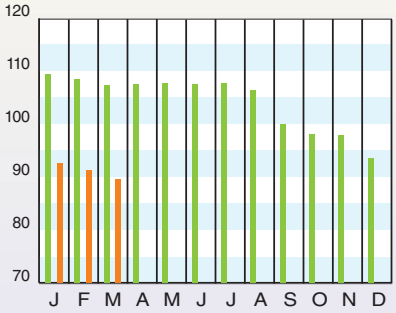


Starting with the April 2007 Final numbers, several of the data series for labor and compressors have been converted to accommodate series IDs that were discontinued by the U.S. Bureau of Labor Statistics

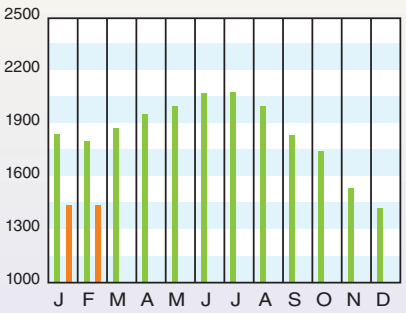
CURRENT BUSINESS INDICATORS

	LATEST		PREVIOUS		YEAR AGO	
CPI output index (2000 = 100)	Mar.'09 = 89.6		Feb.'09 = 91.2		Jan.'09 = 91.5	Mar.'08 = 107.3
CPI value of output, $ billions	Feb.'09 = 1,438.0		Jan.'09 = 1,436.7		Dec.'08 = 1,422.1	Feb.'08 = 1,803.9
CPI operating rate, %	Mar.'09 = 65.3		Feb.'09 = 66.3		Jan.'09 = 66.5	Mar.'08 = 78.8
Producer prices, industrial chemicals (1982 = 100)	Mar.'09 = 224.0		Feb.'09 = 224.1		Jan.'09 = 226.2	Mar.'08 = 261.3
Industrial Production in Manufacturing (2002=100)*	Mar.'09 = 95.8		Feb.'09 = 97.5		Jan.'09 = 98.1	Mar.'08 = 112.7
Hourly earnings index, chemical & allied products (1992 = 100)	Mar.'09 = 144.2		Feb.'09 = 145.4		Jan.'09 = 145.2	Mar.'08 = 140.9
Productivity index, chemicals & allied products (1992 = 100)	Mar.'09 127.2		Feb.'09 = 127.1		Jan.'09 = 125.1	Mar.'08 = 132.7

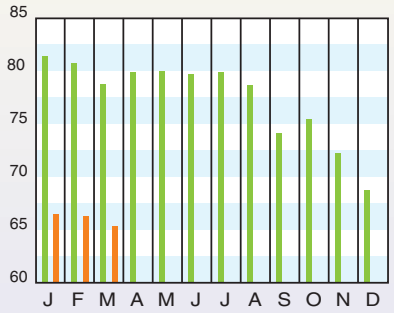
CPI OUTPUT INDEX (2000 = 100)



CPI OUTPUT VALUE ($ Billions)



CPI OPERATING RATE (%)



*Due to discontinuance, the Index of Industrial Activity has been replaced by the Industrial Production in Manufacturing index from the U.S. Federal Reserve Board.
Current business indicators provided by Global insight, Inc., Lexington, Mass.

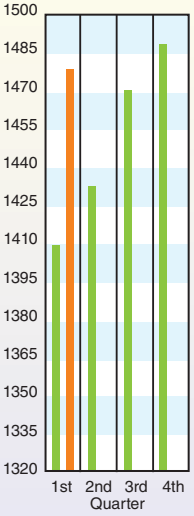
MARSHALL & SWIFT EQUIPMENT COST INDEX

(1926 = 100)

	1st Q 2009	4th Q 2008	3rd Q 2008	2nd Q 2008	1st Q 2008
M & S INDEX	1,477.7	1,487.2	1,469.5	1,431.7	1,408.6
Process industries, average	1,553.2	1,561.2	1,538.2	1,491.7	1,463.2
Cement	1,551.1	1,553.4	1,522.2	1,473.5	1,448.1
Chemicals	1,523.8	1,533.7	1,511.5	1,464.8	1,438.5
Clay products	1,526.4	1,524.4	1,495.6	1,453.5	1,429.1
Glass	1,439.8	1,448.1	1,432.4	1,385.1	1,359.7
Paint	1,554.1	1,564.2	1,543.9	1,494.8	1,467.6
Paper	1,453.3	1,462.9	1,443.1	1,400.0	1,377.7
Petroleum products	1,663.6	1,668.9	1,644.4	1,594.4	1,555.8
Rubber	1,600.3	1,604.6	1,575.6	1,537.5	1,512.3
Related industries					
Electrical power	1,425.0	1,454.2	1,454.4	1,412.8	1,380.4
Mining, milling	1,573.0	1,567.5	1,546.2	1,498.9	1,473.3
Refrigeration	1,807.3	1,818.1	1,793.1	1,741.4	1,711.9
Steam power	1,509.3	1,521.9	1,499.3	1,453.2	1,426.8

Annual Index:

2001 = 1,093.9	2003 = 1,123.6	2005 = 1,244.5	2007 = 1,373.3
2002 = 1,104.2	2004 = 1,178.5	2006 = 1,302.3	2008 = 1,449.3



CURRENT TRENDS

While the decrease in the CEPCI from February to March was slightly larger than from January to February, the more notable trend is the difference between the February number and that of the previous year. As expected, the preliminary February CEPCI marks the first time since the beginning of this particular economic slowdown that the CEPCI has dipped below its value at this time one year ago.

Visit www.che.com/pci for more on capital cost trends and methodology. ■

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