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November 2009

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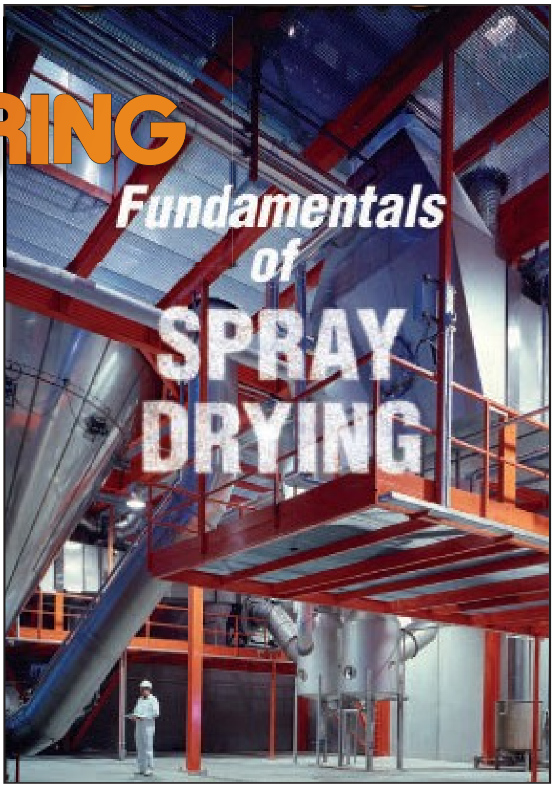

COMING IN DECEMBER

Look for: **Feature Reports** on Chemical & Engineering Software; and Heat Transfer Fluids; An **Engineering Practice article** on Millichannel reactors for Pharma Plants; A **Focus** on Level Measurement & Control; **News articles** on Drying; Screening; and the Kirkpatrick Award Winners; **Facts at Your Fingertips** on Control Valves; and more

Cover: GEA Niro

The presence of polar gas or steam is no match for dynamic gas phase compensation

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Winner of Eight Jesse H. Neal Awards for Editorial Excellence

CHEMICAL ENGINEERING

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Editor's Page

Nobel puts CPI on world stage

Early next month, the Royal Swedish Academy of Sciences will hold its award ceremonies for the 2009 Nobel Prizes, the winners of which were announced in October. The prestigious awards are arguably the most high-profile recognitions of the two cornerstones of our profession, chemistry and physics, and underscore the prolific benefits that the chemical process industries (CPI) provide to society. Meanwhile, they are a good predictor of the CPI sectors that will continue to strengthen in the future.

The Nobel Prize in Chemistry for 2009 awards studies of one of life's core processes: the ribosome's translation of DNA information into life. Ribosomes produce proteins, which in turn control the chemistry in all living organisms. As ribosomes are crucial to life, they are also a major target for new antibiotics. This year's Nobel Prize in Chemistry awards Venkatraman Ramakrishnan (MRC Laboratory of Molecular Biology, Cambridge, U.K.), Thomas A. Steitz (Yale University, New Haven, Conn.) and Ada E. Yonath (Weizmann Institute of Science, Rehovot, Israel) for having shown what the ribosome looks like and how it functions at the atomic level. All three have used a method called X-ray crystallography to map the position for each and every one of the hundreds of thousands of atoms that make up the ribosome.

DNA molecules contain the blueprints for how a human being, a plant or a bacterium, looks and functions. But the DNA molecule is passive. The blueprints become transformed into living matter through the work of ribosomes. Based upon the information in DNA, ribosomes make proteins: oxygen-transporting hemoglobin, antibodies of the immune system, hormones such as insulin, the collagen of the skin, or enzymes that break down sugar. There are tens of thousands of proteins in the body and they all have different forms and functions at the chemical level.

An understanding of the ribosome's innermost workings is important for a scientific understanding of life. This knowledge can be put to a practical and immediate use; many of today's antibiotics cure various diseases by blocking the function of bacterial ribosomes. Without functional ribosomes, bacteria cannot survive. This year's three Chemistry Laureates have all generated 3D models that show how different antibiotics bind to the ribosome. These models are now used by pharmaceutical researchers in order to develop new antibiotics.

The Nobel Prize in Physics is awarded for two scientific achievements. The first half of the prize goes to Charles K. Kao, a Chinese-British physicist who has played a major role in the development of modern fiber optic technology. Kao realized that light transmission over long distances is possible only with ultrapure glass. An important raw material for producing this ultrapure glass is chlorosilane silicon tetrachloride (STC). The clear, colorless liquid is produced by a number of CPI companies, including Evonik Industries AG (Essen; www.evonik.com), from silicon and hydrogen chloride. The advantage here is that silicon is available in virtually unlimited quantities, unlike the copper that is required for other cables.

The second part of the physics award goes to Willard S. Boyle and George E. Smith (both Bell Laboratories, Murray Hill, N.J.) for inventing the first successful imaging technology using a digital sensor, a CCD (charge-coupled device). The CCD technology makes use of the photoelectric effect, in which light is transformed into electric signals, and serves as a digital camera's electronic eye. CCD revolutionized photography, as light could now be captured electronically instead of on film. Since the digital form facilitates the processing and distribution of these images, it has revolutionized the possibilities for inline process-analysis techniques, such as spectroscopy. ■

Rebekkah Marshall

Letters

Call for papers: AIChE Spring meeting

The call for papers process for the 2010 AIChE Spring Meeting (San Antonio, Tex., March 21–25, 2010) is now open. Professionals working in all areas of chemical engineering and related disciplines are invited to submit proposals. Submissions in the following subject areas and for these topical conferences are particularly welcome:

Subject areas:
- Energy
- Environmental issues
- Fuels & petrochemicals
- Greenhouse gas management
- Management
- Nuclear process chemistry
- Process development
- Separations
- Sustainability
- Process safety

Topical conferences:
- The 6th Global Congress on Process Safety featuring the 25th CCPS International Conference, the 44th Loss Prevention Symposium and the 12th Process Plant Safety Symposium
- 10th Natural Gas Utilization Conference
- 13th Topical Conference on Refinery Processing
- 22nd Ethylene Producers' Conference
- Advanced Fossil Energy Utilization
- Clean Fuels and Energy Efficient Processes
- Distillation

To submit a proposal, visit www.aiche.org/spring and click the Call for Papers/PTP link. Deadline for all preliminary submissions is December 1, 2009.

Postscripts, corrections

February, Facts At Your Fingertips, Causes of Overpressurization, p. 31: The subheadings for "Exchange tube rupture" and "Upstream relieving" were switched. A corrected version is available at www.che.com/facts.

July, Separation: More, More, More, pp. 20–24: On p. 20, the location of Fractionation Research Inc. (FRI) is incorrectly stated as Stillwater, Calif. The correct location of FRI is Stillwater, Okla. on the campus of Oklahoma State University. We thank Frank Rukovena, Jr. and his wife for bringing the error to our attention.

Do you have —
- Ideas to air?
- Feedback about our articles?
- Comments about today's engineering practice or education?
- Job-related problems or gripes to share?

If so —
Send them, for our Letters column, to

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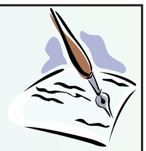
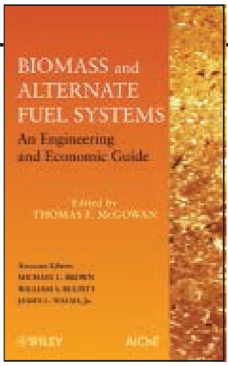


Bookshelf



Biomass and Alternate Fuel Systems: An Engineering and Economic Guide. Edited by Thomas F. McGowan. John Wiley and Sons Inc. 111 River St., Hoboken, NJ 07030. Web: www.wiley.com. 2009. 264 pages. $89.95

Reviewed by Thomas B. Reed, The Biomass Energy Foundation, Franktown, Colo.

Biomass and wood are sleepers in the alternate energy field. While wind and sun provide transient sources of energy, the Earth is covered with biomass, continually storing energy as a fuel that can be converted to heat, power or liquid fuels with the right chemical process technology. The agriculture and forestry industries guarantee a continuing supply of available waste biomass. The scientific and engineering community knows how, in principle, to convert biomass to heat, power and fuel, but ongoing work is needed to identify the most practical and economic routes for such conversions.

For the past two decades, the authors have developed pilot- and commercial-scale biomass-conversion processes. After an overview covering the uses, properties and potential of biomass for fuel and energy, the authors detail the processes of acquiring, burning, gasifying and converting biomass to heat, power and fuels. Later chapters examine practical questions on competing routes and economics, and include real-world examples.

Biomass can fit into a world increasingly sensitive to the human effect on climate and exploitation of natural resources. Processing biomass in a cost-effective and technically feasible manner could reduce our dependence on fossil fuels and could realize advantages of energy production from coal and oil, but without their disadvantages.

Interest in biomass energy must start with a knowledge of its potential supply. Civilizations have fallen because of overharvesting of wood and unsustainable agriculture, so any future use must be sustainable. Studies at Oak Ridge National Laboratory (Oak Ridge, Tenn.; www.ornl.gov) suggest that we could sustainably harvest 350 million (dry) ton/yr of wood residues. The U.S. agricultural industry currently burns or buries 900 million ton/yr. This total is comparable with the total U.S. coal production which, on an energy basis, is equivalent to 1.4 billion tons of biomass.

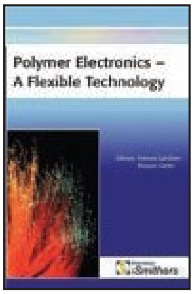
Biomass most easily substitutes for other fuels in industrial boilers where coal or wood can be burned interchangeably with minor alterations to the system. The book covers direct combustion and gasification as well as the systems necessary to support the large-scale use of biomass.

The book also covers the densification of biomass to form pellets, cubes and logs that makes different forms of biomass available as a uniform fuel that can be stored, shipped, sold and fed easily for many applications.

Another alternative fuel topic in the book is ethanol as a gasoline substitute or additive. Its production has grown because of its ease of production from sugarcane and corn, but is limited because these feedstocks are food sources. More advanced processes to produce ethanol from cellulose have been slower to mature, but are increasingly well-funded.

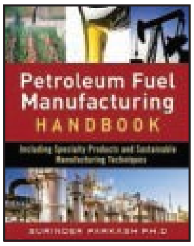
Biodiesel produced from fresh and used vegetable oils and animal fats by transesterification with methanol is also covered.

I recommend the book for practical and economic questions on the science and engineering of biomass conversion.

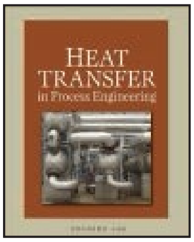


Framework for Chemical Risk Management under REACH. Research and Markets. Guinness Centre, Taylors Lane, Dublin 8, Ireland. Web: www.researchandmarkets.com. 2009. $132.00

Polymer Electronics: A Flexible Technology. Smithers Rapra Technology publishing, Shrewsbury Shropshire, U.K. Web: www.ismithers.net. 2009. 158 pages. $144.00



Petroleum Fuels Manufacturing Handbook: Including Specialty Products and Sustainable Manufacturing Techniques. By Surinder Parkash. McGraw-Hill, 1221 Avenue of the Americas, New York, NY 10020. Web: www.mhprofessional.com. 2009. 464 pages. $150.00



Heat Transfer in Process Engineering. By Eduardo Cao. McGraw-Hill. 1221 Avenue of the Americas, New York, NY 10020. Web. www.mhprofessional.com. 2009. 576 pages. $89.95

The Pressure Strain and Force Handbook, 9th ed. Vol. MMXI. Omega Engineering. One Omega drive, Stamford, CT. 06907. Web: www.omega.com. 2009. 1,200 pages. no cost.

Basic Process Measurements. By Cecil Smith. John Wiley and Sons Inc. 111 River St. Hoboken, NJ 07030. Web: www.wiley.com. 2009. 346 pages. $89.95 ■

Scott Jenkins

CHEMENTATOR

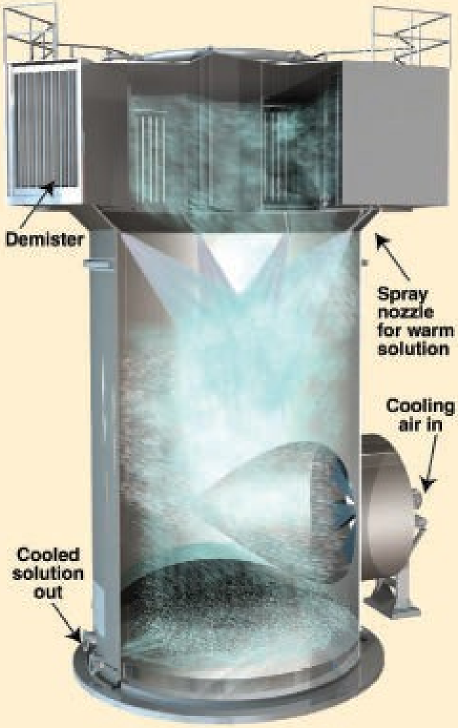
Edited by Gerald Ondrey November 2009

This high-efficiency cooling tower slashes emissions from metallurgical processes

Outotec Oyj (Espoo, Finland; www.outotec.com) has commercialized a new cooling tower that offers increased cooling capacity with significantly lower emissions to air when cooling solutions in metallurgical processes. The new tower can be used in a wide range of process solutions, including zinc plant electrolyte cooling, gypsum and chloride removal by cooling, and gypsum removal for solvent extraction plants.

In the Outotec design (diagram), the warm solution is sprayed into the cooling tower through nozzles near the top, and cooled liquid exits at the bottom. Cooling air is blown into the tower through a fan tunnel at the side, then emerges through horizontal demisters at the top. The main difference between the Outotec and conventional designs is the patented top structure, which enables about twice the air flowrates with smaller emissions, says process metallurgist Tuomas Hirsi. For example, when cooling a Zn electrolyte (2,112 m^3/h solution flowrate), from 38°C to 33.5°C, the Outotec tower achieves Zn emissions of 120 kg/yr and sulfuric acid emissions of 370 kg/yr — much lower that the 1,200 kg/yr of Zn and 3,600 kg/yr H_2SO_4 released from conventional designs, he says.

Outotec tower's "dramatically higher cooling efficiency" means fewer towers are required to handle a given capacity, thus investment cost per cooling capacity is lower than in conventional equipment. As a result, there is a corresponding reduction in both operating and investment costs, as well as savings in accessory equipment (pumps and valves), foundations and construction space, says Hirsi. The new design also offers higher availability and online maintenance possibilities, eliminating the need for backup equipment, he says.



Construction on the first commercial application of Outotec cooling towers is underway in Vladikavakaz, Russia, where seven Outotec 6000 Cooling Towers will be installed at the Elektrozinc Zn tank house. Five units will be used in the electrowinning process, and two units for gypsum removal. Startup is scheduled for 2011.

Capsosomes: a new launching platform for delivering drugs where needed

Transport systems that can encapsulate medications for release when and where needed are the subject of much research and development, especially for two potential synthetic vessels: liposomes and multilayered polymer capsules. Both, however, entail limitations. The permeability of polymer capsules, although partly desirable, also makes them unsuitable for providing a protective barrier for small drugs and reagents. On the other hand, small unilamellar liposomes can be susceptible to structural instability and are largely impermeable to their surroundings.

To overcome those limitations, a group of researchers from the University of Melbourne (www.unimelb.edu.au) and CSIRO Molecular and Health Technologies (Parkville, Victoria, both Australia) and led by professor Frank Caruso, Dept. of Chemical and Biomolecular Engineering at Melbourne, has developed a method for creating capsosomes — polymer capsules that contain liposomal subcompartments to maximize the benefits offered by both, polymer multilayer capsules and liposomes. The group has shown that capsosomes inherit the structural stability of the polymer capsules, and have a semipermeable nature; and the liposomes are capable of restricting the access of solutes to an encapsulated model enzyme, β-lactamase.

This new platform — capsosomes — can be optimized to accommodate several biomedical applications, say the researchers. The group is now extending the system to co-encapsulate different enzymes, while equipping the liposomes with specific triggers toward encapsulated enzymatic cascade reactions without destroying the subcompartments. It is investigating the potential of capsosomes for encapsulation and the combined delivery of hydrophobic or hydrophilic drugs and nanoparticles.

SAFT into gPROMS

Process Systems Enterprise Ltd. (PSE; London, U.K.; www.psenterprise.com) is to make new advanced thermodynamic modeling tools for prediction of liquid and gas thermodynamic properties available through its gPROMS process-modeling environment. The technology makes it possible to considerably speed up the optimal design of new process plants by integrating molecule and process design, says Mark Matzopoulos, PSE's COO and marketing director.

PSE has signed an agreement to commercialize Imperial College London's (www3.imperial.ac.uk) Statistical Associating Fluid Theory (SAFT) research. SAFT allows many different thermodynamic properties of mixtures to be determined accurately based on physically realistic models of

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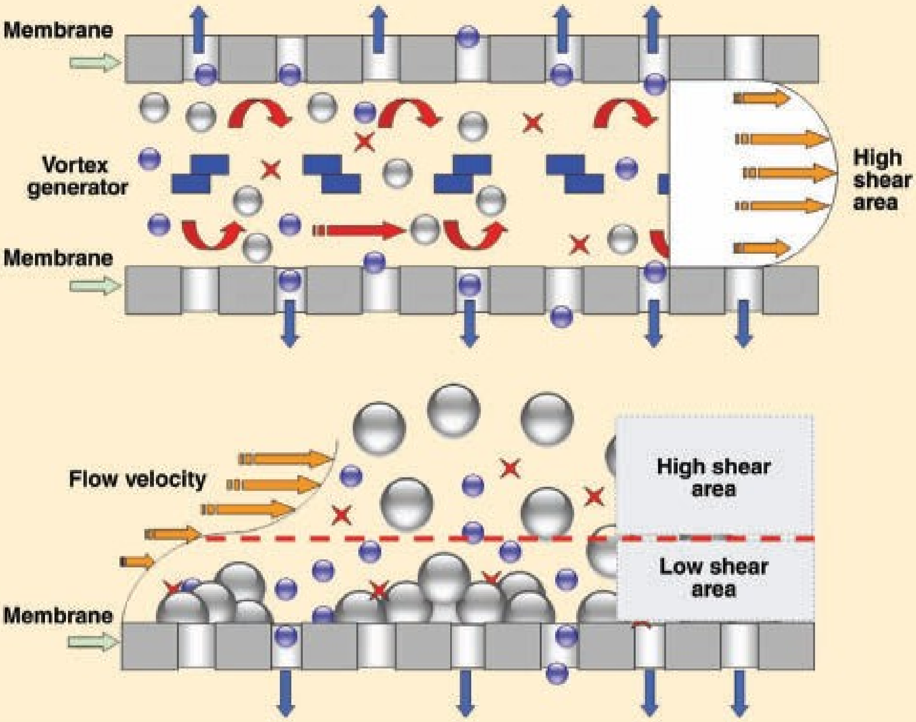
Note: For more information, circle the 3-digit number on p. 62, or use the website designation.

A new spin on reducing membrane-filtration fouling



Last month at Filtech (Wiesbaden, Germany; October 13–15), Fil Max Inc. (Brea, Calif.; www.fmxfiltration.com) exhibited a new application for its FMX vortex-generating, membrane-filtration technology — treating wastewater from a biogas plant. Fil Max installed its first commercial system — three KFS units with 220 m^2 of filtration surface area — for this application in August at a 6-MW biogas facility in Europe. The system integrator of the plant had experienced considerable problems due to clogging of the previous tubular ultrafiltration system, explains Fil Max director Tzu-Lung Lin. Pilot trials (conducted in March) demonstrated FMX technology's ability to not only meet EU water-quality standards, but also to increase methane production in the biogas-plant digester.

FMX consists of a stack of membrane filters with a vortex-generating blade sandwiched between the membranes. The blade — jointly developed by the Korean Institute of Machinery and Materials (Daejeon; www.kimm.re.kr) and Fil Max — is spun by a variable-speed drive creating a swirling pattern known as Kármán vortices, which generate a strong turbulence with minimum energy. This turbulence dislodges foulants from the membrane surface, enabling the foulants to be carried away by the feed stream (diagram, top). In contrast, conventional membrane filtration systems, which rely on a cross flow to remove the boundary layer built up by foulants, are less efficient because the shear force is often weakest near the membrane surface (diagram, bottom).

FMX made its commercial debut in 2005 for treating wastewater from a methyl cellulose plant of Samsung Fine Chemicals. Since then, the technology has found applications in the oil-and-energy, chemical and environmental industries. Units are available with membrane areas of 10 to 100 m^2, and the modular design enables stacking as many membranes as needed to meet the required capacity, says Lin.

Demonstration of a straw-to-bioethanol process

This month, Mitsubishi Heavy Industries, Ltd. (MHI; Tokyo; www.mhi.co.jp) is starting up a demonstration plant for producing bioethanol from the straw of rice and wheat. Located at the Futami Farm of MHI Kobe Shipbuilding Plant, the facility — developed in collaboration with Hakutsuru Sake Brewing Co. (Kobe; www.hakutsuru.co.jp) and Kansai Chemical Engineering Co. (Amagasaki, both Japan; www.kce.co.jp) — will produce 200 L of ethanol from each ton of straw.

MHI has developed two pretreatment steps for the production of bioethanol. First, milled straw is pyrolyzed in a reactor using pressurized hot water (less than 300°C). Pyrolysis products are then separated and saccharified into pentose and hexose, which can then be fermented into ethanol. MHI technologies used in other sectors have been adapted for this application, such as: an injection molding machine, for injecting soft straw into the closed reactor; welding technology and construction materials from nuclear power equipment, for the high temperature and high pressure reactor; and the aqueous pyrolysis process, which is used for the degradation of polychlorinated biphenyls (PCBs; *CE*, November 1998, p. 23).

By March 2010, MHI aims to produce ethanol with a production cost of ¥90/L (about \$3.75/gal). The company plans to commercialize the equipment for aqueous pyrolysis in 2011.

(*Continued from p. 11*)

molecules and their interactions with other molecules. Its key advantage is the ability to predict very accurately the behavior of strongly associating systems, such as azeotropic refrigerant mixtures, aqueous solutions of non-ionic surfactants and even strong electrolyte solutions. It also accurately quantifies behavior of systems involving high molecular weight components, such as polymer-gas systems. All of these systems are typically represented poorly by conventional techniques, such as cubic equations of state.

Microbial H_2

The first pilot-scale demonstration of hydrogen production from wastewater using a microbial electrolysis system has been set up at a California winery. Penn State University (University Park, Pa., www.psu.edu) environmental engineer Bruce Logan and colleagues set up the 1,000 L/d microbial electrolysis system at Napa Wine Co. (Oakville, Calif.). The demonstration will help determine what yields of hydrogen are possible. The target is to produce 1,000 L H_2 per 1,000 L of wastewater.

(*Continues on p. 14*)

First commercial transport, coal-gasifier contract awarded

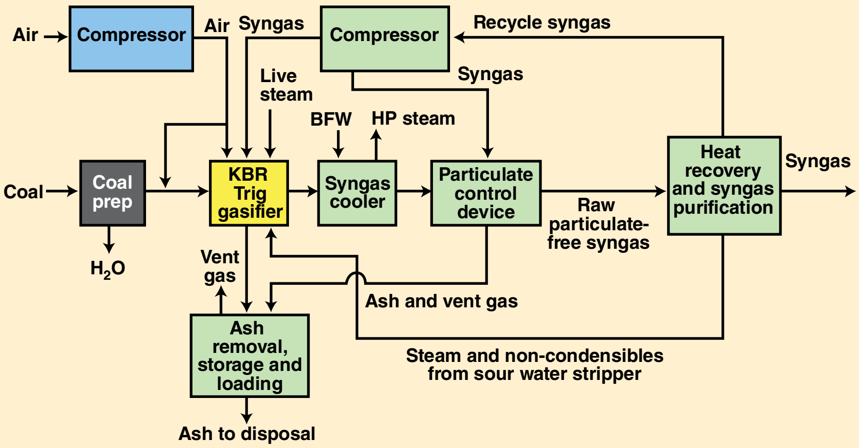
A contract for the world's first commercial transport-gasification facility was awarded to KBR (Houston, www.kbr.com) by Beijing Guoneng Yinghui Clean Energy Engineering Co. for a coal power plant in China's Guangdong province.

The two-phase project will showcase KBR's transport integrated gasification (TRIG) technology, which is designed specifically for the efficient conversion of low-rank coal to synthesis gas (syngas). The first phase of the project will be a 120-MW integrated gasification combined cycle (IGCC) power plant, scheduled for completion in 2011. That facility will be followed by an 800-MW IGCC plant with TRIG technology, scheduled for completion in 2012.

TRIG technology includes a refractory-lined, circulating-bed gasifier that enables economic conversion of low-grade coals, such as lignite, subbituminous and high-ash, into syngas. The circulating-bed gasifier uses a dry feed and operates at temperatures below the melting point of ash, so it is suitable for lower-cost fuels with high ash or moisture content, KBR explains. "Coals with up to 50% ash can be processed in the TRIG gasifier," the company notes.

In the riser portion of the gasifier unit, TRIG takes advantage of the reactivity of low-rank coals to form raw syngas in a short period. The syngas, laden with unreacted solids, then moves through a series of cyclones where the solids are removed. TRIG technology uses a proprietary refractory with extended life as well as a proprietary ash-removal system designed to address the technical difficulties of handling slag.

In addition to producing syngas for electric power generation, TRIG technology can be applied to the manufacture of ammonia, methanol, substitute natural gas and transportation fuels.



Integrity Software: first to map the 'automation genome'

Last month, PAS, Inc. (Houston; www.pas.com) launched Integrity Automation Genome Software, said to be the world's first software capable of analyzing assets, functionality and dataflow within and among automation and production systems. Integrity provides a universal framework for aggregating and contextualizing assets while mapping dataflow. The software interfaces with each individual data source through a library of asset models, which include the majority of distributed control systems (DSCs), programmable logic controllers (PLCs) safety instrumented systems (SISs), HMI/SCADA packages, historians and

(Continues on p. 16)

A boost for acetonitrile

Acetonitrile, a byproduct of acrylonitrile production, has been in short supply for about a year because of a dramatic reduction in the demand for acrylonitrile, used in plastics for the manufacture of cars, appliances and electronic goods. A process modification that promises to relieve the shortage by increasing the yield of acetonitrile has been implemented by Ineos Nitriles (Houston; www.ineos.com) in its acrylonitrile plants at Lima (Ohio), Green Lake (Tex.) and Seal Sands (U.K.). The technology allows Ineos "to produce around 50% more acetonitrile during periods of weak acrylonitrile demand without having to increase the production of acrylonitrile," says Rob Nevin, CEO of Ineos Nitriles.

Acrylonitrile is produced by propylene ammoxidation, in which propylene is reacted with ammonia and air over a fluidized-bed catalyst that contains bismuth, cerium and molybdenum. The process takes place at 400–510°C and 5–30 psig and coproduces about 3% acetonitrile. The company declines to say how the additional acetonitrile is produced, except to say that it involves a process modification. Ineos supplies around 40% of the world's acetonitrile.

AUTOMATION GENOME MAPPING

(*Continued from p. 13*)

asset management packages.

Integrity imports system database configurations, checks data consistency and automatically generates control diagrams to assist with control strategy visualization. The details of the interrelationship of data objects are displayed together with appropriate documentation, which can be "attached" by means of a Smart Link.

(*Continued from p. 12*)

Bacteria can produce small amounts of hydrogen, along with other fermentation products in normal respiration process. By introducing electrodes and applying a small (0.25 V) voltage to the system, H_2 production from acetate is increased because the thermodynamics of the reaction are made favorable by the small voltage boost. The system requires about one tenth of the voltage needed for the direct electrolysis of water (*CE*, May 2005, p. 19).

‘Electronic marshalling’ uproots 35 years of spaghetti wiring practices

Last month, in unveiling the S-Series release of its DeltaV digital automation system, Emerson Process Management (Austin, Tex.; www.emersonprocess.com) introduced electronic marshalling, a new concept in input/output (I/O) configuration that promises to streamline the design and installation of automation systems, substantially reduce hardware and wiring needs, and eliminate delays and cost overruns that are often attributed to the automation portion of capital projects.

New single-channel Characterization Modules (CHARMS) make this possible for individual point-wired field devices, featuring built-in electronics that relay I&C data to the appropriate DeltaV controller via Ethernet backbone. Such electronic marshalling circumvents the need for users to cross wire each field device to specific controller-I/O cards, thereby avoiding so-called spaghetti wiring that is rigidly configured and diagramed in complex drawing sets. In fact, for a project with 15,341 hardwired points, electronic marshalling can achieve a 50% reduction in the number of controller cabinets, a 40% reduction in the cabinet footprint and a 90% reduction in intra-cabinet wiring when compared to conventional I/O marshalling, says Peter Zornio, chief strategic officer.

The DeltaV S-Series also supports wireless and fieldbus I/O, allowing users to easily integrate and swap out a combination of I/O options at any stage of a project. And since the S-Series integrates fieldbus power conditioners onto the I/O cards themselves, a large fieldbus project with 2,501 segments could avoid the need for 5,002 power conditioners and the 32 power cabinets that would be needed to support them, for examle.

Beyond wiring and hardware savings, the combination of electronic marshalling and I/O flexibility addresses a chronic problem that has plagued capital projects for the past 35 years. Whereas traditional project engineering requires considerable time and cost in changing rack-room I/O wiring and terminations as process design is refined during project execution and construction, the DeltaV S-series hardware adapts to changes easily. “The bottom line is that it takes automation out of the scheduling bottleneck,” says Zornio.

Bio-oxidation

A two-phase microbial bio-oxidation system for removing volatile organic compounds (VOCs) from air streams at chemical processing plants has been installed at ten wood-products facilities in 2009, says Bio-Reaction Industries LLC (Tualatin, Ore., www.bioreaction.com), the purveyor of the technology.

In the process, contaminated air streams are pulled through a humidification vessel, where water-soluble compounds are separated. Pollutants are removed by passing the VOC-laden streams through a packing of compost-filled polyethylene balls that contain the microbes. Bio-oxidation requires 90% less

(Continues on p. 16)

Scaleup planned for a scale-reducing RO process

Rotec Ltd. (Ashkelon, Israel; www.rotec-water.com), a technology-transfer company of Ben-Gurion University of the Negev (BGN; Beer-Sheva, Israel), is developing a new desalination technology that promises to increase the water-recovery rate of reverse osmosis (RO) systems from 75–85% up to 95%. This can boost existing RO plant capacities by 5–12% while dramatically reducing the brine disposal volume, which results in savings of up to $0.09/m^3 of product water, says CEO Noam Perlmuter.

One of the main factors limiting water recovery in conventional RO systems is scaling caused by precipitation of sparingly soluble salts. This occurs because the salt concentration near the membrane surface can become 13–20% higher than the concentration of the bulk solution due to the permeation of water through the RO membrane. Rotec's system prevents scaling from occurring by reversing the flow of feed before the salt concentration at the surface becomes saturated. The system incorporates two main technology components: a valve-controlling device, which enables the adaptation of Flow Reversal to Tapered-Flow RO, and a Saturation and Deposition Sensor, which combines a detection array and a control algorithm that triggers flow reversals in real time.

Rotec has demonstrated a full proof-of-concept in a laboratory-scale prototype and is now designing two pilot-demonstration systems that will desalinate 120 m^3/d of brackish groundwater. The company is working with researchers from BGN, the University of Colorado and Hashemite University of Jordan in a project funded by the NATO Science for Peace program and the Middle East Desalination Research Center. The first pilot unit is expected to be operational by the Fall of 2010 at a beta site near Eilat, Israel, and the second will start up early 2011 at a beta site near Al-Zarqa, Jordan. Rotec is also developing its Saturation Sensor subsystem, which the company plans to incorporate into the first pilot systems by 2ndQ 2010. ■

(*Continued from p. 15*)

energy than traditional thermal oxidizers, thus reducing CO_2 emissions and operating cost, says the firm.

The technology is capable of efficient removal of light alcohols, benzene, toluene, xylenes (BTX), pinenes, turpenes and aliphatic compounds from process air streams. Wood products companies utilizing the technology include Weyerhaeuser, Collins Forest Products, J.M. Huber, Norbord and others.

UV-cure silicone rubber

Last month, Momentive Performance Materials, Inc. (Albany, N.Y.; www.momentive.com) introduced a new platform of elastomer products that can be cured by ultraviolet (UV) light at room temperature. Normally, silicone elastomers are vulcanized with peroxide catalyst and thermally cured. Parts commonly produced by extrusion can be cured with "significantly reduced times" compared to conventional silicone elastomers, says the company. ❑

INDUSTRIAL WIRELESS: PROVEN SUCCESS, UNTETHERED POTENTIAL

An explosion of success stories, final ratification of the ISA 100.11a standard and technological improvements have officially removed this technology from the black box of 'promised' benefits

Emerson Process Management

FIGURE 1. WirelessHART adapters provide access to diagnostic data that are stranded in many multivariable devices, such as shown here with the Emerson Thumb attached to a Coriolis flowmeter

For many years now, talk of wirelessly networking and transmitting process signals has projected new levels in process performance, safety and overall efficiency for the chemical process industries (CPI). Until recently, however, a number of strings held back widescale adoption. Those strings are finally unravelling, and there is concrete evidence to prove it.

A key breakthrough occurred last month, when final ratification became official for ISA100.11a, "Wireless Systems for Industrial Automation: Process Control and Related Applications", the International Society of Automation's (Research Triangle Park, N.C.; www.isa.org) standard for wireless communication. Like the WirelessHART standard that has been official for about two years now, ISA100.11a provides end users with assurance that wireless instrumentation and networks from different vendors will communicate seamlessly. Unlike WirelessHART, however, the scope of ISA100.11a goes beyond the instrumentation-to-gateway segments on up through the control and enterprise systems.

Another development that is poised to accelerate wireless infiltration is the commercial launch of wireless position sensors and other low-cost wireless adapters that can simply and easily be added onto existing equipment to bring stranded — but valuable — data back to the control room (Figures 1 and 2).

Most compelling of all, however, is the explosion of end-user success stories, which signal that the comfort factor is no longer an insurmountable hurdle. Of course, when the benefits are big and the costs are relatively small, the wireless solution is hard to ignore. Consider CHS Inc.'s petroleum refinery in Laurel, Mont., where a previous tank overfill cost the refinery $1.5 million in tank repairs and $50,000 in soil remediation. By installing wireless instrumentation for monitoring tank levels, the facility saved $500,000 in comparison to a wired solution.

To both early adopters and those who haven't yet taken the plunge, one factor is particularly reassuring: End users can start small and expand as they get more comfortable. "The success we saw in the first installations gave us the confidence to go forward," says Gary Borham, Severstal Wheeling engineering manager. "Now that we've used this technology, it's like anything is at our finger tips if we want it."

For more on Borham's experience and others', see the five case studies that follow in the next six pages.

STOPPING COSTLY LEAKS

Wireless valve position monitors help Kansas City facility avoid three product-release incidents and save $75,000. Harcros Chemicals in Kansas City, Kan., uses manual valves for sampling, directing, injection, and extraction processes at the chemical production facility. Many of the valves are in remote, hard-to-reach locations too costly to access with wires. Monitoring them was a difficult process, requiring operators to enter hazardous areas or climb ladders to check the valves' state or position. Searching for an easier, safer way to monitor valve performance, managers at the Harcros site installed Emerson Process Management's (St. Louis, Mo.) new Fisher 4320 wireless position monitors.

Unit manager Kevin Root says total savings are already far beyond the basic cost savings of choosing a wireless solution over a wired one. "This was about eliminating mistakes and increasing safety," he said. "Wireless valve position monitoring enabled us to reduce inadvertent emissions and bad batches, as well as avoid the high costs of rework, clean-up, and lost material. Eliminating these costs, up to $25,000 per incident, not including fines, is a good thing for our plant."

The Fisher 4320 wireless-communication position monitor can be used to monitor the position of any valve, anywhere in the plant. The easy-to-install instrument provides frequent, wireless updates about the valve's position while reducing the time and risk associated with visual inspections.

At Harcros, worker safety is a primary concern, not only because of the location of the valves but also because of the toxic chemicals the valves contain and control. The facility uses propylene oxide and ethylene oxide for its processing operations, and exposure to either one can irritate a person's eyes, skin and respiratory tract. Leaks involving toxic chemicals can also result in expensive fines.

Sample and drain valves, for example, are opened and purged before and after each batch. Some product may be released or leaked during this process, and a new batch begins every 8 to 16 hours. Adding 22 wireless position monitors to these isolated, manual valves (Figure 3) enabled Harcros personnel to identify inadvertent emissions before they could result in costly fines or production delays. The wireless monitor units have so far helped Harcros avoid three product release incidents, saving at least $75,000 in downtime, rework, clean-up and disposal costs, not including fines.

"Besides applying the Fisher wireless position monitors to more of our manual valves, we are considering Emerson Smart Wireless technology for tank level management, rail-car monitoring, and a host of temperature, pressure and flow applications at our Kansas City site," says Lloyd Hale, director of manufacturing at Harcros Chemicals. ❑

PREVENTING CRITICAL EQUIPMENT FAILURES

U.S. steel producer saves $300,000 in roll failures, saves over $36,000 in fire-safety-system upgrade and prevents big spills. Severstal Wheeling, the U.S.'s fourth-largest integrated steel producer, initially employed Emerson Process Management's Smart Wireless technology to prevent roller failures valued at $300,000 and has since expanded its use to improve process, fire safety, and environmental monitoring at its fully integrated, 80-in. hot strip mill in Mingo Junction, Ohio.

One of the additional applications uses Emerson's Rosemount wireless temperature transmitters to check bearing lubricant on backup rolls in the plant's finishing mill, reducing maintenance costs and downtime. "Since we installed the wireless network, we've not needed to replace backup rolls because of overheating bearings and damaged rolls," says Gary Borham, Severstal Wheeling engineering manager. "It takes four hours to change a roll, and costs could reach $200,000. We can now see when bearing temperatures rise and can shut down to perform maintenance, which only takes an hour."

A second application uses Rosemount wireless pressure transmitters to monitor the water pressure of the fire safety system protecting the plant's oil cellar. The network has detected two water leaks, enabling quick repairs that returned water pressure to a safe level. Severstal Wheeling was also able to discontinue clipboard rounds once made to check the system, which extends 1,500 ft through a series of tunnels.

The company had to upgrade its fire safety system to comply with insurance requirements but estimated it would cost $60,000–100,000 to install a hard-wired monitoring network. "The hard-wired installation cost estimate was outrageous, and with the economy the way it is, there was no way we could do it," Borham said. "The cost of installing the wireless network was 60% less than a hard-wired solution."

In the third application, the company installed Rosemount wireless transmitters on 11 oil-storage tanks located inside and outside its facility. The devices are connected to, and convert the 4–20 mA signals from, existing hard-wired pressure transmitters that measure tank levels. Environmental managers are alerted if oil levels are high or if a spill occurs. "If there is a spill, we know exactly which tank and what time it occurred," Borham says. "We can immediately work to contain it. We can also use the level data to monitor when to order more oil."

Two Emerson Smart Wireless gateways receive data sent continuously from these self-organizing networks and relay it to the plant's data historian. Some transmitters are located as far as 600 ft away from a gateway. The devices have transmitted data reliably despite harsh conditions, particularly in the processing areas, and even though the transmitters are installed in areas where they are separated by walls and equipment. "We've lost no data and had no problems with any of our wireless networks," Borham says. "It's so simple to expand networks to get new points and any kind of process data we want."

Borham adds that installation and commissioning were easy and fast for all applications. Some took only hours to get up and running. Severstal Wheeling's technicians and automation engineers performed the work themselves with assistance from Emerson. ❑

Emerson Process Management

FIGURE 2. The new Fisher 4320 position monitor delivers equipment-position data that would otherwise be unavailable in the control room, thereby improving plant performance and safety

SOLVING REGULATORY COMPLIANCE HURDLES

California cement plant meets air-quality emissions requirements despite rotating equipment and harsh conditions. CalPortland Co. uses a selective non-catalytic reduction (SNCR) process of spraying ammonia into its cement kiln to control emissions of oxides of nitrogen (NOx). The gradually sloped 540-ft-long, 13-ft-dia. kiln (Figure 4) rotates almost twice a minute and operates at temperatures as high as 2,800°F. In this application, CalPortland needed to monitor the temperature of the ammonia, the process gases as well as the kiln's slight vacuum. It had tried using a slip ring around the kiln to check these parameters, but frictional wear ground down

Emerson Process Management

FIGURE 3. The installation of 22 wireless position monitors helped this facility save $25,000 per incident related to the release of propylene and ethylene oxides

Emerson Process Management

FIGURE 4. This cement kiln rotates almost twice per minute and operates at temperatures up to 2,800°F — a case in point where wireless instrumentation excels over wires

the ring. Meanwhile, the growth of the kiln as it heated up broke insulators isolating the process signal.

"By installing this wireless network, we were able to monitor and treat the NOx in the kiln successfully when there was no other alternative," says Steve Tyrrell, CalPortland senior electrical supervisor. "Wireless was a brilliant option for our project. This has allowed us to comply with the NOx emissions regulations and improve control over the process."

The CalPortland installation includes a self-organizing wireless network of field instrumentation that reliably monitors the process used to reduce NOx emissions inside a rotating cement kiln at the facility. The wireless network includes four Rosemount wireless temperature transmitters, one wireless differential-pressure transmitter, and an Emerson Smart Wireless Gateway.

"With a rotary kiln, the continued addition of process variable instrumentation to optimize the control strategy becomes overwhelming. The wireless option allowed for movement of the process indicators to various positions on the kiln for development of the control strategy," says Tyrrell. "Minimal maintenance of the wireless option also ensures reliability of the process signals for greater process control. We thought this was a perfect opportunity to apply wireless."

The installation of the four devices onto the kiln was completed in one day. The differential pressure transmitter was installed on the injection shroud to measure the extremely low vacuum inside the kiln. The temperature transmitters were installed at different locations around the kiln.

The self-organizing network transmits signals reliably to the Smart Wireless Gateway despite the fact that devices are installed at opposite sides of the kiln. The line-of-sight view is blocked at times between some devices and the gateway, but no data has been lost. The gateway is integrated with the facility's existing programmable logic controller system.

"Our plan is to equip our second kiln at this facility with the same equipment later as market conditions dictate," Tyrrell says. ❑

ELIMINATING PRODUCT DEFECTS AND EH&S RISKS

Huntsman's Port Neches facility implements a widescale mobile operator solution and reduces the number of pumps requiring daily inspection by 50%. Last month, Huntsman Corp., a global manufacturer and marketer of differentiated chemicals, completed work on an aggressive industrial-wireless project aimed at eliminating injuries, product defects, and environmental releases at its Port Neches, Tex., facility. Termed "Project Zero", this program was centered around a completely mobile solution to empower operations and maintenance personnel to capture product defects, track work progress and make process and safety related decisions in realtime.

Huntsman Port Neches faced four fundamental challenges that its phase-one wireless implementation needed to address the following:

- Design and implement a system that could execute both business value and process improvement while adhering completely to its Project Zero approach
- Implement a wireless solution that would replace a completely manual approach consisting of pen-and-paper recording and phone calls
- Reduce high costs due to equipment downtime and lifecycle run time
- Roughly 30% of the workforce eligible for Huntsman's retirement program and the majority of the plant knowledge has not been captured or documented for use by the newer, inexperienced workforce

To address these challenges, Huntsman partnered with three key vendors. Industrial Mobility's (The Woodlands, Tex.), MobilOps field mobility software enables field operators to execute rounds, enter work requests for defects in realtime, monitor and control standard operating conditions (SOCs) for each piece of equipment, and access the most up-to-date, approved standard-operating procedures (SOPs) for execution in the field, including consequences of deviation (CODs) and corrective actions (CAs). The MobilOps software runs on MC9090 rugged, mobile handheld computers from the Enterprise Mobility Solutions business of Motorola (Holtsville, N.Y.). The ION System, from Apprion (Mountain View, Calif.), serves as the wireless infrastructure throughout the plant for applications that include video, voice communications, energy efficiency and condition monitoring. The ION System includes IONosphere, a centralized dashboard that brings together application data, regional maps, and equipment-status and maintenance views and reports.

The new wireless-mobility solution installed at Huntsman replaced a completely manual process. Instead of using pen, papers and clipboards to record critical field data and then either carrying the paperwork to the central data area or calling in the data via the phone for input, now Huntsman field personnel can automatically execute inspections of non-instrumented equipment (rounds) and confirm equipment conditions.

To date, Huntsman's Mobility Solution is in three units at the 4-mi^2 site. Initial results show significant improvements and indicate the goals of Project Zero will be achieved. With realtime wireless tracking of the rounds activity, the number of pumps requiring daily inspection has reduced by 50% — allowing more time for other more crucial inspection areas.

The new automated Mobility Solution has already provided:

- Improved equipment reliability, reduced maintenance costs and process improvements
- 75% reduction in safety incidents
- Improved defect capture
- Increased equipment uptime and associated production quality and quantity improvements ❑

DEMONSTRATING INTEROPERABILITY

Texas Gulf-Coast facility is the first to undertake a multi-vendor, ISA100.11a-compliant field test. Within 10 days of final ratification of the ISA100.11a standard for wireless automation, the ISA100 Wireless Compliance Institute installed a multi-vendor user test at an Arkema plant in Crosby, Tex. The purpose of the test was to demonstrate the standard's ability to achieve interoperability among devices from multiple vendors.

Arkema's site in Crosby produces liquid organic peroxides. Like many CPI facilities, the plant was built in stages, and has three different generations of process control technology, says Didier Auber, plant manager. So, a key selling point for wireless implementation was the ease and low cost of bringing all the data into one, centralized control room. Meanwhile, the facility installed nine wireless sensors, which immediately improved the process safety of the plant and will ultimately reduce the need for operators to physically monitor remote locations.

For instance, the site includes numerous cold-storage warehouses operating at temperatures below 0°F. If these warehouses exceed a certain temperature, the peroxides can potentially decompose and ultimately catch fire. Local weather conditions at the site cre-

Arkema

FIGURE 5. A wireless pressure transmitter was installed on this firewater tank, replacing a simple mechanical sight gauge that fails full

WIELDING WIRELESS WARES

Apprion	www.aprion.com
Emerson Process Management	www.emersonprocess.com
Gastronics	www.gastronics.com
Honeywell Process Solutions	hpsweb.honeywell.com
Industrial Mobility	www.industrialmobility.com
Invensys	www.ips.invensys.com
Motorola	www.motorola.com
Wilson Mohr	www.wilsonmohr.com
Yokogawa	www.yokogawa.com

ate a propensity for high winds, which periodically reach hurricane force. High wind speeds not only increase the likelihood that a door will open unintentionally and let in warmer air, but they increase the danger for the operators who must walk out on hourly rounds to check the doors. Temperature was already being reported to the control room by wire, with an audible remote alarm to indicate if a door is left open. But the delay in temperature change can take many minutes if not hours to reveal itself through those means. Wireless door and temperature sensors (for redundancy) from Honeywell Process Solutions (Phoenix, Ariz.) were added to the three warehouses, providing central reporting of exception conditions.

The interoperability test at Arkema also includes a wireless gas sensor from Gastronics (Bedford Heights, Ohio) and Yokogawa's (Sugarland, Tex.) early prototype wireless-pressure transmitter, which replaces a simple mechanical sight gauge on the firewater tank (Figure 5). All installed transmitters have been tested for ISA100.11a compliance using a noncommercial version of the Wireless Compliance Institute's Device Interoperability Test Kit (ITK), which is scheduled for commercial release in early 2010. Meanwhile, plans for additional wireless transmitters are in the works at Arkema and will act as 4–20-mA adaptors to existing wired sensors.

All deployed transmitters at Arkema have routing capability, so as more transmitters are added the number of possible ISA100.11a mesh connections will increase exponentially. The ISA100.11a sensor mesh extends coverage to the edges of the 50 acre facility while providing redundant paths of communication in case the primary route fails. "The mesh is important in terms of system reliability because you don't always have a clean line of sight back to the control room," explains Ryan Burke, maintenance and engineering manager at the Arkema Crosby plant.

So far, however, all transmitters have been primarily communicating directly through one of the Honeywell wireless backbone routers. In fact, the only real surprise the project has faced is not experiencing the worst-case conditions that make having a mesh necessary. During preparation for the initial press demonstration at the plant, Andrew Neeb, wireless business development leader at Wilson Mohr, Inc. (Sugarland, Tex.), the system integrator on the project, had to bring in a couple of tractor trailers to introduce physical obstructions and force the system to mesh. ■

Rebekkah Marshall

DIAGNOSTICS: SIMPLIFYING OPTIMIZATION

Improved programming and interfaces are making it easier for end users to marry process control, asset management and diagnostic data

Emerson Process Management

FIGURE 1. These new Device Dashboards simplify predictive diagnostics and shorten the time to convert information to decision-making and action

As the chemical process industries (CPI) continue to focus on improving operations and lowering costs, interest in process automation diagnostics, which can play a critical role in helping processors reduce maintenance spending, continues. "Processors are beginning to realize that good diagnostics can help them reduce their overall costs," says Moin Sheikh, marketing manager with Siemens Energy and Automation (Spring House, Pa.). Coupled with the nearly limitless potential and growing acceptance for accessing data wirelessly (for more, see p. 17), the spark of interest has prompted vendors to include technologies with improved logic, diagnostic data that is easier to exploit, and systems and services that help end users assimilate the plethora of data into their work processes.

Process system diagnostics

Obviously one of the key duties of a process automation system is to control the process, and plant asset-management systems serve as an extension of those systems. "When you have all these assets communicating information back to a central location, such as a DCS, you can not only get information about process conditions and parameters; you can also use the same mechanism to gather diagnostic information from these assets," says Sheikh.

Process assets typically include valves, instrumentation, control system equipment, output modules, logic solvers, drives or anything else that's part of the process, such as heat exchangers, boilers and mechanical equipment. These process components not only provide information about their own conditions, but can also provide insight into the process parameters when an asset management system is used in conjunction with a process control system.

The combination of the two systems allows diagnostic information to be mined out and, once this diagnostic information is integrated into a DCS, it becomes very relevant, explains Sheikh. "You can look at a process parameter, such as temperature or pressure, and also look at the asset that's generating that information so you get diagnostic data from the asset as well as the process," he says.

Stuart Harris, vice president of marketing, asset optimization with Emerson Process Management (Austin, Tex.), agrees. "There's been a tremendous amount of work done in putting predictive intelligence into these devices to the point where they can not only diagnose themselves, but they can also serve as the eyes and ears of the process and the plant," he says.

Having such holistic information helps reduce downtime and increase plant activity because knowing what's going on with both the process and the involved assets prevents breakdowns before they occur, says Amit Ajmeri, a consultant for field network technology with Yokogawa Corp. of America (Newnan, Ga.). Planning and scheduling maintenance activities and resources are also better handled when accurate, detailed diagnostic information is available.

Technology improvements

Many automation providers are adding logic on top of their asset management solutions to keep tabs on diagnostic data from various assets, enabling predictions to be given ahead of time. Once the asset management system uses its logic to determine that a device needs maintenance in the near future, a notification tool sends the message to the DCS, an email to the appropriate person and/or gives an alert via the system itself. Following this alert, users of the system can input detailed information, and if a specific condition is recognized by the logic in the system, it spits out probable causes and actions that will correct the situation.

And, improvements to technology are making this holistic approach easier for processors to achieve. Machinery protection is a profound example. In traditional control systems, integration is complex and expensive, requiring Modbus and system expertise as well as specific machinery knowledge. Typical machinery protection systems can require more than 2,000 steps and up to five days to set up. The latest release of Emerson Process Management's DeltaV digital automation system, however, is preconfigured for machinery protection and thereby completes the same installation in three simple steps that take less than ten minutes, says Craig Llewellyn, president of Emerson's Asset Optimization division.

Of course, one size does not fit all when it comes to logic for the process itself. Programmable logic is key to making a diagnostic system work on an individual basis. For this reason, many vendors are working to improve their logic so it is easier to program. Yokogawa, for example, offers Exapilot, which automates standard operating procedures to provide early detection of process and device abnormalities. The software also provides tools that allow operators to create and automate their own operating procedures.

Yokogawa Corp. of America

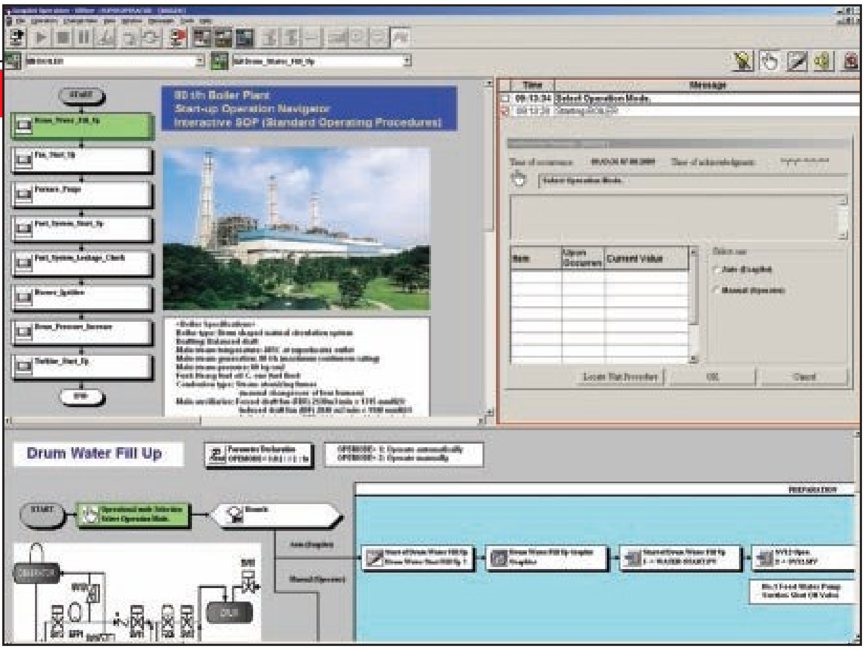


FIGURE 2. Exapilot automates standard operating procedures to provide early detection of process and device abnormalities. The software also provides tools that allow operators to create and automate their own operating procedures

Exapilot simplifies the creation of programs, monitors operation progress and navigates appropriate actions. In addition, the advanced alarm function permits monitoring programs to be created by pasting each of the monitoring icons in a logic chart diagram and provides a visible process and device status. When used in combination, the advanced alarm function and

ANNIVERSARY
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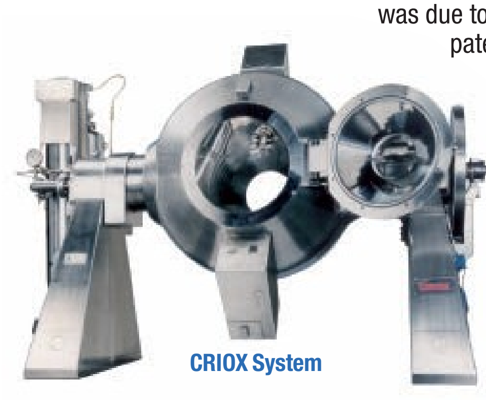
italvacuum

70 years of experience in vacuum drying and vacuum pumps for fine chemicals, intermediates and active pharmaceutical ingredients

Ever since its foundation in 1939, **Italvacuum** has manufactured industrial vacuum pumps and vacuum dryers for process use in the chemical, pharmaceutical and cosmetics industries.

In the 1950s Italvacuum broadened its market base by developing rotary dryers in addition to cabinet tray dryers. The original cylindrical rotary dryers – today sold under the name **Tumble Dryer** for drying, mixing and condensing in the manufacture of plastic granules – were soon followed by double-cone types. The latter saw such international success that by the mid-1980s they had become one of the company's best-selling lines. This was due to the introduction of the patented **CRIOX System**, which is also capable of creating powders thanks to powerful lump-breakers inside the vessel. These crush any blocks inside the mass and prevent the formation of new lumps, yielding product in the form of loose dry powder ready for storage or final sieving. Italvacuum has sold around 400 CRIOX System units to date.


CRIOX System

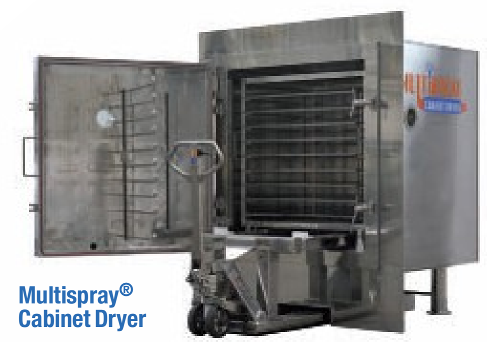
By the beginning of the 1990s accelerating growth brought a need for restructuring and optimization. The Technical Office, the Engineering Services, the Sales Office and Customer Service departments were strengthened. At the same time the Spare Parts Warehouse, with its computerized management system, was updated to ensure effective and timely delivery of original spares to anywhere in the world.

In the new millennium Italvacuum has been committed to improving its vacuum pumps. Developments include the new **Saurus939** range, fitted with the new LubriZero® lubrication system. Saurus939 pumps provide incomparable performance in all the main chemical and pharmaceutical processes – such as drying, distillation and reaction – even under severe operating conditions, with unchanging efficiency over time.

Saurus939 vacuum pump


At the same time, Italvacuum has continued to optimize and extend its range of dryers. Recent developments include:

- hygienic automated Criox System equipment for loading and unloading. This prevents cross-contamination and ensures that operator exposure meets the most stringent health and safety regulations;
- the **Multispray® Cabinet Dryer**. This new static dryer is equipped with the patented CIP Multispray fast washing system, allowing the drying chamber and shelves to be cleaned thoroughly in just a few minutes;
- the **Planex System®**, a brand-new patented horizontal paddle vacuum dryer carefully designed to overcome the peculiar limitations of traditional paddle dryers. The Planex System has an eccentric agitator, much smaller in diameter than the mixing chamber, with two independent axes of movement. The peculiar configuration of the agitator and its double combined rotation allow the product to revolve continuously and prevent local overheating by limiting mechanical stress and friction. Mechanical and thermal stresses on the product are about one-third of those found in traditional dryers, according to an independent analysis by Professor M. Vanni of the Material Science and Chemical Engineering Department at the Politecnico di Torino.


Multispray® Cabinet Dryer



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Today's Italvacuum is a modern and consolidated company employing 60 people in a production area of more than 5,000 m^2. With an ISO 9001 quality management system and continuous quality control throughout the production cycle, all Italvacuum machines comply with the main international regulations (CE, ATEX, PED) and the increasingly stringent FDA rules and cGMP standards. ■

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manual operation function allow for early detection of device abnormalities and dealing with them quickly. For example, adjusting the aperture of a control valve in response to changes in the performance of a compressor ensures stable operation.

Other technology improvements allow users to not only diagnose and troubleshoot, but also to do a complete analysis of diagnostic data. Siemens' PCS 7 Plant Asset Management suite performs all the usual tricks: It is able to generate diagnostic information from a control system configuration with just a few clicks of the mouse, have that data automatically populate and create a visual of the plant with all the assets and recommend what type of tasks should be performed. However, the system takes it a step further by logging all the diagnostic information. "In a manner similar to the event logs in alarm management systems, the same methodology allows the tool to archive all messages related to asset diagnostics in a single database," says Sheikh. "Once you have access to that kind of information, it can be used to do statistical analysis to determine which pieces of equipment are causing the most problems."

The system allows users to make histograms and charts and look at the frequency of different alarms. This provides maintenance managers with an indication of which assets need to be fixed in order to reduce unplanned downtime.

Making it easier for the user

While the advanced logic and new capabilities provide more data, it's important to get that information into the work processes within the plant, say the experts. "With the new technology comes more data, but not everyone knows how to use that data to their maximum benefit," says Yokogawa's Ajmeri "All the tools we're talking about only provide information and data, but how that data are implemented into the work processes is something else entirely."

To help users incorporate diagnostic data in a helpful way, Yokogawa offers the RPO (Real-time Production Organizer) suite of applications. RPO is a collection of software components and infrastructure that connects monitoring and control applications with production management applications. It provides users with "Advisory Live Information" in a way that allows end users to make intelligent business decisions. The tool provides the right information in context to the specific workers who need it, when they need it.

"After analyzing the diagnostic data, the end user figures out where in the workflow the changes need to be made. RPO serves as a way to organize workflow items, including corrective actions, within a plant for operations and tracks the success of workflows," says Ajmeri.

APPLYING DIAGNOSTICS TO ENERGY EFFICIENCY GOALS

While process automation diagnostics are helpful in reducing maintenance costs, diagnostics can also help reduce energy costs. Because energy management is becoming more critical in today's current economic and regulatory environment, Honeywell Process Solutions (Morristown, N.J.) has developed a monitoring solution, the Energy Dashboard, that provides complete integration with the overall information and work processes of a facility to help better manage energy use within the plant.

The integrated monitoring and decision-making suite gathers information from various instruments, systems and processes so energy consumption can be tracked against dynamic energy targets, according to Brendan Sheehan, senior marketing manager, process industries, with Honeywell. Capturing and analyzing these data allow users to understand key energy indicators and how they affect overall energy consumption, enabling users to establish specific goals for improving energy use and emissions reduction objectives. The Dashboard ensures that energy management flows from planning and business functions through to operations and provides the associated feedback. It captures raw energy data from the process and organizes them in a way that enables users to quickly identify the big energy consumers and how they compare with a set of appropriate targets.

A set of analytical tools helps develop models that describe the relationship between process operating conditions (such as throughput, yield and other operating parameters) and process energy and emissions. These are derived from a combination of historical data and the use of first principles simulation tools to represent the process across a range of operating points.

These models provide targets for process operations and planning groups to measure against actual performance and to identify deviations. Actual performance is monitored in real time and compared against targets from planning systems and against target models based upon current operating conditions. Deviations are measured, and economic impacts are calculated using a range of methods. Operators and other staff can select reason codes for deviations, as well as input comments to provide later analysis of results. Data reconciliation is used to drive out errors and maximize the use of available instrumentation and data.

"By first measuring and monitoring their energy performance against active targets and then using that to help them identify where their poor energy performers are, it can help processors identify root causes of energy issues and find a solution," says Sheehan. "This type of information is essential for operational improvements as well as justifying capital improvements down the line." ❑

Under the current economic situation, simplified work processes are even more critical. "Enhanced usability is a serious need for end users who are pressured by larger facilities run by fewer and less experienced personnel," says Duane Toavs, director of Emerson's Human Centered Design Institute. "They want technology to work for them, streamlining their routine scanning of plant assets, quickening their recognition of issues, and shortening the time to convert information to decision-making and action; and they don't want to require experts to do this, or undergo massive training to make it work."

One of Emerson's answers to the usability challenge is a family of more than 50 Device Dashboards for its AMS Suite: Intelligent Device Manager. Developed from human-centered design practices, the new dashboards provide, in one glance, a clear view of everything users need to evaluate, diagnose, and configure a field device. Each has embedded expert guidance to streamline the most important and frequent tasks performed by plant operations, engineering and maintenance personnel. The Device Dashboards are powered by enhanced electronic device description language (EDDL), so they function independent of protocol, including HART, WirelessHART, Foundation Fieldbus, or Profibus, and present data in a similar user experience regardless of the device.

The dashboards are easy for both experienced and the inexperienced worker. All landing screens follow a similar format including red-yellow-green device-status graphics to alert users and enable a direct link to graphical diagnostic and troubleshooting help. The same screens show graphical display of the primary variable of devices; and shortcuts to most-often-used tasks. Guided setup assists with configuring complex devices. If desired, more experienced users can access manual setup data and more detailed information.

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ABB	www.abb.com
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Honeywell Process Solutions	www.Honeywell.com
Invensys	www.invensys.com
Siemens Energy and Automation	www.siemens.com/process
Yokogawa Corp. of America	www.yokogawa.com

ABB also offers diagnostic services. "If our customers don't follow up diagnostic data with implementation of corrective actions and then more actions to sustain it, it doesn't give them the boost in performance they are looking for," says Kevin Starr, global service development manager with ABB (Houston, Tex.). "For this reason we preach diagnose, implement and sustain."

To this end, ABB offers it's Process Fingerprint service, which allows ABB to diagnose 200 to 300 control loops that represent a process area at the desired frequency of the customer. "The service provides a troubleshooting and periodic delivery of diagnostics that the user can schedule according to their needs," explains Starr.

The diagnostic phase uses a structured engineered approach, including proven methodology and in-depth knowledge of systems and processes. It provides comprehensive testing and analysis of several process performance indicators including high-frequency analysis, process stability and control loops to measure performance and identify improvement potential. Existing process controls are compared with industry standards, as well as actual operating data to expected capability. The resulting process performance benchmark provides information needed to identify and understand areas of improvement opportunity.

Based on "fingerprint" findings, a customized implementation plan is developed, including estimated return on investment for each recommendation. Implementation engineering services are available to help customers achieve the benefits of identified opportunities. Once optimization goals have been met, ABB's expertise is offered as a service contract to sustain the financial and operational benefits gained through the optimization process.

"For diagnostics to be valuable, they have to be presented in an environment or application that is already working and they have to be in the context of what they are trying to achieve," says Emerson's Harris. "The approach of linking diagnostic data with equipment and activities that support the business goals helps build a bridge between the diagnostics that are out there and what the user should be doing with them. By taking advantage of the advances in process automation diagnostics technology and using the diagnostic information to make repairs to the equipment that is most critical to the business goals in a pre-emptive manner, chemical processors will find the best results and can boost their productivity levels." ■

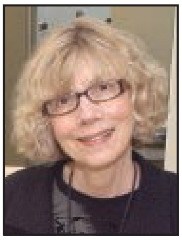
Joy LePree

WHO'S WHO


Barlow


Mink


LaSelle


Fowler


Mayhew

GE Water (The Woodlands, Tex.) names *Buzz Barlow* global general manager — hydrocarbon processes.

Kim Ann Mink becomes president and CEO of Dow Chemical subsidiary **Angus Chemical Co.** (Buffalo Grove, Ill.). She also serves as global general manager of Performance Materials, another Dow business unit.

Rush LaSelle becomes director of global sales and marketing for robotics and automation company **Adept Technology** (Pleasanton, Calif.).

Invensys Operations Management (Plano, Tex.) adds *Ravi Gopinath* as regional president of the Asia Pacific region and *Teemu Tunkelo* as regional president for the Europe/Russia/Africa region.

Todd Caccamo becomes director of sales and marketing for **B&P Process Equipment** (Saginaw, Mich.).

Joanna Fowler, a senior chemist and director of Radiotracer Chemistry, Instrumentation and Biological Imaging at the U.S. Dept. of Energy's **Brookhaven National Laboratory,** (Upton, N.Y.), receives the National Medal of Science, the highest award for lifetime achievement in science.

Teuvo Salminen deputy to the president and CEO of **Pöyry PLC** (Vantaa, Finland) voluntarily steps down in January. His replacement has not yet been announced.

Brian Mayhew is named comptroller and CFO of **PolyMedex Discovery Group** (Dayville, Conn.). ■

Suzanne Shelley

Aboveground and underground storage tanks

The ultimate objective of storing liquid, fluid and gaseous products, which may be corrosive, flammable or unstable, is to store material in an environmentally safe and economically viable manner. Storage tanks in the chemical process industries (CPI) can be most broadly divided into those buried underground, and those constructed aboveground. The following is an outline of considerations associated with each category and positive and negative aspects of each. Also included are potentially applicable regulations and codes from the U.S. Environmental Protection Agency (EPA), the Occupational Health and Safety Administration (OSHA) and others.

UNDERGROUND STORAGE TANK (UST) ADVANTAGES

Physical safety — USTs are out of the way of automobile traffic

Fire safety — With a relatively constant underground temperature, USTs have superior vapor suppression and fire protection for flammable and volatile contents, as well as a reduced need for fire hazard permits

Security — The American Petroleum Institute has shown that vandalism is a leading cause of tank failures. USTs are less subject to vandalism and easier to protect

Aesthetics — USTs are out of sight, which eliminates a possible public objection

Land use — USTs offer a more efficient use of land space and allow more flexibility in placement location

UST DISADVANTAGES

Leak detection and containment — Leak monitoring, detection and containment is more difficult and more expensive underground

Installation complexity and cost — Excavation and special backfill materials add costs

Depreciation — Real estate depreciation is possible due to threat of contamination

ABOVEGROUND STORAGE TANK (AST) ADVANTAGES

Construction — ASTs are simpler and less expensive to construct and install. One significant aspect eliminated is the need for excavation and special backfill materials

Maintenance — Visual inspection is possible, which leads to more reliable leak detection and easier repair

Insurance — Lower pollution insurance premiums because of reduced risk of groundwater contamination

Regulatory burden — ASTs are subject to less regulatory requirements than USTs

Costs — ASTs have lower monitoring and record-keeping costs

REGULATIONS AND CODES POTENTIALLY APPLICABLE TO UST AND AST

Regulation name	Applicability	Governing Body
Resource Conservation and Recovery Act Subtitle C — hazardous waste regulations	AST and UST	EPA
Spill Prevention, Control and Countermeasures within Clear Air Act amendments of 1990	AST and UST	EPA
Hazardous Waste Operations and Emergency Response Regulations — 29 CFR 1910.120	AST and UST	OSHA
Flammable and Combustible Liquids Standard — 29 CFR 1910.106	AST and UST	OSHA
Hazard Communication Standard — 29 CFR 1910.1200	AST and UST	OSHA
Confined Space Safety Standard — 29 CFR 1910.146	AST and UST	OSHA
Oil Pollution Act of of 1990	AST only	EPA
National Pollutant Discharge Elimination System	AST only	EPA
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	AST only	EPA
Benzene — 29 CFR 1910.1028	AST only	OSHA
Process Safety Management of Highly Hazardous Chemicals, Explosives and Blasting Agents — 29 CFR 1910.119	AST only	OSHA
Resource Conservation and Recovery Act Subtitle I — regulations addressing USTs storing petroleum and hazardous substances — 40 CFR 280	UST only	EPA
Stage II Vapor Recovery Regulations — established in Clean Air Act Amendments of 1990	UST only	EPA
Clean Air Act Title V — operating permits	UST only	EPA
Emergency planning and Community Right-to-know Act — Title III of Superfund Amendments and Reauthorization Act.	UST only	EPA
National Fire Protection Association NFPA 30 (Flammable and Combustible Liquids Code)	AST and UST	NFPA code
International Code Council (ICC) International Fire Code	AST and UST	ICC code

AST DISADVANTAGES

Physical safety — ASTs are more vulnerable to vandalism, contact with automobiles and external damage

Fire safety — ASTs have an elevated fire risk relative to USTs

Aesthetics — ASTs may be objectionable in certain locations

Space use — more real estate required to house ASTs

Temperature variation — ASTs experience greater ambient-product-temperature fluctuations than USTs

MAKING THE CHOICE

When making decisions about whether to use an AST or a UST, consider the following:

Regulatory — The local authority in the area where the tank system will be assembled has control of whether a tank permit will be issued, based on whether plans for the tank comply with local, state and federal requirements. Regulatory frameworks are different for AST and UST

Space — Space requirements to separate an AST from traffic, buildings, property lines, present and future can be significant, while they are not an issue for USTs. Fire codes generally dictate separation distances

Security — Protection from vandalism is more difficult for ASTs

Cost — Several aspects of cost should be considered, including: storage tank, tank system equipment, initial installation cost, ongoing maintenance cost, security cost, land cost, regulatory cost and secondary containment cost

References:

1. Geyer, W.B. To Bury or Not to Bury: Steel Tank Technology Decisions. In: "Handbook of Storage Tank Systems," Marcel Dekker, New York, 2000.
2. Cheremisinoff, P.N., and Vallamar, O. Aboveground and Underground Storage Tank Comparison. In: "Storage Tanks. Advances in Environmental Control Technology Series," Gulf Publishing, Houston, 1996.


Do you see a ladybug?
We also see an opportunity for industry
to benefit from protecting the environment.
Managers within the industrial sector face the never-ending issue of balancing business performance and environmental compliance goals. As the world reference in environmental services, Veolia Environnement helps industry achieve sustainable objectives through our four core service areas: water services and technologies, waste services, energy and facility management, and transportation and logistics.
The environment is our universal challenge.
VEOLIA
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Circle 35 on p. 62 or go to adlinks.che.com/23020-35

The New

ChemShow

Processing Solutions for a Changing Marketplace

Thermo Fisher Scientific

Boerger

Dynaflow Engineering

JAG flocomponents

ChemShow 2009

The 53rd Chem Show 2009 exhibition will be held November 17–19 at the Jacob Javits Convention Center in New York with the theme "Processing Solutions for a Changing Marketplace"

Fluid Imaging Technologies

The following partial list of Chem Show exhibitors continues the one published in the October 2009 issue of *Chemical Engineering*. Show attendees are encouraged to visit us at Booth 703.

This floating ball valve uses reinforced Teflon seats

The T2W stainless-steel, floating ball valve (photo) has reinforced Teflon seats and graphite gaskets. It can accommodate pressures up to 2,160 psi and temperatures up to 450°F. Product features include seal welding, locking handles and a fire-safe design that meets the requirements of American Petroleum Institute (API) Standard 607 (fire test for soft-seated, quarter-turn valves). The T2W is American Society of Mechanical Engineers (ASME)-compliant and comes with threaded ends in sizes from ¼ in. to 2 in. Booth 368 — *JAG flocomponents, Edmonton, Alta., Canada*
www.jagflo.com

This rotary lobe pump features pulsation-free operation

This positive displacement pump (photo) operates without pulsing, and contains several additional technical features, such as a flow range of up to 5,000 gal/min. The self-priming rotary lobe pump has a maintenance-in-place (MIP) design and can be customized with different shaft seal designs, rotor materials and coatings. Booth 351 — *Boerger GmbH, Borken-Weseke, Germany*
www.boerger-pumps.com

Improved particle imager is available at lower cost

A more compact version of the FlowCAM V-1000 (photo) automated particle imaging instrument is now available. The new version is available at a lower cost than its predecessor. FlowCAM enables process engineers to take high-resolution digital images of particles and cells in a sample and simultaneously collect realtime data on particle size, shape, length, width and other parameters for further analysis. The instrument comes with software and is designed for use in the chemical, pharmaceutical, food, plastics, coatings and manufacturing industries. Booth 616 — *Fluid Imaging Technologies, Yarmouth, Maine*
www.fluidimaging.com

Note: For more information, circle the 3-digit number on p. 62, or use the website designation.

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Berndorf Band

Lower measurement times with these handheld analyzers
The XL3t Series analyzers (photo, p. 32D-2) can lower measurement times by about 10-fold compared to conventional silicon-PiN (positive-intrinsic-negative) detectors, and are widely used for metal alloy analysis. The handheld analyzers are equipped with geometrically-optimized, large-area drift detector (GOLDD) technology, which enables laboratory-quality analysis of light elements such as magnesium, aluminum, silicon, phosphorous and sulfur without helium or vacuum purging. Booth 736 — *Thermo Fisher Scientific Inc., Billerica, Mass.*
www.niton.com

These pumps are designed for harsh chemicals
These Mag-Drive gear pumps (photo, p. 32D-2) are constructed of chemically resistant materials. Made of alloy 20 (nickel-chromium-molybdenum stainless-steel), one pump type is specifically designed to handle the metering or transfer of sulfuric acid at all concentrations. Other Mag-Drive gear pump constructions, made of Ryton plastic or 316 stainless steel, offer a less expensive alternative to alloy pumps in handling hydrochloric acid, sodium hypochlorite and other chloride-bearing chemicals. Booth 913 — *Dynaflow Engineering Inc., Middlesex, N.J.*
www.dynafloweng.com

This DCS is well-suited to smaller plants
The Experion LS process control system manages all continuous process control applications and optimizes batch and sequence-oriented applications typically found at specialty chemical, pharmaceutical, food-and-beverage and consumer goods plants. Its design allows manufacturers increased flexibility to adapt their processes to respond to market changes, but still offers process and batch control features that maintain process reliability and control lifecycle costs. The system is scalable to varying sizes, and is easier to configure and maintain than a programmable logic controller (PLC) or distributed control system (DCS). Booth 427 — *Honeywell Process Solutions, Morristown, N.J.*
www.honeywell.com

Save space with these blast-resistant modules
The Quad Pod (photo) is a two-story stack of this company's standard blast-resistant modules for personnel and storage. The stacked two-by-two set of four units is available in three floorplans — 8 ft by 20 ft, 8 ft by 40 ft and 12 ft by 40 ft. Quad Pod setups are designed for easy installation and teardown with no welding required at the job site. This company offers the only two-story, blast-resistant module lease fleet available. Booth 827 — *A Box 4 U, Wichita, Kan.*
www.abox4u.net

Save time by drying product inside this centrifuge
The HF Model centrifuge offers the capability of contact drying a product inside the centrifuge equipment. The all-in-one separation and filtration equipment features inverting filter technology, thin-cake processing technology along with the ability to contact dry the product. The machine is designed for delivering high-production capacities and for handling materials that are difficult to filter. The HF centrifuge also will leave no residual heel remains on the filter cloth, and can accomodate management of a flexible process. Booth 729 — *Heinkel Filtering Systems Inc., Swedesboro, N.J.*
www.heinkelusa.com

Handle high-viscosity materials with this mixer
Powered by a heavy-duty totally enclosed, fan-cooled motor that is rated at 0.75 hp, the Model DH-050 Double Helixx mixer (photo, p. 32D-5) is designed for 1–5-gal batches of highly viscous materials. Among the materials handled by the mixer are two-component epoxies, greases, adhesives, floor coatings, pastes and solid powder mixtures. The mixer is controlled with a NEMA-4 (National Electrical Manufacturers Associa-

ARDE Barinco

tion) variable-speed PWN d.c. motor with speed control. — Booth 103, *ARDE Barinco Inc., Carlstadt, N.J.*
www.arde-barinco.com

This pastillating system is designed for low maintenance
The AccuDrop pastillating system (photo, p. 32D-4) demonstrates high production rate and consistent product quality in a low-maintenance rotary depositor system. It is ideal for antioxidants, calcium chloride, hotmelts, hydrocarbon resins, sulfur, waxes and more. Booth 461 — *Berndorf Band GmbH, Berndorf, Austria*
www.berndorf-band.at

This fire-extinguishing system avoids the use of toxics
The Vortex 1000 hybrid water and inert-gas fire suppression equipment extinguishes fires with a high-velocity, low-pressure mixture of water and nitrogen to put out fires without toxic chemicals. Designed for fire suppression with limited residual moisture, the system can be utilized in a sealed or open space in applications such as oil pumps, oil tanks, fuel filters, generators, transformer vaults, gear boxes, drive shafts, lubrication skids, diesel-engine-driven generators and other similar machinery. Booth 349 — *Victaulic, Easton, Pa.*
www.victaulic.com

This software is designed for process optimization
The new version of the modeling software ProSimPlus (photo) can help with process optimization, unit troubleshooting, front-end engineering analysis, plant revamping and eliminating process bottlenecks. It features an easy-to-use graphical interface, a comprehensive unit-operations library and a unique thermodynamic module. Booth 838 — *ProSim SA, Labege, France*
www.prosim.net

Tight tolerances offered with these rupture discs
Axius rupture discs offer tolerances of ±1 psig for pressures greater than

Myers Engineering

15 psig in the 1–12-in. sizes. Designed for aggressive chemical and pharmaceutical applications, the discs are constructed of corrosion-resistant materials and are available with burst pressures from 7–600 psig. The discs are capable of operating with both liquid and vapor environments and can cycle from full vacuum to 95% of burst pressure more than 100,000 times, even at the lowest available burst pressures. Booth 521 — *Fike Inc., Blue Springs, Mo.*
www.fike.com

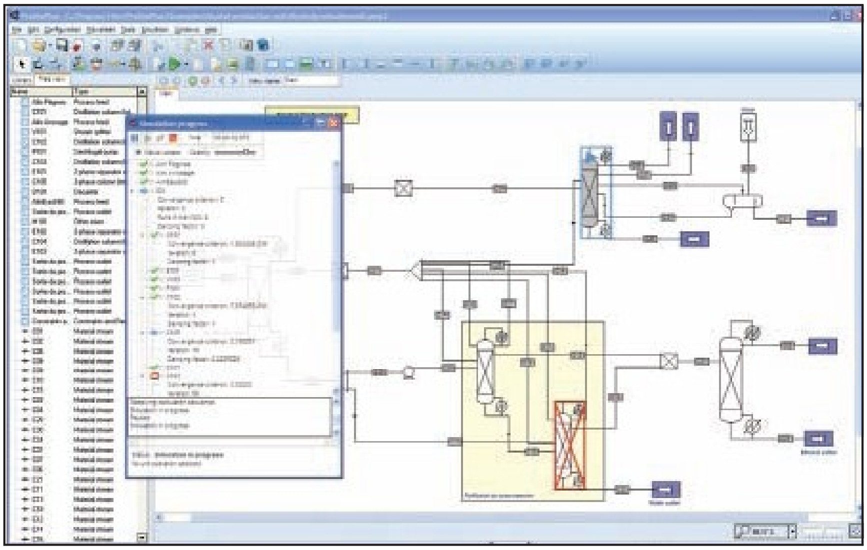
Handle hot melt epoxies with this mixing unit

This mixer (photo) is a hoist-mounted, dual-shaft unit designed to handle processing hot-melt epoxies with viscosities of 15,000 cP. Its electric heating system maintains temperatures between 140 and 200°F. The technology was developed for an aerospace materials producer and can be used in many advanced composite, resin-based processes. — Booth 634, *Myers Engineering Inc., Bell, Calif.*
www.myersmixer.com

A new decanter for food-and-drink applications

The GCF 405 decanter is designed for products that are difficult to discharge, which makes it suitable for use as a clarifying decanter in brewing and beverage industries. The multifunctional machine with a bowl diameter of 400 mm ensures maximum performance combined with high clarifying efficiency and maximum dry matter in the solids. This is achieved by the high speed, high torque, large clarifying area and the deep pond in conjunction with minimum space requirements. The machine is a so-called hydro-hermetic decanter with a pressurized separation chamber; pressure buildup enables the solids to discharge reliably. The new design also provides major advantages for foaming and degassing products. Booth 428 — *GEA Westfalia Separator GmbH, Oelde, Germany*
www.westfalia-separator.com

ProSim



This tool for blower selection incorporates humidity

An updated version of the BlowerXpert software tool incorporates relative humidity when used for air applications. The software is designed to aid the sizing and selection of rotary blowers in process applications. It can be used to size blowers based on discharge flow as well as inlet flow, and is available as a Web-browser-based system that can be customized. Booth 543 — *Tuthill Vacuum and Blower Systems, Springfield, Mo.*
www.tuthill.com

These filter housings can handle 10,000 gal/min

These affordable filter housings support a range of filters, strainers and separators for applications in chemical processing. The housings are constructed of carbon steel or stainless steel and can accommodate flow rates of up to 10,000 gal/min. There is no need for special tools to open the housings, and the surfaces are electropolished. The housings are available in single-bag, multibag and polypropylene models, and can be used in centrifugal separators, backwashing systems and coolant filter systems. Booth 603 — *Rosedale Products Inc., Ann Arbor, Mich.*
www.rosedaleproducts.com

Save space with this reverse cone strainer

This stainless-steel cone strainer with fine mesh filtration compresses effective flow area of a 20-ft cone strainer into a compact 4-ft strainer. Its flow filtration configuration conserves space and is easy to clean. The units can be custom-designed and fabricated to meet specific industrial requirements. Booth 727 — *Sure Flow Equipment Inc., Tonawanda, N.Y.*
www.sureflowequipment.com

Learn energy-saving tips with this DVD

A new DVD, titled "Energy Smart," includes tips designed to help organizations realize cost savings through managing energy use. The DVD course presents a business case for thoughtful energy management and outlines a host of low-cost, easy-to-implement energy-saving best practices used by the most energy-efficient organizations. The DVD is the first in a series of energy management e-courses. — Booth 113, *Coastal Training Technologies Corp., Virginia Beach, Va.*
www.coastal.com

Reduce energy use with this fluid delivery system

The AutoJet FDS30100 fluid delivery system is a portable pump designed for a wide range of tank-cleaning and spray nozzles. The pump is equipped with a variable frequency drive, which adjusts automatically to maintain pressure and can reduce energy consumption when operating at lower speeds. The AutoJet, along with its motor and touchpad control, are integrated on a compact cart. The system is compatible with spray balls, tank cleaning nozzles and general purpose full cone, flat spray, hollow cone and fogging nozzles.

Circle 40 on p. 62 or go to adlinks.che.com/23020-40

Show Preview

Fluid Metering

Mettler Toledo

Wilden Pump & Engineering

The AutoJet pump has a range up to 30 gal/min. at 100 psi. Booth 514 — *Spraying Systems Co., Wheaton, Ill.*
www.spray.com

Pump operators can select efficiency point and flowrate
Advanced Series metal pumps (photo) are air-operated double-diaphragm pumps featuring an air distribution system that helps allow operators to use an integrated control dial to select the efficiency point and flowrate that best suits the application. The pumps ensure total product containment while the redesigned liquid path reduces internal friction to maximize output and efficiency. Advanced Series pumps are available in aluminum, stainless steel and alloy C. With sizes from 25–76 mm, the Advanced Series pumps have flow rates that range from 212 to 1,021 L/min and maximum pressures to 8.6 bar. Booth 227 — *Wilden Pump & Engineering Co., Grand Terrace, Calif.*
www.wildenpump.com

Use this scale for filling and dosing applications
The IND560x weighing terminal (photo) is designed for process control as well as manual weighing in Zone 1/21 areas (those where an explosive atmosphere occurs regularly). It has a target update rate of 50 Hz, allowing users to tigger a process control in 20 ms. The scale features electromagnetic force restoration (EMFR) weighing technology, and is available with analog or high-precision scale interface. The design allows repeatable measurements from the milligram to ton scale in manual, semi-automatic and full-automatic operations. It can communicate via a variety of interfaces, including Ethernet and PLC (private leased circuit) connections. Booth 358 — *Mettler Toledo, Columbus, Ohio*
www.mt.com

Directly inject hydrazine into water systems with this system
The RHV System (photo) is designed to inject concentrated hydrazine as an anticorrosion agent directly into water and steam lines at system pressure, without dilution. The direct injection avoids the holding tanks and pumps needed for pre-mixing and dilution of hydrazine. The RHV can inject hydrazine at rates as low as 0.2 mL/min or as high as 180 mL/min within 1% accuracy. The energy-efficient RHV pump features chemically inert ceramics, and operates on less than 50 W. It is designed for use in water and steam systems in power plant applications. Booth 410 — *Fluid Metering Inc., Syosset, N.Y.*
www.fmipump.com

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 allow approximation of a production-scale centrifugation process. The basket has a solids-holding capacity of 41 in.^{3} and is able to reach speeds of 4,000 rpm. Booth 402 — *The Western States Machine Co., Hamilton, Ohio*
www.westernstates.com

Reuse this rupture disc detector after one-time installation
The Opti-Gard rupture disc is ASME-certified and has a reusable, non-invasive rupture detection device. The Opti-Gard is available in a number of sizes and burst pressures for various liquid, vapor and gas applications. The disc boasts a 95% operating-to-burst-pressure ratio and a performance tolerance of 3%. All Opti-Gard parts exposed to media flow are manufactured from either 316 stainless steel or corrosion-resistant Hastelloy C as standard. Booth 921 — *Oseco, Broken Arrow, Okla.*
www.oseco.com

A Hose series that meets a range of needs
Hoses from this company are designed for a variety of uses. The highly flexible X Series hoses feature a smooth-bore PTFE core and a bonded fiberglass inner layer to reduce kinking. The S Series has a smooth silicone cover to make the hose easier to clean. Lightweight C Series hoses have a PTFE core and helical convolutions to promote drainage. F Series hoses have a nonmetallic, smooth-bore PTFE core designed for chemical compatibility with a nonconductive braid. — Booth 403, *Swagelok Co., Solon, Ohio*
www.swagelok.com ■

Scott Jenkins

CiK Solutions

NOVEMBER New Products

WIKA

Pump Engineering

Rotex Europe

This mini data logger handles lots of data points

The MSR165 (photo) is a miniature, universal data logger for measuring and storing different physical parameters. The device is equipped with a temperature sensor, a humidity sensor with integrated temperature measurement, a pressure sensor and a three-axis accelerometer. Three optional ports, two for analog inputs and one for digital trigger input, are also available. The thumb-sized device weighs only 16 g and logs up to 1,000 recordings per second. Up to 2 million data points can be stored — more when expanded through SD RAM. — *CiK Solutions GmbH, Karlsruhe, Germany*
www.cik-solutions.com

A mag-drive pump that handles higher pressure

Recently launched by 3M Pumps and now available from this firm, the T MAG-M pump (photo) is a horizontal, sealless peripheral pump with a permanent-magnet drive system and no mechanical seals. Features include a high-power, synchronous magnetic coupling, which can be operated at liquid temperatures up to 350°C (without external cooling); a hydraulic design with a self-balancing impeller, which improves wear ring life; and a sealing system with flat gaskets, which prevents leakage to the atmosphere. The real shell is made in a single piece, without welding, and its ellipsoidal profile helps it to withstand higher pressure than traditional designs. The pumps deliver flows up to 12,000 L/h at pressures up to 16 bar. — *Pump Engineering Ltd., Littlehampton, U.K.*
www.pumpeng.co.uk

This screener now has side access doors

The APEX Screener (photo) is a self-contained production screening machine that retains the gyratory motion and efficient processing characteristics of the Rotex Screener, yet incorporates new, ergonomically designed performance and service features. As its predecessor, the APEX features gyratory, reciprocating motion, positive screen cleaning, bouncing balls to reduce blinding and inlet-outlet connections. It is also enhanced with side access doors to enable screen cleaning and changes that can be performed by a single person. — *Rotex Europe Ltd., Wavre, Belgium*
www.rotex.com

Plastic tubing for multiple lines of corrosives

Fluoroplastic Paratubing consists of two to four tubes thermally welded longitudinally to create one conduit of multiple, individual tubes. Paratubing enables running several fluid lines as one entity and then splitting the tubes apart for branching to different connectors. This tubing is available in Texfluor FEP and PFA, and is offered in sizes as small as 0.031-in. I.D. with 0.030-in. wall thickness and up to 3-in. O.D. Different colors are also available for identification of different lines. — *Parflex Div., TexLoc, Parker Hannifin Corp., Ft. Worth, Tex.*
www.texloc.com

Differential-pressure transmitters for sterile applications

The new DPT-10 differential pressure transmitters (photo) are now available with housings in electropolished stainless steel in combination with sterile process connections. The device can be used in combination with diaphragm seals or diaphragm inline seals, and the connection to seals can be made directly or via a capillary extension. The DPT-120 Series is particularly suited to level measurement in pressure-blanketed sterile tanks and for monitoring sterile filters. — *WIKA Alexander Wiegand SE & Co. KG, Klingenberg, Germany*
www.wika.de

Save considerable energy when mixing with these agitators

This firm has launched a new range of energy-efficient agitators designed to enhance flow by eliminating potential blockage areas. The detachable agitator shaft is completely smooth and the clutch is positioned outside the tank; this ensures excellent levels of hygiene, says the firm. Energy saving can lead to payback in less than one year compared to conventional, direct drive agitators. The high flowrate created by the uniquely shaped propellers provides much higher efficiency than blades with a standard pitch, which can lead to an installation that uses up to 80% less energy, says the firm. The product range includes top-mounted units — with (ALT) or without (ALTB) bottom support — the ALS side-mounted version, and the ALB bottom-mounted agitator. — *Alfa Laval AB, Lund, Sweden*
www.alfalaval.com

Surge voltage protection for sensor heads

Surgetrab surge-voltage-protection devices (photo, p. 32I-3) are for all commonly used standard signals that are installed with connection threads directly to the sensor head. This type

Note: For more information, circle the 3-digit number on p. 62, or use the website designation.

Phoenix Contact

Herbold Meckesheim

of installation is said to save time and money, and an additional connection box for accommodating surge voltage protection is no longer necessary. The housing is a robust hexagonal pipe made of V4A stainless steel with the option of 1/2-in. NPT or M 20X15 threading. — *Phoenix Contact, Blomberg, Germany*
www.phoenixcontact.com

Combining granulation with shredding in one machine

A new series of slow-running granulators is now available in two sizes: HGM 60/100 and HGM 60/145. The so-called Hog shredder (HGM; photo) is a single-rotor, size-reduction machine that combines the advantages of a granulator (size-reduction by knife cutting) and those of a shredder. The system handles difficult materials, especially viscous ones or those containing many foreign bodies where the service life of knives would be too short with traditional granulator. The Hog shredder can be used in both dry and wet operation. Typical applications include pre-shredded tires, metal-reinforced rubber or plastic parts and shredded waste from car recycling. — *Herbold Meckesheim GmbH, Meckesheim, Germany*
www.herbold.com

Zirconium improves corrosion resistance in this density meter

The Micro Motion 7826 Insertion Liquid Density and Concentration Meter (photo, p. 32I-4) is now available in zirconium for enhanced corrosion resistance. The zirconium fork density and concentration meter is designed to monitor inorganic chemicals, such as hydrochloric, nitric and sulfuric acids. It can also be used for applications in the oil-and-gas industries as

New Products

well as clean-in-place (CIP) processes in the food-and-beverage sector. The device has the same form, fit and function of the existing meter, offering an integral mount transmitter with two milliamp outputs and Modbus/RS-485 communications. — *Emerson Process Management, Baar, Switzerland*
www.emersonprocess.eu

A new valve position monitor that's easy to configure

The new Type 3738 Electronic Valve Position Monitor (photo) can be used on on/off valves in all fields of application. The device indicates the end positions and controls the actuators. The position monitor features a contactless, magneto-restrictive sensor system and an integrated microprocessor, and can be configured at the push of a button. It operates using a Namur signal in compliance with IEC 60947-5-6 and is powered by a two-wire supply. As a result, the position monitor can replace solenoid valves and limit switches without having to change the wiring or signal levels. Other functions include self-tuning and diagnostics. — *Samson AG, Frankfurt, Germany*
www.samson.de

Enhanced graphical software for better welding

New software has recently been released for this firm's welding system M200 power supply (photo) to deliver increased performance and an updated graphical interface. The portable M200 is easy to use and offers 200-A capability for orbital welding at a weight of less than 23 kg. A high-resolution 12.1-in. touch screen gives users a simple, intuitive pathway to enter weld programs. The streamlined display includes an improved weld-head graphic, which presents weld progress in greater detail to help operators better evaluate the weld. Progression, performance levels, and stop/start for each level of the weld are displayed in real time. — *Swagelok Co., Solon, Ohio*
www.swagelok.com

A tiny GC for reliable gas analysis

The C2V-200 micro GC (gas chromatography) integrates micro-chip technology with narrow-bore capillary GC to achieve a high performance at low cost. The device is designed for ease of use, can be easily installed, and has reduced maintenance and low gas consumption. The GC columns can be programmed up to 10 temperature segments with a 0.01°C repeatability to temperatures up to 180°C. The integrated micro-chip injector and fast (240°C/min) temperature programming enables reliable analysis within seconds. — *C2V, Enschede, the Netherlands*
www.c2v.nl

'Hyphenated' instrument for testing drugs and plastics

The DSC-Raman system (photo) combines the strengths of thermal analysis (differential scanning calorimetry; DSC) with Raman spectroscopy into an integrated system. When combined, the two complementary techniques provide greater insight into material changes at the molecular level. The system simultaneously analyzes chemical and structural information from the Raman spectrometer, and correlates it with the calorimetric data of the DSC. "Test drives" of the system at several universities and pharmaceutical companies have found the system gives greater insight into polymer crystallizations, drug-carrier interactions, curing and polymorphic changes, says the manufacturer. — *Perkin Elmer, Inc., Waltham, Mass.*
www.perkinelmer.com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Seybert & Rahier

Dinnissen

Precisely mix a large number of ingredients with this unit

The new Pegasus Mixer (photo) is capable of adding up to 18 different liquids — very precisely and in all possible types of combinations and quantities — to dry materials, such as powders, granules and granulates. These liquids can be oil-, water- or acid-based, and can be used to modify and improve the water content and chemical properties of the product. The unit operates with a precise coefficient of variation (2–3%), making it possible to realize an extremely homogeneous end result. The mixing occurs very quickly, making it possible to realize energy savings of 30–40%, says the firm. The mixer also features extra space at the top, due to the use of large, quick-release sides, which makes it possible to achieve capacity increases of 15–20%. — *Dinnissen B.V., Sevenum, the Netherlands*
www.dinnissen.nl

Standardized dosing systems in a cost-efficient, compact design

Three types of dosing systems (photo) for conveying capacities up to 60, 550 and 1,500 L/h are offered under the name CVD 1 (for compact vertical dosing system). These systems are composed of a motor diaphragm pump; two-part ball valve on the pressure side; diaphragm overflow valve; wall mounting plate of polypropylene (with collecting basin); pipework of PVC-U, PP or PVDF on pressure side; and gaskets of EPDM or FPM. Modular construction enables the addition of numerous optional and standardized accessories, such as pulsation dampers, terminal boxes, leak sensors and a splash guard for the entire system. — *Seybert & Rahier GmbH + Co. KG, Immenhausen, Germany*
www.sera-web.de

Two new terminals for more than 30 drivers

The Silver Series of touchscreen operator interface terminals (OITs) is designed for equipment manufacturers and end users that want to provide an integrated, customized interface for their equipment. Two models are offered — 7- and 10-in.-diagonal display sizes (photo) — that support a full set of features, including serial and Ethernet communication with multiple controllers; more than 30 drivers for communicating with devices; USB; SD Card; data logging; and flexible password security and multi-language support. — *Watlow GmbH, Kronau, Germany*
www.watlow.com

A parallel reactor system for process optimization

The Atlas Parallel Systems — multi-position reactor stations for up to eight jacketed reactors or round-bottomed flasks — offer full, independent control and logging of all reaction parameters. Controlled from a single PC, temperature, pH, stirrer speed, dosing, heat flow and turbidity can all be monitored simultaneously, making the system suitable for process optimization. A number of systems are available, including the Lithium, which automates heating/cooling in round-bottomed flasks or vials with magnetic stirrers; the Sodium, for overhead stirring and temperature control; and the Potassium, for jacketed reactions from 50 mL to 5 L. — *Syrris Ltd., Royston, U.K.*
www.syrris.com ■

Gerald Ondrey

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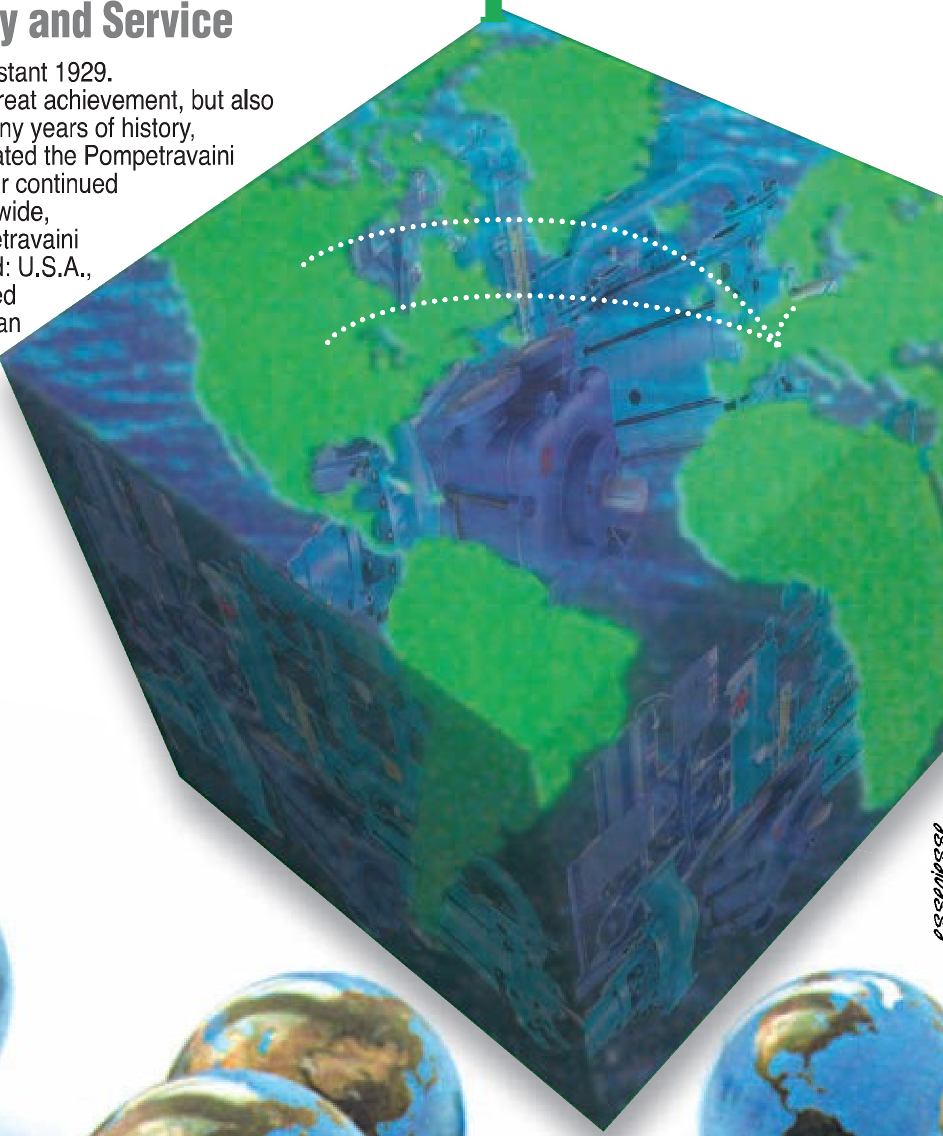

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A Primer on Spray Drying

An understanding of the basic information presented here will help you produce powdered products with desired characteristics, while operating the drying plant safely and with minimum energy

This photo shows a spray dryer with a heat recuperator. The plant has an evaporative capacity of 1,825 kg/h

Jens Thousig Møller
and **Søren Fredsted**
GEA Niro

Spray drying is one of the major industrial drying technologies. It is applied by many industries because of its ability to convert a liquid product into a dried powder in a lenient single step and because it allows you to control temperature and the particle formation process very accurately. Altering the process parameters allows you to produce complex powders that meet exact powder properties in terms of particle size and shape, bulk density, dispersibility, polymorphism, flow properties and so on, in a very efficient manner. Spray drying is applied in the production of an endless number of products in the chemical process industries (CPI) ranging from advanced chemical compounds to bulk chemicals. Spray drying plants can be designed for almost any capacity from very small quantities up to several metric tons (m.t.) per hour.

Historical development

Spray drying of liquid products commenced at the end of 19th century with the first patents issued for drying of egg products. In the 1920s, the commercial use of spray drying increased with the major breakthrough being for production of milk powder and detergents. The milk powder production was a major step forward in a period when refrigerators were not that widespread and the shelf life of milk consequently was very low.

In the pioneer years of spray drying, the emphasis was simply put on removing the water without too much heat distortion and thereby obtaining a dry powder with good keeping properties. Spray drying proved to be an outstanding technology for this as the drying process is almost instantaneous. With the spray of liquid having a very large surface, heat transfer and mass transport are very rapid, and the solid product is protected against thermal overload by the evaporation of the water.

Since the early years, spray drying technology has developed tremendously and some of the major achievements have been to divide the drying process into several stages — reflecting that the conversion of the liquid product into the final dry powder usually takes place in two steps (Figure 1). In the first step — referred to as the constant rate period — drying is controlled at the surface of the liquid droplets, that is, heat transfer through the gas phase to the droplet surface and mass transport of water vapor from the droplet surface into the gas phase. In the second step, a solid particle has been formed and the evaporation rate is then controlled by diffusion of moisture inside the particle towards the particle surface. Multistage drying takes advantage of the above knowledge by adding one or more fluidized-bed drying stages where the residence time is higher and the applied drying media temperatures are lower. The overall drying process is thus divided into a very rapid evaporation of surface moisture in the spray chamber part and an accurately controlled drying of the internal particle moisture in the fluidized bed.

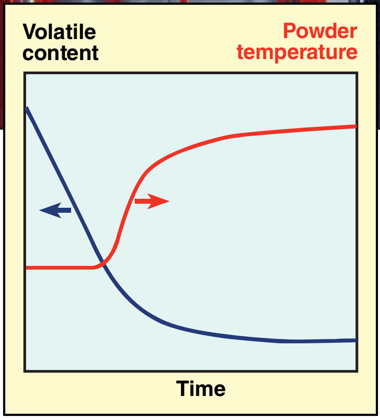

FIGURE 1. This product drying curve shows that two stages typically occur: a constant rate period followed by diffusion-controlled period

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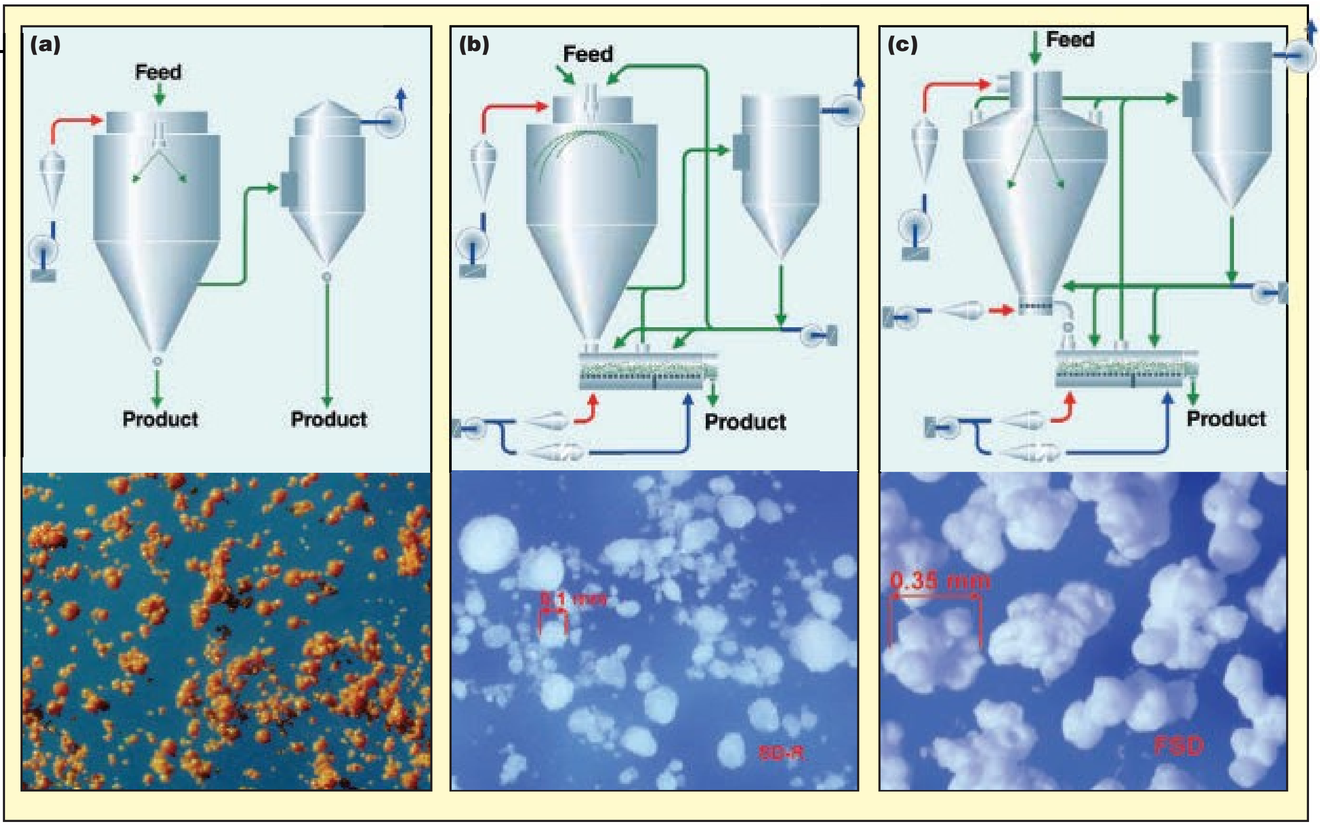

FIGURE 2. In the simplest configuration (a), a spray drying system consists of the dryer and a cyclone for product recovery. Accounting for the multi-stage drying process, systems can also incorporate an external vibrating fluidized bed (b) and an integrated fluidized bed (c). Typical products from these configurations are shown below

The first spray dryers built according to the multistage principle were made with a separate, vibrating fluidized bed of rectangular shape (Figure 2b), which sometimes caused problems when the moist solid was difficult to fluidize at the entrance. This problem was overcome with the introduction of an integrated fluidized bed mounted directly at the conical bottom of the spray dryer (Figure 2c). The integrated fluidized bed is — contrary to the external fluidized bed — working in back-mix mode (mixing finished and moist powders) in order that the average powder moisture in the integrated fluidized bed is sufficiently low to ensure a satisfactory fluidization.

With the use of integrated fluidized beds, further developments were made to improve the quality of the dried powders. By reintroducing the fine powder fraction to the atomization zone and by using the fluidized bed to classify the powder, powders with less dust, improved dispersibility and a narrower particle-size distribution can be produced.

Applications of spray drying

The principle of drying a spray of liquids has found many uses beyond the mere removal of water. Spray drying is also applied in formulating products with unique properties. In the aroma industry, water-insoluble liquid aromas are encapsulated in a solid matrix of water-soluble carrier material and surface active ingredients. After spray drying, the result is a powdery flavor with excellent shelf life and good redispersibility in water. The same is the case for oil-soluble vitamin powders.

Very fine powders, such as ceramics or hard metals, can — by the addition of binding agents — be formulated into larger compact particles of spherical shape with good flowability. Being very uniform and with a consistent density, they can be used directly in pressing dies for forming ceramic products, cutting and mining tools and other products. Within dyestuffs and pesticides, the non-soluble active material can be formulated with binding and dispersing agents to produce a non-dusting and water-dispersible powder.

Coating of suspended solids by spray drying the suspension is used for taste masking and controlled release of active materials in the pharmaceutical industry.

The spray drying process can also be applied for congealing. In this case, a melted feedstock is atomized and turned into a free-flowing powder by cooling it in a stream of cold air or gas. It finds use for several types of products — from palm oil derivatives to special waxes, fats, glycerides, hydrates and other inorganic or organic melts. Spray congealing is also applied for encapsulation. If a potent or otherwise harmful chemical is suspended in a molten wax, it can be encapsulated and the user is protected from the malicious effects. Many enzymes for the detergent industry are congealed this way.

Spray drying is also applied for production of e-PVC (emulsion polyvinyl chloride) and PVAc (polyvinyl acetate), where formulations have been developed so the liquid feed can be spray dried to produce high quality powders.

The spray drying process can be applied for carrying out chemical reactions. Dry absorption of SO_2 from fluegases from coal-fired power plants, and HCl and HF from waste incineration plants are some examples. The reaction takes place when the atomized liquid is suspended in the drying air/gas stream.

Spray drying is used for bioactive products. In this case, the gentle process dries the product without destroying the bioactive elements. It is also applied in solid dosage pharmaceuticals where spray drying can be applied to increase the bioavailability of the drug. Active pharmaceutical ingredients (APIs) in an amorphous structure often have a better bioavailability (Figure 3). Stable structures containing amorphous materials can be made by spray drying the API with an excipient.

Structure and morphology

One of the major benefits of spray drying is that it allows for production of precisely defined powders. The basis can be almost any pumpable solution, suspension or emulsion with a wide range of rheological properties. Depending on the characteristic of the liquid feed, the atomization technology, plant geometry and process parameters, particles of different sizes, shapes and porosities can be produced.

The size of the particle produced from the liquid droplet depends on the solids content in the liquid feed, inlet air temperature and the plasticity of the moist solid phase.

Often, the particles' shrinking due to water evaporation can be seen directly on the surface; other products form a rigid shell at the droplet surface and leave a hollow interior part when the remaining water evaporates. As the inlet air temperature determines the rate of water evaporation after atomization, it will often influence the ability of the particles to shrink and thereby the porosity of the particles. In extreme cases, the particles may break down due to very high internal vapor pressures (Figure 4).

Powder flowability and dispersibility can be greatly improved by agglomerating several fine particles into larger clusters of porous structure. Due to the large quantity of capillaries, the particles will have improved wettability. Agglomerated powders will furthermore be less dusty and therefore more environmentally friendly.

The basics of spray drying

The essential in spray drying is the atomization of the liquid feed and the distribution of the drying media allowing the liquid to evaporate and particles to form. The dried particles are continuously discharged from the drying chamber and recovered from the drying media using a cyclone or a bag filter. The spent drying media is often treated in a scrubber to meet environmental requirements before being exhausted to the atmosphere. It can also be recirculated. The whole process generally takes no more than a few seconds.

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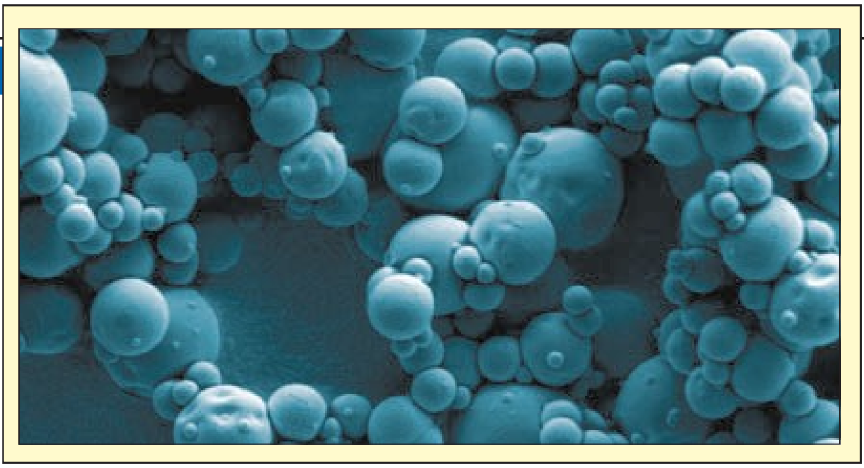

FIGURE 3. APIs in an amorphous structure often have better bioavailability. Stable structures can be made by spray drying the API with an excipient

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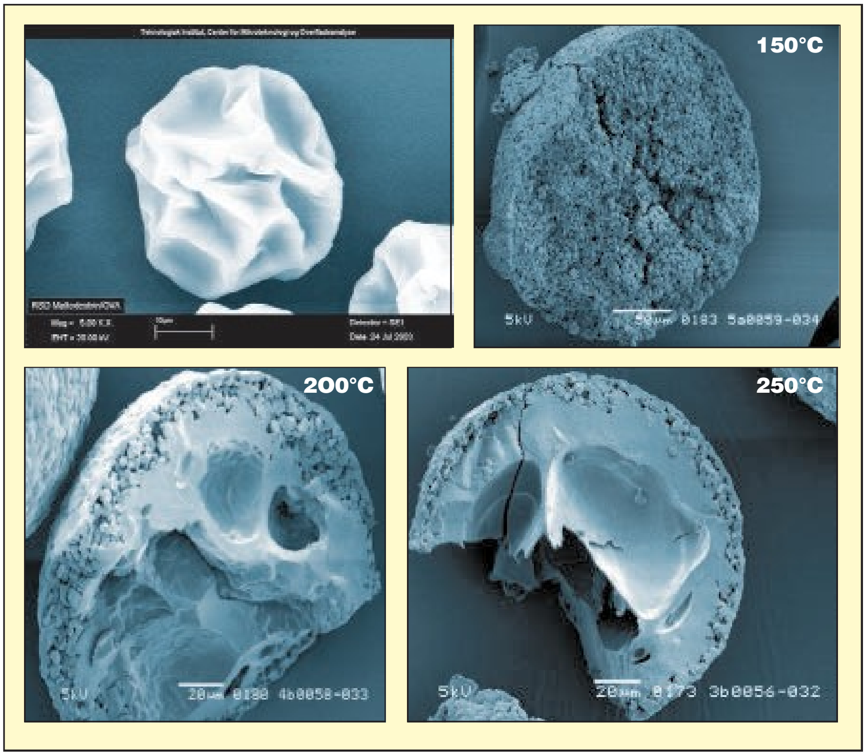

FIGURE 4. Shrinking can be observed (upper left) due to water evaporation from a particle. The other three images show the effect of increasing air drying temperature, which influences the rate of water evaporation, for the same product

Atomization. Several types of atomization can be employed in a spray drying system, including centrifugal, nozzle, pneumatic and sonic atomization. The average droplet size and distribution is fairly constant for a given method of atomization, but the average particle size can be in the range of 10–300 microns. Atomizing 1 L of feed generates a total surface area of 20–600 m^2.

The droplet size from a given type of atomization device depends on the energy spent for breaking down the liquid into fragments, that is, increasing the overall surface of the liquid. For most atomization systems, the liquid does not leave the atomizing head as a droplet, but as a fragment of a thin liquid film. The droplet formation takes place immediately after the liquid has left the atomizing head due to the surface tension of the liquid. The formation of a perfect droplet is therefore very dependent on the rheological properties of the liquid and the inter-

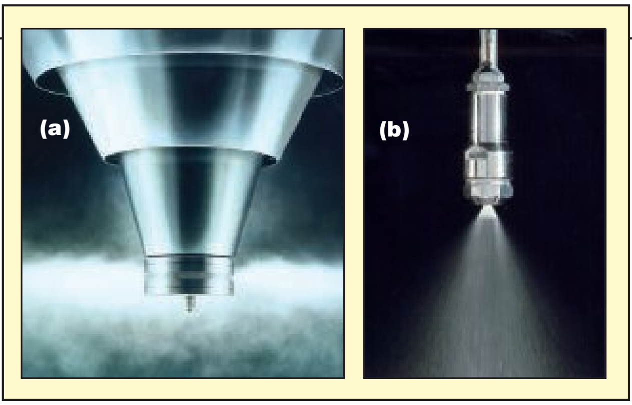

FIGURE 5. Rotary atomizers (a) produce a liquid mist horizontally from the atomizer wheel. Atomization by nozzle (b) often leads to a narrower particle-size distribution

action with the hot drying medium just outside the atomizing device.

Centrifugal (or rotary) atomization is the most common form of atomization. Here, a rotating disc or wheel breaks the liquid stream into droplets (Figure 5a). The devices normally operate in the range of 5,000 to 25,000 rpm. Discs or wheels typically have a diameter of 5 to 50 cm. The size of the droplets produced is nearly inversely proportional to the peripheral speed of the wheel.

Rotary atomization produces a liquid mist horizontally from the atomizer wheel. The spray cloud leaving the atomizer wheel will be distributed over an angle of 180 deg., and therefore the drying chamber is often designed with a height-to-diameter ratio close to 1:1. Due to the limited impact of the liquid flow on the particle size, it is possible to operate the rotary atomizer with a large turndown in feed capacity keeping the particle size within the specifications. The use of variable speed drives makes the control of droplet size — and therefore particle size — very easy.

Rotary atomizers are available in many sizes. A small air-driven laboratory unit handles from 1–10 kg/h of liquid feed, while the largest commercial units driven by 1,000 kW motors can handle in excess of 200 m.t./h.

With pressure-nozzle atomization (Figure 5b), the liquid is pressurized by a pump and forced through the orifice of a nozzle to break it into fine droplets. The orifice size is usually in the range of 0.5 to 3.0 mm. This limits the capacity of a nozzle to approximately 750–1,000 kg/h of feed, depending also on pressure, viscosity and the solids content of the feed. The size of the droplet depends on the size of the orifice and the pressure drop. A larger pressure drop across the orifice produces smaller droplets. Therefore, to reduce the particle size for a given feedrate (capacity), a smaller orifice and a higher pump pressure must be provided to achieve the same mass flow through the nozzle. Large systems may have as many as 40 nozzles, making control of particle size difficult. Although the pressure nozzle is very simple, maintenance — especially of multiple nozzle systems — can become troublesome as wear of the insert changes the characteristics of a given nozzle. The potential for plugging the relatively small orifices is another drawback for nozzle-based atomization systems.

Pressure nozzles usually give a narrower particle-size distribution, and the spray angle, and pattern can be adjusted by varying nozzle inserts and position in the drying chamber.

Two-fluid pneumatic atomization is primarily used in smaller drying systems. The atomization is accomplished by the interaction of the feed with a second fluid — usually compressed air. Neither the feed nor the air requires very high pressure (typically in the range of 200 to 350 kPa). Particle size is controlled by varying the ratio of the compressed-air flow to that of the feed. As the two-fluid nozzles have rather large openings for the feed, the risk of clogging is reduced, which makes this nozzle ideal for use in pilot- or laboratory-scale equipment. Both nozzle types' spray patterns (angle and flight paths of the droplets) can be altered by different nozzle types and internals.

Sonic atomization has been tested in small capacity dryers, but has not been applied for larger production units thus far. Ultrasonic energy is used by passing the liquid over a surface vibrated at ultrasonic frequencies. These systems are suitable for producing very fine droplets at low flowrates. A very uniform particle-size distribution is furthermore achievable.

Dryer configuration. Proper size and geometry of the spray drying chamber and the gas disperser are essential for the optimum particle formation as the flow patterns of the droplets and the gas through the dryer must provide for sufficient contact time to allow evaporation of essentially all of the liquid. As a result, atomizers are usually installed at the center of the roof of a relatively large diameter spray dryer. The heated gas is introduced through a roof-mounted air/gas disperser around the atomizer, creating a co-current flow of gas and droplets/particles. This takes advantage of evaporative cooling and decreasing temperatures downwards.

With atomization by pressure nozzles, a spray drying chamber with extended height — for some products up to 20 m or more — is required for the particles to obtain sufficient retention time in the chamber. These types of spray dryers — also referred to as "nozzle towers" — are often used in production of coarse powders like foodstuffs, dyes, pesticides and other heat-sensitive products.

The larger the particle size desired in the final powder, the larger the diameter of the drying chamber, regardless of the unit's total throughput. When coarse powders are needed in small production rates, a pressure nozzle spray in fountain configuration (for example, spraying upwards from the bottom part of the chamber) is often found to be more practical. The spray travels upward until overcome by gravity and the downward flow of air. It then reverses direction and falls, finally landing in the bottom cone of the drying chamber. The major drawback in fountain nozzle drying can be that drying actually begins in a cooler part of the dryer and continues into the hottest zone. Since each droplet is already partly dried, the evaporative cooling effect is lessened and the chance of thermal degradation becomes larger. Lower inlet temperatures can solve this problem, but also reduces the total evaporation capacity.

Collecting dried powder. After drying, the particles must be separated from the drying media, which is cooled due to the evaporation of the liquid from the droplets. This colder and humid gas is discharged from the dryer after separation of the now dry

Flamex Inc.

FIGURE 6. By the very nature of the spray drying process — fine dust suspended in air — there is a risk of fire and dust explosions. Over-pressure venting, explosion suppression and inerting the complete plant are ways to prevent accidents and to make any incident proceed in a controlled manner to minimize damages

particles. Due to the fact that the gas has some entrained powder, cyclones or fabric filters are used to clean the gas. In some cases, the combination of cyclones followed by a wet scrubber proves more effective.

Coarse powders are most easily collected directly from the bottom of the drying chamber. In this arrangement, the spent drying gas exits through an outlet duct in the center of the cone. The reversing of the gas flow allows the majority of the powder to settle in the cone and slide to the bottom outlet, which is often equipped with an airlock for discharge. If the powder is very fine, a small amount is collected from the drying chamber. In this case, the cyclones or the bag filter become the primary collection point. To eliminate chamber collection, a U-bend is used at the outlet for both gas and powder from the chamber to the downstream collectors.

Process gas flow. The flow of drying gas through the system is much the same as for any gas-suspension drying system. Heating by direct combustion of natural gas is the most efficient — backed up by fuel oil or propane combustion when gas curtailment is possible. If indirect heating is required, shell-and-tube or finned-tube heat exchangers are used with steam or a heat transfer fluid as heating source. Electric heaters are used in smaller spray dryers.

The design of the gas disperser is of ultimate importance for the proper function of a spray dryer. Today, gas dispersers are often configured by means of computational fluid dynamics (CFD) analysis to define air flow pattern and temperature distribution within the drying chamber. Different types of gas dispersers are often used with different atomization technologies and chamber geometries. For example, with a rotary atomizer a gas disperser with air rotation is often preferred, whereas a more streamlined air distribution is applied in nozzle towers.

For most applications, the gas disperser is constructed with adjustable guide vanes allowing for fine tuning during plant commissioning.

Industrial radial fans are used to move the gas through the system, employing a combination of forced and induced draft or induced draft only. If ambient air is the drying gas and a very clean process is required, high-efficiency, particulate-matter air filters are applied. In some cases, additional measures are required in order to protect the environment and eliminate emissions completely. This can be achieved by working in a closed loop system or by adding HEPA filters to clean the exhaust air. Some products may contain powerful odor components that have to be removed. This can be done either by thermal or catalytic incineration, carbon black absorption, chemical scrubbing or bio filtration.

Ductwork with appropriate dampers, expansion joints, vibration isolators and noise abatement devices is supplied with most dryers. All equipment is usually insulated and cladded to minimize heat loss and condensation, and personnel hazards.

Process design and control. The evaporation rate in a spray dryer is directly proportional to the product of the temperature difference from inlet to outlet and the mass flow of gas through the system. Outlet temperature is established by the desired moisture content in the product according to that product's equilibrium isotherm. Since true equilibrium is never reached, the actual values are usually determined experimentally. Inlet temperature is also determined by experience and should be as high as possible without product degradation. Then, for a given evaporation rate, the required process gas flow can be determined from the temperature difference. All system components can be sized based on gas flow. A gas residence time must be selected from experience based on the particle size desired and the product's known drying characteristics. This permits direct calculation of a chamber volume.

As mentioned above, spray drying is still largely based on empirical data, and industrial-scale drying tests are required for determining the process parameters and plant design that will result in the desired product — unless, of course, experience and data is already available from dryers in production. Optimization of the performance of existing installations can also be carried out by testing in smaller units.

Once designed and built, a spray drying system needs fairly simple controls. As the performance of a spray dryer is very dependent on the air velocities and flow pattern inside the drying chamber, it is common practice to operate the dryer at a fixed air flowrate. Since outlet temperature determines the moisture content in the final product, the temperature must be controlled and modulated with respect to other changes in the system. Depending on the mode of operation, the outlet air temperature is either controlled via the amount of feed conveyed to the dryer or by adjusting the temperature of the inlet gas.

Pressure drops across filters and cyclones are usually monitored to assure that the system is operating properly. The pressure in the drying chamber is usually controlled by the suction fan and kept at slight vacuum in order to avoid dust escaping the equipment. Rotary atomizers require monitoring lube-oil flow, temperature and vibration, whereas nozzle atomization systems require monitoring feed pressure or flow.

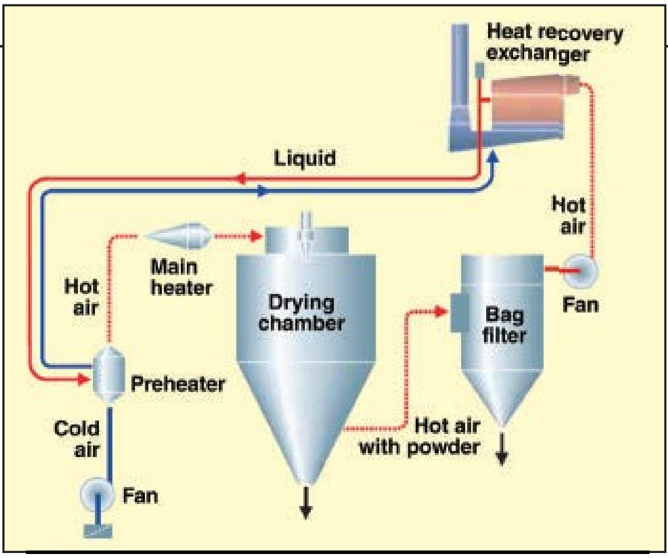

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FIGURE 7. This spray drying system is equipped with a heat recovery unit

plant can be varied from a start/stop command, and afterwards the programmable logic controller (PLC) is programmed to undertake all startup and shutdown routines and all operation parameters set via a predefined recipe to almost manual control. Trend analysis of the plant's operation facilitates troubleshooting and quality control.

Safety & environmental issues

By the nature of the spray drying process — a fine dust suspended in air — there is a risk of fire and dust explosion (Figure 6). This risk needs to be considered very carefully and for this, characteristics of the powder need to be established. The most important parameters to be determined are the following:

- Dust explosion pressure rise, *Kst*
- Maximum dust explosion pressure, P_{max}
- Minimum ignition energy, MIE
- Minimum ignition temperature, MIT
- Minimum auto-ignition temperature, MAIT

MAIT is of particular interest as most fires and dust explosions in spray dryers are initiated by product deposits starting an exothermic reaction. Based on the product data, a risk analysis of the entire spray drying plant has to be carried out identifying all possible ignition sources and drying parameters, and possible protection of the plant must be defined. (For more on preventing dust explosions, see *CE*, October, pp. 49–51.)

In Europe, this risk analysis should be carried out according to the ATEX directives, whereas NFPA (National Fire Protection Assn.) will provide guidance for plants in the U.S. With the safety regulations in place, explosions are very rare. For protection of the spray dryers, overpressure venting is widespread, and guidance is established both in Europe and the U.S. for sizing in relation to the chamber volume and the powder characteristics.

Explosion suppression is also used. This system is often the only realistic way of protection if the powder is harmful and an escape of the product in the event of an explosion could be critical for the environment. Containment, that is, designing the plant to resist the maximum explosion pressure, is only an option for small scale plants.

For products where the minimum ignition energy is very low, the likelihood of an explosion can become so large that it is preferable to "inert" the entire plant. In this case, the plant is operating in a closed loop with a condenser for removal of evaporated liquid, and the inerting gas can either be taken from an external source or be produced by a direct, gas-fired air heater for the dryer (the self-inerting principle). In cases where organic solvents are evaporated, the drying gas will always have to be inert and supplied from an external source.

Energy conservation

The spray drying process is rather energy intensive, and consequently, an effort must be made to optimize the plant in order to reduce the energy consumption per kilogram dry material. The first parameter to consider in this context is the concentration of the feed. Increasing the solids content in the feed with just a few percentages can reduce the specific energy consumption per kilogram dry material by 10–20%.

The drying process efficiency, η, is often defined as:

$$\eta = (T_{in} - T_{out})/(T_{in} - T_{amb}) \quad (1)$$

Where T_{in} is the inlet air temperature, T_{out} the outlet air temperature and T_{amb} the ambient temperature.

From Equation (1), it appears that the higher the inlet temperature and the lower the outlet air temperature, the better the efficiency. In practice, this means that one should strive to operate at the highest possible inlet air temperature without deteriorating the product and the lowest possible outlet air temperature that can result in acceptable powder moisture. By performing the drying process in multiple stages, the outlet air temperature from the spray dryer can be reduced significantly whereby the overall energy consumption will be lowered.

Heat recovery (Figure 7) by preheating the incoming fresh air by means of the outgoing hot air — or excess heat from another process — is a viable way of saving energy. Efficient heat recovery planning and design has proved to save as much as 20% of the energy for heating the drying media. Heat recovery can be either by direct injection into the drying gas stream or using a heat exchanger. Most systems include heat exchangers with a heat transfer fluid (water) in order to avoid complicated large air ducting within the plant. Finned-tube or plate-type heat exchangers are used depending on the dust content in the hot drying media.

Generally, it is not possible to exploit the latent heat from the dryer because the dew point of the outgoing air is rather low (40–50°C). For products that are not very heat sensitive, a partial recirculation of the warm drying air offers a cost effective and simple way of heat recovery. The dew point of the outlet air will, in this case, increase significantly and hot water in large quantities may be produced utilizing the latent heat in this instance.

Novelties in spray drying

A major development in spray drying technology has been the ability to make feasibility tests on just a few droplets of feed material (Figure 8).

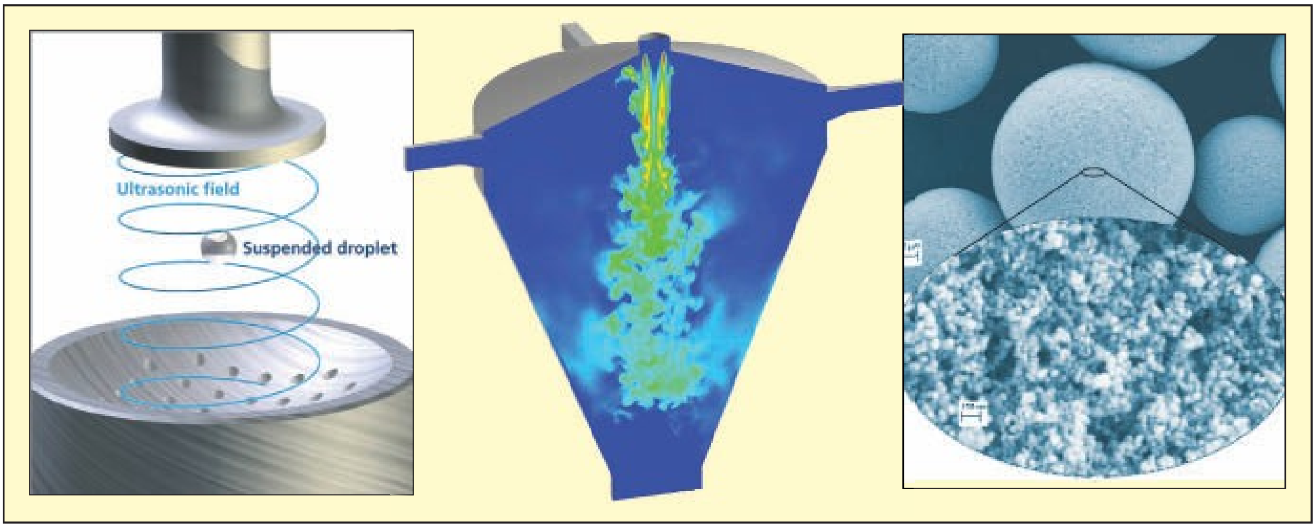

FIGURE 8. Ultrasonic levitation (left) is used to suspend a single droplet of feed being tested, making it ideal for observing and measuring the drying process. CFD simulation results (center) show the instantaneous fraction of water vapor in a spray dryer. The combination of levitation and CFD simulation has enabled better designed spray dryers. Agglomerating nanoparticles into larger, spray-dried particles (right) allows for safer processing

This makes it possible to determine the applicability of spray drying and to optimize product formulations at a very early stage in development when only a small amount of the product is available. The results also allow for more precise CFD simulations and thereby better designed spray dryers.

The method is based on an ultrasonic levitator equipped with a climate chamber to control air humidity, temperature and velocity. The levitator keeps the droplet to be studied suspended in the air, allowing for precise studies and measures of the drying kinetics. A mathematical description of the drying kinetics is established, and very accurate spray-drying simulations using CFD software are performed. It is now possible to calculate the time-temperature history during drying, which enables the design of minimum-thermal-degradation spray dryers for temperature sensitive products. Knowing the state of drying when the particles hit the dryer walls will — together with a stickiness criterion — give accurate information on what areas will be prone to develop deposits. Utilizing high performance computing clusters makes it possible to design optimal spray dryers with unprecedented accuracy.

Spray drying can be a vital link in the application of nanotechnology to achieve products with superior performance (for instance, fuel cell elements, automobile light covers and so on). It is still uncertain to what extent nano-based materials will be implemented in the future. Safe processing technology is of paramount importance and one safe route will be spray drying of nano-suspensions into powders or granules sized 10–100 microns. Developing process technology to exploit nanotechnology has international attention. An example is the EU-funded Saphir project (www.saphir-project.eu), which aims at demonstrating an environmentally safe production process — from the synthesis of nanoparticles, particles processing to the making of the final products.

Within the pharmaceutical industry, particle engineering is very important, and the use of spray drying is being explored widely. Spray drying can be applied to produce encapsulated powders for controlled release of API or taste masking, just as it can maintain the API in its amorphous form to enhance bioavailability. Since solid dosage forms in general are preferred to liquid based systems, research is driven toward delivery forms based on powders, for which spray drying is an ideal process. Research in spray drying and, for instance, controlled release is conducted by several groups worldwide, including the international Swedish-based research consortium Codirect (www.codirect.se) and others.

The field of spray drying is constantly developing. Increasing and more precise knowledge about the spray drying process and its dynamics opens avenues for using the technology in new fields just as new products and standards set new demands. ■

Edited by Gerald Ondrey

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De-emphasize Capital Costs For Pipe Size Selection

Focus more on mass flowrates, fluid densities and operating hours for real savings

Rajiv Narang, Subodh Sarin, Anu Anna George
Fluor Corp.

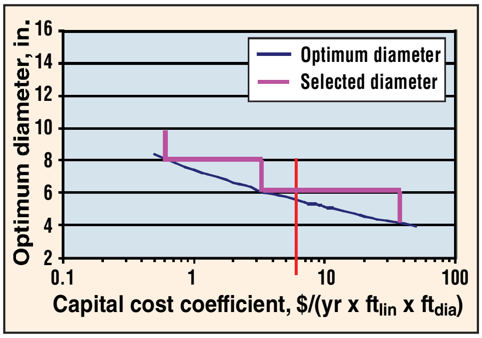


FIGURE 1. Selected pipe diameter is never below D_{opt}. The liquid flowrate here is 28 lb/s.

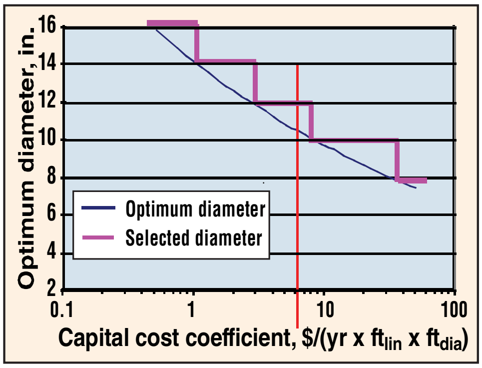


FIGURE 2. Capital cost coefficient for 2008 ≈ \$6/(yr × ft$_{dia}$ × ft$_{lin}$). Liquid flowrate = 112 lb/s

Piping represents a major cost for projects in the chemical process industries (CPI). Larger pipe diameters increase upfront capital costs for a project, but the lower pressure drops afforded by large pipes mean less power is required to move the fluid through the pipe. Optimizing pipe diameter becomes an exercise in balancing the capital cost savings realized by using smaller pipes with the power required to pump the fluids.

Price volatility in industrial piping commodities, such as carbon steel, can complicate the selection of optimal pipe diameters at the start of a project. But while constantly changing capital costs will certainly affect optimal pipe diameter, plants can realize significant cost savings by focusing more on fluid densities, mass flowrates and hours of operation when selecting pipe sizes, and worrying less about varying commodities prices.

In this analysis, the authors evaluated the sensitivity of optimal pipe diameter to changing capital costs, and concluded that variable capital costs have only a minimal effect on commercial pipe size selection up to diameters of 10-in. nominal pipe size (NPS). Once diameters reach larger than 12 in., it then becomes worthwhile to include capital costs in determining optimal pipe diameter. However, even at larger pipe sizes, mass flowrates and fluid densities should drive decision-making on pipe sizes because those factors affect optimal diameter more strongly than capital costs.

When determining optimum line size, plant designers tend not to include density and mass flowrate explicitly as important elements. Most use personal experience and "rules of thumb" to determine the economics of pipe selection at the beginning of a project. Our analysis suggests that considering other factors, such as mass flowrate, densities and hours of operation could achieve greater cost benefits. Engineers should prepare a table listing these values for typical fluids in a plant as they decide on pipe diameter. These decisions should hold despite cost variations.

For the purpose of this analysis, the authors assumed that operating costs (utilities prices) are constant for a given project, since electricity-cost increases tend to be much more gradual and prices less volatile than those for commodities. For example, U.S. electricity costs rose from 4.7 to 7.1 ¢/kWh between 1990 and 2008 [*1*]. In cases where capital costs and operating costs change proportionally in the same ratio, optimum pipe size remains the same.

Optimum diameter and velocity

Equation (1) determines the optimum diameter (D_{opt}) in feet of a pipe [*2*].

$$D_{opt} = 0.9\left[C_0 + \left(C_1 \eta g_c\right)\right]^{0.164} \times m^{0.459} \times \mu^{0.033} \times \rho^{-0.328} \quad (1)$$

Where: C_1 is a capital cost coefficient that includes the capitalization charge of pipe per unit length, represented by \$/[yr × foot linear length × foot diameter]. And C_0 is a cost coefficient (power cost in \$/kWh). The units of this coefficient are changed to (\$/yr)/[(lb(ft²/s³)] for consistency of units by using: [(\$/kWh) × (no. of hours/year)/K], where K is equal to 737.37, and is obtained from various conversion factors. Also in Equation (2), η is the pump efficiency, g_c is mass-force conversion constant, m is the mass flowrate (lb/s), ρ is density (lb/ft³) and μ is viscosity [lb/(ft)(s)].

To obtain optimum pipe diameter from Equation (1), the following assumptions are necessary:

- Assume incompressible flow
- Assume turbulent flow regime
- Ignore pressure loss from fittings and valves
- Ignore pump capital costs
- Elevation changes are not considered

The optimum velocity is given as:

$$V_{opt} = C_2 \times m^{0.082} \mu^{-0.066} \rho^{-0.344} \quad (2)$$

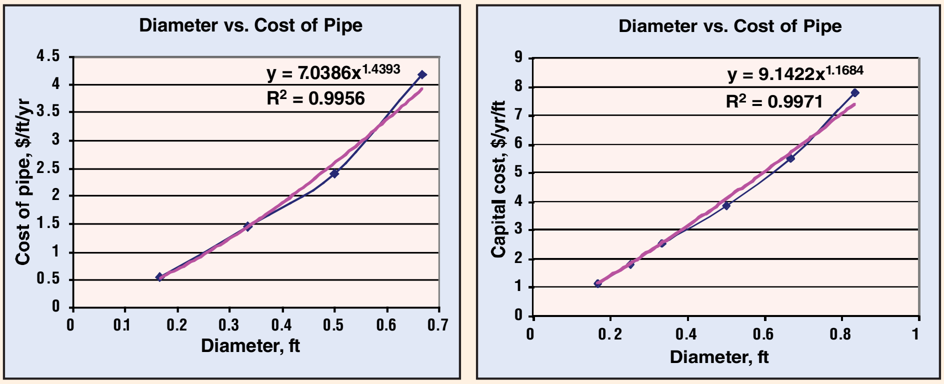
The validity of the power law to regress capital cost is given in Ref. [2] as: $C_{inv} = C_1 \times L \times D^n$, where: C_{inv} is the annualized capital cost ($/yr); C_1 is the capital cost coefficient, which includes capitalization charge for pipe per unit length [$/(yr × ft_{dia} × ft_{lin})]; n is an exponent from a cost correlation; and D is pipe diameter in ft.

In Ref. [2], n is assumed to be 1.3, and in an example, takes C_1 as $5.7/ yr × ft_{dia} × ft_{lin}

C_1 incorporates the annualization factor and is a useful coefficient that simplifies the correlation of pipe diameter with annualized capital costs and makes the optimization problem tractable.

Project data are used to examine the range and validity of the power law, as well as representative values for C_1 and n.

PROJECT ESTIMATED COST DATA



Cost correlation exponent (*n*) variation. Carbon steel (left) and SS 316 (right) pipe

For carbon-steel STD Schedule, A106 pipe, the capital cost is annualized over 10 years at 5%, and C_1 varies from 5.14 to 5.63, while n varies from 1.46 to 1.61.

It can be concluded that for the purpose of this study, using n as 1.3 would not lead to erroneous conclusions.

For carbon-steel XS Schedule pipe, the following data are available (above figure, left): In this case, C_1 rises to 7.03, while n is at 1.44.

For stainless-steel 316, Schedule 10S pipe, the following data are available (above figure, right): C_1 has risen to 9.14 and n is at 1.17.

The authors conclude that using an n value of 1.3 works well for thicker carbon steel as well as for stainless-steel pipes. C_1 does increase for XS schedule and 10 S schedule as expected, but the increase is not excessive. ■

Where C_2 is a consolidated constant [2].

$$C_2 = 4 + \left(\pi \times C^2\right) \quad \text{(2A)}$$

$$C = 0.9 + \left[\frac{C_0}{\left(C_1 \times \eta \times g_c\right)}\right]^{0.164} \quad \text{(2B)}$$

For the equations above:

- The optimum diameter is independent of the length of pipe
- The optimum diameter is more sensitive to mass flowrate and density than to capital and operating cost
- The optimum velocity is less sensitive to mass flowrate but quite sensitive to density
- As long as the capital-cost-to-operating-cost ratio (C_0/C_1) does not change, optimum diameter remains the same, assuming other conditions are unchanged

The capital cost coefficient, C_1, is derived from the capital cost equation given below [2].

$$C_{inv} = C_1 \times D^n \times L \quad \text{(3)}$$

In Equation (3), C_{inv} is the annualized capital cost ($/yr); C_1 is the capital cost coefficient, which includes capitalization charge for pipe per unit length ($/year × diameter in ft × linear length in ft); D is the diameter in ft; L is the length of pipe in ft; and n is assumed to be 1.3.

The validity of Equation (3) is examined in the box above. Although better correlations can be developed for capital cost, the analysis in the box suggests the result will not be radically different.

Capital cost considerations

To examine how optimum diameter and velocity affect capital cost, the following case uses a stream with mass flowrates of 28 lb/s, 56 lb/s and 112 lb/s, a density of 29.05 lb/ft^3 and viscosity of 0.000058 lb/(ft × s), or 0.08 cP. The operation is assumed to run 8,000 h/yr. The efficiency of the pump is assumed to be 0.6. The operating cost coefficient C_0, which is the cost of electricity purchased, is fixed at $0.10/kWh. The capital cost coefficient C_1, which is the coefficient of annualized capital cost of pipe, is varied from $0.5 to $50/(yr × ft_{dia} × ft_{lin}). The optimum diameter was found using Equation (1) by keeping the operating costs and other variables constant.

The analysis in the box above concludes that capital costs for the year 2008 reflect a C_1 of about $6/ (yr × ft_{dia} × ft_{lin}) for carbon steel, STD Schedule A106 pipe.

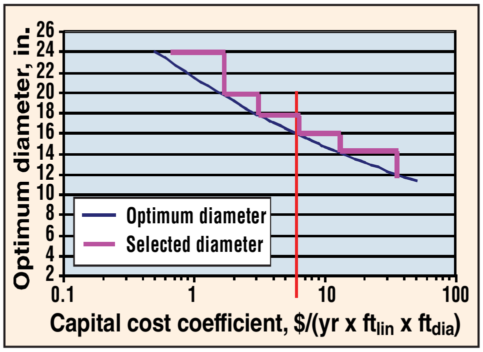


FIGURE 3. In this case, D_{opt} was calculated for a gas with a mass flowrate of 28 lb/s, a density of 0.936 lb/ft^3 and viscosity of 0.00000672 lb/(ft × s).

The optimum velocity with this variation of capital cost coefficient was also calculated using Equation (2).

The optimum diameter and optimum velocity graphs are plotted on a semi-log scale to illustrate the changes clearly. The selected diameter is such that it is never below the optimum diameter. The optimum diameter for the current capital cost coefficient of carbon-steel pipe, STD schedule A106 [~$6/(yr × ft_{dia} × ft_{lin})] is also shown in Figures 1 and 2.

The above case was repeated with

TABLE 1. PIPE SELECTION FOR A LIQUID WITH 28 LB/S MASS FLOWRATE

Capital cost coefficient (C_1), \$/ (yr × ft_{dia} × ft_{lin})	Optimum diameter, in.	Optimum velocity, ft/s	Selected diameter, in.
0.5	8.36	2.53	10
1	7.466	3.17	8
1.5	6.99	3.62	8
2	6.664	3.98	8
2.5	6.424	4.28	8
3	6.2	4.55	8
4	5.95	4.99	6
5	5.74	5.38	6
6	5.57	5.71	6
7	5.43	6.01	6
8	5.31	6.28	6
9	5.21	6.5	6
10	5.12	6.75	6
20	4.57	8.47	6
30	4.27	9.68	6
40	4.08	10.64	6
50	3.93	11.44	4

TABLE 2. SAMPLE ANALYSIS FOR OPTIMUM VELOCITY

Mass flowrate, lb/s	Optimum velocity, ft/s			
	Fluid A (Water)		Fluid B (Naphtha)	
	Intermittent	Continuous	Intermittent	Continuous
10	5.3	3.4	6.2	3.9
50	6.1	3.9	7.1	4.5
500	7.3	4.7	8.5	5.4

Water density = 62 lb/ft^3 and viscosity = 1 cP. Naphtha density = 40 lb/ft^3 and viscosity = 0.3 cP. Different fluids and mass flowrates can be added to the table as required.

56 lb/s mass flowrate and 200 h/yr of operation with the remaining parameters unchanged. A capital cost coefficient of \$6/(yr × ft_{dia} × ft_{lin}) and 8,000 h of operation yields a selected pipe size of 8 in., while 200 h of operation gives a selected pipe size of 6 in. The optimum velocity is 6 ft/s and 20 ft/s correspondingly. The above analysis does not take into account other factors, like maximum safe velocity or erosion velocity.

A variation of the case was considered to examine the change for gases using a gas with a mass flowrate of 28 lb/s, density 0.936 lb/ft^3 and viscosity 0.00000672 lb/(ft × s). For this case, the remaining parameters are unchanged. Results are plotted in Figure 3.

Key tips

Use the following tips to help make selections of pipe sizes at the investment stage:

1. The optimum diameter is less sensitive to capital cost variation until diameters of about 10 in. It may be worthwhile to calculate the optimum diameter above 12 in., the point at which optimum diameter becomes quite sensitive to capital cost.
2. It may be worthwhile to calculate the optimum diameter when the number of hours per year of operation is fewer, such as for sump pump service, as this is an opportunity to choose a lower diameter than usual, and thus save on capital cost.
3. The optimum velocity is inversely proportional to $\rho^{0.344}$, so when density doubles, the optimum velocity decreases by about 20%. Thus, optimum velocity for water and hydrocarbons will be significantly different. For gases, the variation in density along the pipe adds complications to the above analysis, but the conclusion is that varying densities offer opportunities to optimize line sizes.
4. When mass flowrate doubles, optimum velocity increases by 6%. The engineer can justify higher velocities for higher mass flowrates or higher line sizes, a measure that can save capital costs.
5. This article suggests that a table correlating optimum velocity (or diameter) with mass flowrate, for different fluids and modes of operation can be prepared at the beginning of the project for typical fluids. This will serve to inform the process engineer calculating hydraulics for the project. For example, consider Table 2, where C_1 = 5.7 \$/yr/ft_{dia}/ft_{lin} (see box, p.42); utility cost = \$0.10 /KWh; pump efficiency = 0.6; continuous operation is defined as 8,000 h/yr; and intermittent operation is defined as 2,000 h/yr. The analysis could be set up as in Table 2. ■

Edited by Scott Jenkins

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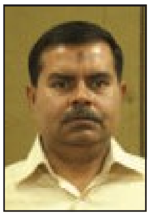

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Making the Leap from R&D to Manufacturing

Crafting the right information-management strategy is essential to scaling up promising discoveries

Martina Walzer
Siemens AG, Industry Automation Division

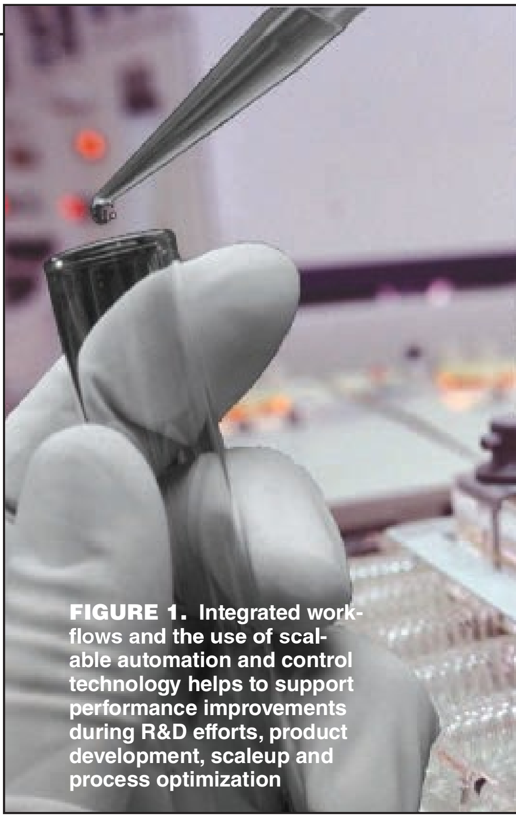

FIGURE 1. Integrated workflows and the use of scalable automation and control technology helps to support performance improvements during R&D efforts, product development, scaleup and process optimization

The success of industrial R&D activities has a direct impact on a company's long-term commercial profitability. Today, a variety of market forces, including the drive for growth, the search for new ideas and innovative products, and the increasingly competitive pressures of the global economy, have made R&D activities more important than ever from a strategic perspective.

The need to streamline the process of moving from industrial R&D through demonstration-scale operations to full-scale manufacturing is a basic business requirement. To develop and manufacture products in the most cost-effective way, companies need a platform that will enable the smooth and consistent transfer of the proven product designs to full-scale manufacturing plants around the globe. Applying state-of-the-art control technology and integrated information-management procedures throughout the discovery, research, process-development and optimization steps will help laboratory processes to successfully make that critical leap.

Streamlining for success

Innovation is a key driver throughout the chemical process industries (CPI), but the creation of innovative products is not sufficient to meet long-term business goals. Innovation must be applied not just to the development of commercial products, but to the processes that are required to produce them. The ability to integrate R&D product data within the manufacturing environment without compromising product and production costs and quality can help process operators to:

- Launch new and modified products faster
- Optimize all costs associated with the product
- Create high-quality products by design
- Improve consumer confidence in the company's products and processes
- Increase the contribution to the company's bottom-line profits

The right combination (and proper integration) of hardware and software solutions enables companies to answer those challenges successfully.

Creating wisdom

Knowledge compiled in laboratories often gives companies strategic advantage over their competitors. It is the primary goal of process development to define process sequences and parameter settings that are appropriate for producing the target product at the desired scale. Numerous experiments and test series are performed to determine the best reaction conditions, to identify suitable catalysts, to define the best possible parameters, and to design appropriate safeguards to protect work processes, people and the environment.

Automation technology — such as analyzers, instrumentaion and process control systems — has proven itself in nearly all industry sectors to improve product quality. This technology can help keep processes in stable conditions while supervising and adjusting process parameter settings (for instance, keeping a reactor at a certain temperature). Additionally, such systems reduce the likelihood of improper operator inputs by automatically checking parameter ranges. Today, many of the automation and control strategies used in production facilities are also applicable to improve laboratory applications.

Nonetheless, the automation requirements of laboratory-scale processes are different from those of larger-scale processes. Where commercial-scale production focuses on stable and safe configurations that rarely change, work procedures in laboratories require flexibility and easy-to-use control equipment. Research, by its very nature, often results in changes in the setup of the experiments (for instance, because the data resolution of the instruments, analytical devices, centrifuges and so on does not match the requirements).

Similarly, data gathered during experiments must be available in an adequate format so that it can be be transferred later to further, often-advanced analytical applications such as statistical evaluations or comprehensive calculation engines.

An environment that reliably secures experiment runs and steadily collects data from various sources helps to support high-quality research,

FIGURE 2. Since flexibility is a hallmark of most industrial R&D operations, modularity is a key consideration for information-management systems for lab environments. Shown here is a modular setup that allows for several analog and serial channels and provides multiple serial interfaces so that users can easily plug in lab devices such as scales and analyzers

and by using a scalable system, users can move easily from lab-scale to pilot and production sizes without changing the working environment, thereby significantly reducing efforts to reengineer the applications at hand.

Clear and explicit data-management practices are essential in industrial laboratory environments to effectively manage, store and share the research findings throughout the organization. For instance, to enable an efficient work flow, notifications (for example, to trigger next steps in the research work) should be delivered to the appropriate people to request further actions. Such advisory notes in email format allow links to related files and documents to be attached, which helps to streamline the sharing of information, making it more automatic and transparent.

Giving team members access

The cross-disciplinary sharing of data calls for a mechanism for handling documents electronically. And the information should be available in a long-term repository that has been set up with optimized access capabilities. This will help to reduce the time required for interested parties to locate and access related materials.

To maintain clear ownership of data, the systems should be configured with check-in and check-out procedures that prohibit concurrent access by multiple individuals. Such protections eliminate the possibility of simultaneous modification of data and the risk of lost information resulting from the accidental overwriting or deletion of files. Properly managed information significantly saves time for everyone, by making information that is related to a specific experiment easily accessible at the right time.

Many researchers appreciate the capabilities of an electronic lab notebook (ELN), which allows them to flexibly store all data related to any type of experiment and to output them in an easily accessible electronic format. Because text-based editing programs and spreadsheets are commonly used to work with the data that are generated as part of R&D activities, ensuring tight integration between the ELN and office-based applications is essential. However, an added value of an ELN is its ability to automatically provide both detailed audit trail information and full access control.

Automatically created audit-trail information helps to provide proof of the starting point of research streams. Assembling information to present to, for instance, a patent office or court is much easier if information is readily available in electronic format, instead of having to assemble, scan and file a lot of papers. With an ELN, all information is electronically stored, providing needed confirmation of the company's role in developing the innovation.

Similarly, by applying access rights, such systems ensure that only authorized people have access to the information. And access rights can be modified at any time, making it easy to ensure data integrity by allowing operators to answer the question "Who can access what when?"

An important aspect of using advanced tools in the R&D process is that the initial raw data generated by the individual researchers need to be verified, condensed and structured in order to be published and distributed in a meaningful way throughout an organization. In the absence of today's advanced data-management tools, the process of manual data management can be substantial and time-consuming, and as a result, complete data capture related to unsuccessful experiments is often aborted at an early phase. The unfortunate consequence of this is that there is then no complete history of these "failures," and this incomplete record often leads investigators to inadvertently repeat similar unsuccessful experiments or process conditions later in the scaleup process. Industry estimates indicate that repeating an average of 15–20 experiments is common.

Even successful experiments are sometimes repeated because useful information is buried within an inefficient or inaccessible data-management system or process (for instance, one that is largely paper-based), and therefore ends up simply being overlooked. Having all of the experimental data stored in an electronic repository makes it possible to search the complete knowledge base (including all previous experiments) using specific keyword searches. This not only saves time but greatly enhances the overall efficiency and effectiveness of the R&D department.

Protect intellectual property

Pressed for time, workers in R&D laboratories often do not follow appropriate procedures to sign and audit trail their work, relying instead on capturing their final results in Excel spreadsheets or Powerpoint presentations. But in order to file for a patent, companies need to prove that their personnel were indeed the first to discover the invention or carry out the process under examination. As a result, the proper capture and structuring of key data, steps, observations and so forth throughout all R&D activities are indispensable. As a general rule of thumb, the following capabilities are useful when considering data-management systems for R&D activities:

- ***Centralized access to a single data repository***: Rather than gathering key information on papers that can be misplaced, improperly filed and not easily accessible, all data are saved and readily accessed electronically
- ***Complete documentation:*** Today's systems ensure that complete and signed documentation are generated for all R&D activites
- ***Appropriate versioning of any type of document***: the content of documents must be up-to-date and searchable

ELNs provide comprehensive support in protecting intellectual property during R&D processes by providing such a centralized electronic access point to all relevant information, and the automatic creation of audit trail information provides proof that is needed during patent-application processes. Within the ELN, all of the relevant information can be easily accessed and appropriately packaged and displayed, thus making it much easier to confirm and prove the innovation to the patent officer or court.

Closing thoughts

Basic research is a core competency of companies throughout the CPI, and such companies must implement the tools needed to strike the right balance between making relavant data and information easily accessible to various collaborators within the organization and protecting trade secrets (for instance, by restricting access to key data to only certain personnel). State-of-the-art information-management tools and control solutions provide sufficient flexibility to allow process developers to strike the balance that is most appropriate for their site-specific needs related to R&D activities, process-scaleup, product-development and marketing efforts. ■

Edited by Suzanne Shelley

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Direct-Fired Heaters:
Evaluate Thermal Performance And the Effects of Fouling

As process specifications change, heaters often need to accommodate increased capacity. Use these calculations to determine the effects of doing so on fouling

Alan Cross, Retired

Direct-fired heaters find wide application throughout the chemical process industries (CPI) and are common in petroleum refineries, where they are used to preheat petroleum or petroleum-derived feedstocks in advance of downstream process operations.

Since excessive internal tube fouling occurs above certain temperatures, designers often try to keep temperatures down by over-specifying the heat transfer surface area. Later on, if the capacity of the heater needs to be changed or if the heater needs to be used for a different service altogether, the engineer needs to investigate how the new conditions will influence fouling.

This article demonstrates mathematically how to determine the effects of a different heat flux specification on run length (the time interval between shutdowns for cleaning or decoking). Such analysis is helpful in understanding the changes in operating costs associated with decoking the heater either more or less frequently.

This discussion focuses on the performance of direct-fired heaters in delayed-coking service, which experience the most-severe operating conditions of any type of petroleum-refining application. The stringent design strategies discussed here are also applicable to fired-heaters used in other refinery and chemical process applications.

Surface-area reduction

When heat transfer duty increases for a given amount of heat transfer surface area (as measured by the resulting increase in heat flux), it would appear that an increase in peak tube metal temperatures and more-rapid coke deposition would result. The calculations presented below verify that this is, in fact, the case.

However, the extent of increased fouling is not necessarily catastrophic. The example shown here for a heater of the design in Figure 1 illustrates that by increasing heat flux from 10,000 to 17,700 Btu/h-ft, the relative run length would be 0.36 or 36% of the run length for the heater as originally designed. If the original heater has a run length of 33 months, then the reapplied heater would have a run length of 1 year. In many cases, it would take many years for the increased operating costs to add up to the cost of a new heater.

Heat transfer conditions

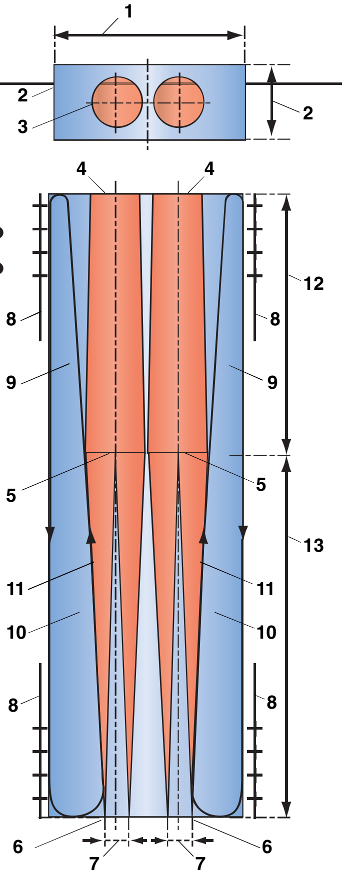
Direct-fired heaters used in delayed-coking service usually come with two sections — a radiant section and a convection section.

In general, the heating surfaces in the convection section may be used for feed preheating, followed by final heating to the design outlet temperature in the radiant section. The convection section may also be used for other types of preheating, such as steam superheating.

Radiant section. The radiant section consists of a refractory-lined enclosure that houses one or more tubular heating coils, through which the process fluids flow. The heating coils are arranged so as to surround a central grouping of one or more burners fueled by natural gas (or other gases).

This section usually uses tubular heating surfaces that are either arranged vertically or horizontally in an enclosure that has a cylindrical or rectangular cross-section. The equations presented below are valid for cabin-type heaters that have a rectangular cross-section and horizontal tubes. Minor modifications would be needed to use these equations to evaluate the performance of a heater with a cylindrical cross-section.

The arrangement of the heating coils forms a combustion chamber into which the high-temperature combustion products generated by the burners flow. Heat is transferred from the combustion products flowing past the coils



1. 8-ft heater width
2. Single dual-burner element length = 3 ft, 28 burners total
3. Top of burner flames
4. Top of 1.95-ft-dia., upper-zone flames at 1,600°F
5. Top of 2.22-ft-dia, lower-zone flames at 2,200°F
6. 3,500°F burner flame temperature at 0 emissivity
7. 1-ft burner inside dia.
8. Tube bank at inside walls of refractory-lined enclosure
9. Upper-zone circulating stream at calculated average temp. of 1,600°F
10. Lower-zone circulating stream at calculated average temperature of 1,900 °F
11. Burner flame
12. 20-ft calculated height of the upper zone
13. 20-ft calculated height of the lower zone

FIGURE 1. This schematic shows a typical direct-fired heater radiant section, and provides dimensional data and temperatures that correspond to the equations provided in this article

to the process fluids flowing through them, with the principal mode of heat transfer occurring via radiation across the walls of the coils (Figure 1).

The radiant section of a typical direct-fired heater most often has two merging zones. The first is a lower firing zone that corresponds to a section of the heater wherein the fuel-air mixture exiting the burners is burned very nearly to completion, and the combustion products are simultaneously cooled by the surrounding heat-transfer surfaces. The length of this section should be very nearly equal to the flame length. In the second zone — located above the first — the combustion products are further cooled prior to entering the convection section.

Convection section. The convection section typically preheats process fluids before they enter the radiant section. It consists of a refractory-lined enclosure that has a rectangular cross-section.

Inside the enclosure are multiple rows of closely spaced, horizontal tubes. These tubes form channels through which combustion products leaving the radiant section pass at relatively high velocity. As this happens, heat is transferred, principally via convection, from the combustion products to the heating surfaces and process fluids. Combustion products typically leave the convection section at a reduced temperature (lower exhaust temperatures corresponds to higher overall thermal efficiencies).

NOMENCLATURE

Term	Units	Definition
a	unitless	Factor converting a single row of tubes backed by refractory to a planar surface (see box, p. 49)
A_{circ}	ft2	Surface area of the circulating stream
A_{flame}	ft2	Surface area of the circulating stream; equal to A_{circ} (Equation 4)
A_t	ft2	Total planar tube surface
A_o	ft2	Total outside radiant heat transfer surface
Cp_{circ}	Btu/lb°F	Average specific heat at the average circulating fluegas, or the average Cp based on a specified temperature interval
D_{burner}	ft	Burner inside dia.
$D_{flame\ avg}$	ft	Average flame dia. (see Figure 1)
$D_{flame\ top}$	ft	Diameter at the top of the flame
D_{tube}	ft	Outside tube diameter
E_{circ}	unitless	Emissivity of the circulating gas stream
E_{eff}	unitless	Effective emissivity between two parallel surfaces (one hot plane and one cold plane). Note: Calculation of E_{eff} in Equation (2a) requires the following substitutions: Equation (1) $E_1 = E_{tubes}$ and $E_2 = E_{fg}$; Equation (12) $E_1 = E_{fg}$ and $E_2 = E_{circ}$; Equation (13) $E_1 = E_{circ}$ and $E_2 = E_{tubes}$
E_{fg}	unitless	Emissivity of the fluegas, obtained from Equation (3), which was obtained by curve fitting a figure obtained from Ref. [3]
$E_{cold\ avg}$	unitless	Average emissivity of the top cold plane
$E_{hot\ avg}$	unitless	Average emissivity of the hot plane
E_{tubes}	unitless	Emissivity of the tubes, as obtained from Ref. [3]
H_{bott}	ft	Height of the lower zone
H_{top}	ft	Height of the top zone
$HTCo_{flame}$	Btu/h-ft2-°F	Convective heat transfer coefficient at the outside of the flame envelope (Equation 10)
$HTCo_{inside}$	Btu/h-ft2-°F	Heat transfer coefficient inside tube
$HTCo_{tubes}$	Btu/h-ft2-°F	The tubular outside heat transfer coefficient from the circulating stream to the tubes (Equation 8)
K_1	unitless	Thermal decomposition constant of process fluid
L	ft	Thickness of the fluegas layer
L_c	in.	Maximum allowable coke thickness
L_f	ft	Flame length
L_t	ft	Tube length
N_b		Total number of burners
P	atm	Total pressure
q_{avg}	Btu/hr-ft2	Average radiant heat flux
q_{max}	Btu/hr-ft2	Maximum radiant heat flux
Q_{bott}	Btu/h	Total heat absorption in the bottom zone of the radiant section (Equation 18)
$Q_{c\text{-}circ\text{-}t}$	Btu/h	Heat transferred by convection from the circulation stream to the outside tube surfaces (Equation 18)
$Q_{c\text{-}circ}$	Btu/h	The quantity of heat transferred by convection from the flame envelope to the circulating fluegas stream (Equation 11)

Temperature and fouling

The temperature of the combustion products generated in the heater vary from very high at the bottom of the radiant section (from a maximum equal to the adiabatic flame temperature at about 3,500°F), to intermediate at the top of the radiant section (also the inlet of the convection section), to very low at the top of the convection section (about 400°F leaving the convection section). The temperature gradient from top to bottom depends on the heat in the combustion products leaving the burners, and the amount of heat removed by the heat transfer surfaces, as determined by the temperature and heat transfer characteristics of both the combustion products and heat transfer surfaces.

Because of the high temperatures in the radiant section, the hydrocarbon fluids at the inside wall of the tubular heating elements in this section tend to experience a degree of thermal decomposition, leaving behind coke deposits that can adhere to the inner surface of the coil. As coke deposits (and deposits from dirt and other impurities in the fluids) build up, they form an insulating layer that restricts heat flow through the tube wall. Eventually, when the tube wall reaches its design temperature (referred to as an end-of-run condition), the heater must be shut down and decoked (for instance, by using steam-air decoking or controlled burning), or mechanically cleaned (by using rotary cutting tools). Periodic removal helps avoid tube damage while ensuring optimum heat-transfer and system performance.

The time interval between shutdowns for decoking or cleaning is referred to as run length. Ideally, the run length should be made as long as possible, but decisions related to appropriate run length must be balanced against the higher capital costs associated with such activities. For instance, it might be prohibitively costly to provide enough heat transfer area to lower the tube-metal temperatures to the level needed to drastically increase the run length.

Heat transfer calculations

Simultaneous solution of Equations (1) through (18) below describe how heat is transferred from the combustion products to the tubular heat-transfer surfaces in the

Term	Units	Definition
$Q_{heat\ loss}$	Btu/h	Radiant and convective heat loss from radiant section enclosure
Q_{lib}	Btu/h	Total burner heat liberation
Q_{r-circ}	Btu/h	Heat transferred by radiation from the burner flame envelope to the circulating fluegas (Equation 12)
$Q_{r-circ-t}$	Btu/h	Heat transferred by radiation from the circulating fluegas to the planar tubes (Equation 13)
Q_{r-t}	Btu/h	The total heat transferred by radiation from the burner flames to the tubular heating surfaces at either side of the burner flame envelopes, with burner flames being generated by two rows of burners firing upward from the hearth (Equation 1)
Q_{top}	Btu/h	Total heat absorption in the top zone of the radiant section (Equation 17)
Q_{total}	Btu/h	Total process heat absorption (Equations 15 and 16)
$Sp.vol._{burner\ gas}$	ft^3/lb	Specific volume of fuel-air mix at the temperature exiting the burner
$Sp.vol._{circ}$	ft^3/lb	Specific volume of the circulating gas
$Sp.vol._{flame\ top}$	ft^3/lb	Specific volume of the flame at the temperature exiting the lower zone
t	s	Time
T_{adb}	°F	Adiabatic flame temperature (about 3,500°F for natural gas)
$T_{bott\ in}$	°F	Temperature of the fluegas entering the bottom zone of the radiant section; same as T_{adb}
$T_{bott\ out}$	°F	Temperature of the fluegas leaving the bottom zone of the radiant section
T_{circ}	°F or R*	Average temperature of circulating fluegas
T_f	°F or R*	Average process fluid temperature, in °F except in Equation (5)
T_{flame}	°F	Average flame temperature
T_{fg}	R	Fluegas temperature
$T_{fg\text{-}avg}$	R	The average fluegas temperature based on the fluegas temperature entering and leaving the zone
T_{MT}	°F or R*	Design temperature of tube metal surface at outside diameter; Subscripts: *sor* = start of run; *eor* = end of run; *avg* = average
$T_{top\ in}$	°F	Temperature of the fluegas entering the top zone of the radiant section; same as $T_{bott\ out}$
$T_{top\ out}$	°F	Temperature leaving the top zone of the radiant section and entering the convection section
V_{burner}	ft/s	Burner exit velocity, which is also equal to V_f, the flame velocity
V_{circ}	ft/s	Velocity of the circulating fluegas stream, as limited by V_{burner}; see Equation (7)
Vp	ft/s	Flame-propagation velocity for the fuel-air mixture [3]; Note: 1 ft/s is a typical value for natural gas and other hydrocarbon mixtures under ordinary burning conditions
V_{flame}	ft/s	Velocity of the flame envelope
$W_{air+fuel\ total}$	lb/h	Total flowrate of the burner fuel-air mix
W_{fg}	lb/h	Burner fluegas flow

* In the case of convective heat transfer [Equations (9) and (11)], use °F; in the case of heat transfer via radiation [Equations (1), (12) and (13)], use R

radiant section by both radiation and convection. The radiant section described in the author's patent [1] and shown in Figure 1 provides an illustrative example.

Calculate Q_{r-t}, the total heat transferred by radiation from the burner flames to the tubular heating surfaces at either side of the burner flame envelopes, using Equation (1):

$$Q_{r-t} = 0.173(a)(E_{eff}) \times \left[\left(\frac{T_{fg-avg}}{100}\right)^4 - \left[\frac{T_{MT}}{100}\right]^4\right](A_{flame})(N_b) \quad (1)$$

See box, right, for discussion of term a.

Emissivity calculations (E_{eff}). E_{eff}, the effective emissivity between two parallel surfaces, is given by Equation (2a) and Ref. [2]):

$$E_{eff} = \frac{1}{\left[\left(\frac{1}{E_1}\right) + \left(\frac{1}{E_2}\right) - 1\right]} \quad (2a)$$

For the purpose of solving Equation (1), E_1 is equal to E_{tubes}, which can be easily found in popular references [5]. At an average temperature of 1,200°F (the design tubes metal temperature T_{MT}) the average emissivity of the tubes (the cold plane) is 0.8. E_2 is equal to E_{fg}, which must be evaluated as two gases (one hot and one cold) using Equation (2b).

$$E_{eff} = \frac{1}{\left[\left(\frac{1}{E_{hot\ avg}}\right) + \left(\frac{1}{E_{cold\ avg}}\right) - 1\right]} \quad (2b)$$

$E_{hot\ avg}$ is equal to the arithmetic average of the top and bottom calculated emissivities for the hot plane using Equation (3). $E_{cold\ avg}$ is calculated in a similar fashion but for the cold plane.

$$E_{fg} = \left(\frac{544}{T_{fg}}\right)\left[(mfCO_2 + mfH_2O)(P)(L)\right]^{0.417} \quad (3)$$

Here, mf is mole fraction of the given subsance, and L is the thickness of the plane at top and bottom. In a burner flame, L is equal in thickness to the flame diameter at the top of the flame, and equal to 0 at the bottom of the flame; see Figure 1).

Surface area of the burner flame envelope (A_{flame}).

$$A_{flame} = 3.14(D_{flameavg})(H_{bott}) \quad (4)$$

Ideally, the flame length, L_f, as given by Equation (5) should be equal to or somewhat less than H_{bott}.

$$3.14(D_{burner})(0.5)(L_f)(Vp) = 0.785(D_{burner})^2(V_{burner}) \quad (5)$$

$D_{flame\ avg}$ is the arithmetic average of D_{burner} and $D_{flame\ top}$, as shown in Figure 1. $D_{flame\ top}$ is calculated from Equation (6):

$$0.785\left(\frac{D_{burner} + D_{flametop}}{2}\right)^2 (V_{burner}) = (W_{air+totalfuel})\frac{Sp.vol._{flametop}}{(3,600)(N_b)} \quad (6)$$

Velocity of circulating fluegas stream (V_{circ}). The circulating fluegas stream, described above and depicted in Figure 1 is generated as a result of fluegas entrainment by the burner jet.

PLANAR TUBE SURFACES

Note that the procedure for the calculation of heat exchange between the burner flame, the circulating combustion products and the tubular heating surfaces assumes that each of the above-mentioned entities are parallel planes. While the flame surface and circulating combustion product surfaces may be considered parallel planes, the tube surfaces cannot.

To covert the outside tubular surface to an equivalent parallel plane or planar surface that is consistent with the flame and combustion product surfaces, the center-to-center distance between tubes is multiplied by the tube length, the number of tubes and the term *a* (see the Equation (1), the Nomenclature box, and the paragraph that follows).

Noting that factor *a* is a function of the tube diameter and the spacing of the tubes, and may be found in [2, 3], the use of the term planar tube surface is then considered to be the surface as calculated by the aforementioned procedure. ❑

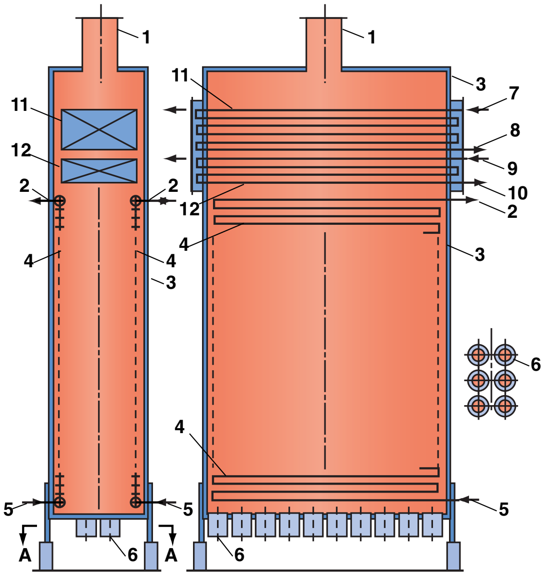


FIGURE 2. Shown here are the arrangements of components in the radiant and convection sections of a typical direct-fired heater

The volumetric gas-entrainment rate for a free jet (that is, one that is not constrained by a surrounding medium) is a function of the length-to-diameter of the jet and the volumetric flowrate of the burner gas. However, since a jet enclosed by a heater enclosure is not truly a free jet, different tactics must be used to calculate the circulation rate, since that rate must be considered to be limited by burner velocity. The following equation may be used:

$$\frac{\left(V_{burner}\right)^2}{\left(2g\right)\left(Sp.vol._{burnergas}\right)} = 4\frac{\left(V_{circ}\right)^2}{\left(2g\right)\left(Sp.vol._{circ}\right)} \quad (7)$$

Note that the above equation considers that a single burner velocity head, generated by the burner, is used to overcome a loss of four velocity heads, corresponding to the circulating stream making four 90-degree turns inside the enclosure.

Heat transfer coefficient for heat transfer from the circulating stream to the tubes ($HTCo_{tubes}$). Heat transfer by convection (from the relatively high-velocity, circulating fluegas stream and tubular heating coil at the inside walls of the radiant-section enclosure) contribute to the total heat flow absorbed by the coils. Equation (8) has been appropriately modified from Ref. [4]:

$$HTCo_{tubes} = 0.133\left[\frac{\left(V_{circ}\right)\left(3{,}600\right)}{\left(Sp.vol._{circ}\right)}\right]^{0.6}\frac{\left(Cp_{circ}\right)}{\left(D_{tube}\right)^{0.4}} \quad (8)$$

The quantity of heat transferred by convection to this surface, $Q_{c\text{-}circ\text{-}t}$, is given by:

$$Q_{c-circ-t} = \left(HTCo_{tubes}\right)\left(3.14\right)\times\left(D_{tube}\right)\left(T_{circ} - T_{MT}\right)\left(N_t\right)\left(L_t\right) \quad (9)$$

Meanwhile, heat transferred by convection from the flame envelope to the circulating fluegas stream must also be considered, and may be calculated using the following equation, also appropriately modified from Ref. [4]:

$$HTCo_{flame} = 0.0144\left[\frac{\left(V_{circ} - V_{flame}\right)\left(3{,}600\right)}{Sp.Vol._{circ}}\right]^{0.8}\times\frac{\left(Cp_{circ}\right)}{\left(D_{flameavg.}\right)^{0.2}} \quad (10)$$

The quantity of heat transferred by convection from the flame envelope to the circulating fluegas stream, $Q_{c\text{-}circ}$, is given by:

$$Q_{c-circ} = \left(HTCo_{flame}\right)\left(T_{flame} - T_{circ}\right)\left(A_{flame}\right)\left(N_b\right) \quad (11)$$

Also note the following relationship, where E_{eff} is given by Equation (2a) $E_1 = E_{fg}$ and is evaluated at $T_{fg\text{-}avg}$ and E_2 is evaluated at T_{circ}:

$$Q_{r-circ} = \left(0.173\right)\left(E_{eff}\right)\times\left[\left(\frac{T_{fg-avg}}{100}\right)^4 - \left(\frac{T_{circ}}{100}\right)^4\right]\left(A_{flame}\right)\left(N_b\right) \quad (12)$$

The heat transferred by radiation from the circulating fluegas to the planar tubes, $Q_{r\text{-}circ\text{-}t}$, is given by:

$$Q_{r-circ-t} = 0.173\left(a\right)\left(E_{eff}\right)\times\left[\left(\frac{T_{circ}}{100}\right)^4 - \left(\frac{T_{MT}}{100}\right)^4\right]\left(A_{flame}\right)\left(N_b\right) \quad (13)$$

Equation (14) shows that the heat entering the circulating gas stream by radiation and convection is equal to the heat leaving the circulating gas stream by radiation and convection. The temperature of the circulating fluegas stream is determined by equating the radiant and convective heat inputs entering the circulating fluegas stream to the radiant and convective heat inputs leaving, and solving for the unknown circulating fluegas temperature. Thus:

$$Q_{r-circ} + Q_{c-circ} = Q_{r-circ-t} + Q_{c-circ-t} \quad (14)$$

Note that Equations (15) through (18) for both zones must be satisfied in order to obtain a proper solution of Equations (1) thru (14):

$$Q_{top} + Q_{bott} = Q_{total} \quad (15)$$

$$Q_{lib} = Q_{top} + Q_{bott} + Q_{heatloss} + W_{fg}\times\left(Cp_{circ}\right)\left(T_{topout} - 60\right) \quad (16)$$

$$Q_{top} = \left(W_{fg}\right)\left(Cp_{circ}\right)\left(T_{bottout} - T_{topout}\right) \quad (17)$$

$$Q_{bott} = \left(W_{fg}\right)\left(Cp_{circ}\right)\left(T_{adb} - T_{bottout}\right) \quad (18)$$

$T_{bott\ in}$ may be taken to be the adiabatic flame temperature, although heat flow from the burner flame at this point is essentially zero since flame thickness and emissivity at this point are also zero.

Equations (1) through (18) can be used to evaluate the performance of both the upper and lower zones of the radiant section, and have been used to calculate the performance of a delayed-coking heater with a total radiant-heat absorption of 100-million Btu/h. Dimensional data provided in Figure (1) are based on data summarized in Ref. [1]. Data calculated via the equations provided herein are summarized in Table 1.

TABLE 1. SUMMARY OF CALCULATED DATA BASED ON REF. [*1*]

Upper zone dimensions, length (L_t)/width/height (H_{top}), ft	42/8/20
Lower zone dimensions, length (L_t)/width/height (H_{bott}), ft	42/8/20
Burner diameter (D_{burner}), ft	1.0
Number of burners (N_b)	28
Temperature leaving upper zone ($T_{top\ in}$), °F	1,600
Temperature leaving lower zone ($T_{bot\ out}$), °F	2,200
Total tubular surface area (A_o), ft^2	5,640
Overall average heat flux (q_{avg}), Btu/h-ft^2	17,700
Calculated heat absorption, upper zone (Q_{top}), million Btu/h	43.0
Calculated heat absorption, lower zone (Q_{bott}), million Btu/h	67.0
Total calculated heat absorption (Q_{total}), million Btu/h	110.0
Design total heat absorption, million Btu/h	100.0
Calculated convection heat transfer coefficient, burner flame to circulating stream ($HTCo_{flame}$), Btu/h-ft^2-°F	3.0
Calculated convection heat transfer coefficient, circulating stream to outside tube surface ($HTCo_{tubes}$), Btu/h-ft^2-°F	5.0
Calculated burner exit velocity (V_{burner}), ft/s	27.0
Calculated circulating stream velocity, as limited by burner velocity (V_{circ}), ft/s	31.0
Calculated average upper circulating stream temperature, °F	1,600
Calculated lower circulating stream temperature, °F	1,900
Maximum allowable coke-deposition thickness (L_c), in.	0.08
Relative run length for a heater where q_{avg} = 17,700 to a conventional heater where q_{avg} = 10,000	0.36

The maximum allowable coke deposition thickness occurs at the critical tube location. A trial-and-error procedure confirms that the critical tube location is mid-height in the radiant section.

Comparing relative run lengths

In the case of the two-zone, direct-fired heater discussed above, it is assumed that direct radiation to a single tube emanates horizontally and obliquely from a point corresponding to the radiating center (which is also the geometric center) of a cross-sectional plane passing vertically through the combustion chamber and burners (Figure 2).

Identify critical tube location. To properly evaluate the relative run length of a given radiant section for two different conditions, first a so-called critical tube location must be identified. The critical tube location is where the combination of maximum heat flux and resulting local-fluid temperature are such that the maximum allowable coke thickness is at its lowest point in the heater (and therefore is the limiting factor in run length). As a rule of thumb, the critical tube location is usually where the fluegas temperature is the highest. In the case of the heater illustrated in Figures 1 and 2, the critical tube location happens to correspond to the radiating center of the combustion chamber (the burner cross-section).

Calculate maximum radiant heat flux (q_{max}). Once a critical tube location has been identified, the maximum heat flux must be calculated.

$$q_{max} = HTCo_{inside}\left(T_{MT,sor} - T_f\right) = 1.8q_{avg} \quad (19)$$

Where

$$q_{avg} = \frac{Q_{total}}{A_o} \quad (20)$$

Note that the factor 1.8 in Equation (19) is for tubes on 2-dia. centers fired on one side only and backed by refractory.

Determine coke deposition temperature ($T_{MT,avg}$).

$$T_{MT,ave} = \frac{\left(T_{MT,sor} - T_{MT,eor}\right)}{2} \quad (21)$$

Where $T_{MT,eor}$ = the maximum tube design temperature (in this case, 1,200°F).

Determine coke deposition thickness (L_c). Once a critical tube location has been identified, the maximum-allowable, coke-deposition thickness can be determined.

$$\frac{1}{HTCo_{inside}} + \frac{L_c}{K_c} = \frac{\left(T_{MT,eor} - T_f\right)}{q_{max}} \quad (22)$$

Where K_c is the thermal conductivity of coke (13.6 Btu-in/h-ft^2-°F).

Determine the thermal decomposition constant (K_1). The coke-deposition temperature, ($T_{MT\ avg}$) in degrees R, can then be used to calculate a decomposition velocity constant [*5*].

$$\ln K_1 = 30.7 - \frac{50,248}{T_{MT,avg}} \quad (23)$$

K_1 is actually defined by Equation (24).

$$K_1 = \frac{1}{t}\ln\frac{100}{\left(100 - x\right)} \quad (24)$$

Since the run length for a given heater is proportional to L_c/K_1, the relative run length for the proposed heater having a lesser amount of tubular heat transfer surface than that of a heater of traditional design can be determined by dividing L_c/K_1 for the proposed heater by L_c/K_1 for the traditional design. This relationship results in the relative run lengths calculated and given in Table 1. ■

Edited by Suzanne Shelley

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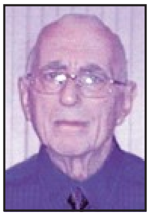
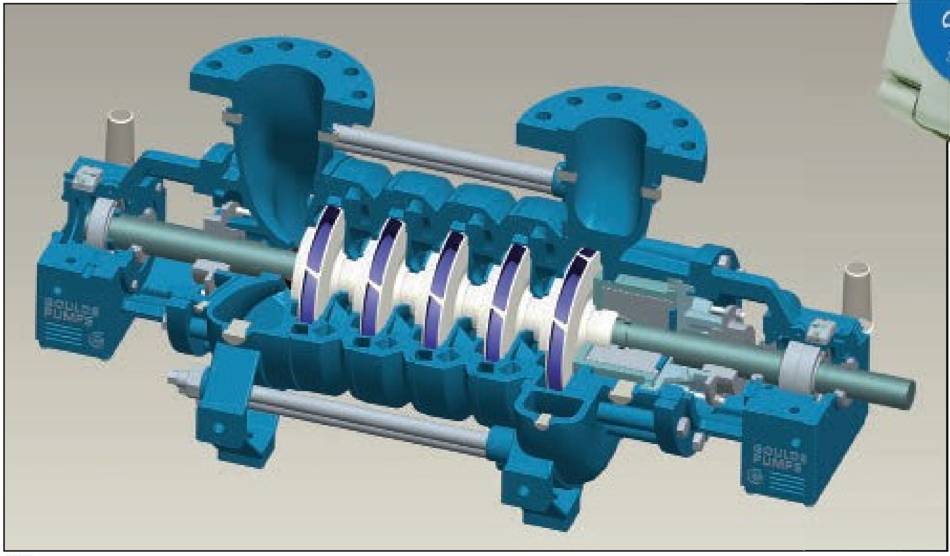
Author



Alan Cross (73-34 244th St., Little Neck, NY, 11362; Email: across8588@aol.com) has had more than 30 years of professional design experience with direct-fired heaters with ABB Lummus Heat Transfer (now CB&I Lummus Technology). He holds a B.S.Ch.E. from The City College of New York, and an M.S.Ch.E. from the Polytechnic University of New York, and is a member of the American Institute of Chemical Engineers. He has authored several patents related to direct-fired heaters, and has several other patents pending related to the design of coal-fired process heaters, compact, low-cost, fired heaters capable of processing low- and high-boiling petroleum-based fluids using design strategies that reduce the fouling of internal tube surfaces from coke deposition. He is also engaged in design studies relating to the development of low-cost, innovative, catalytic steam- methane reformer heaters and hydrocarbon-cracking heaters, with the expectation of patenting and prototyping the proposed equipment, as a result of the very substantial material cost savings indicated by preliminary estimates.

FOCUS ON

Water Treatment



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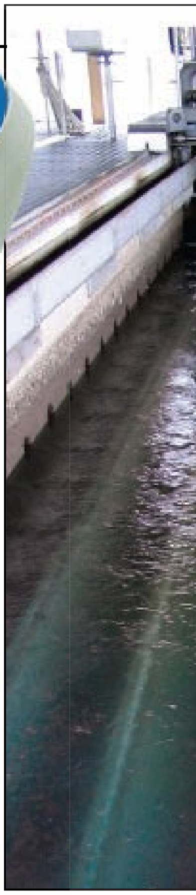


Last month, a total of 17,722 visitors and 995 exhibitors attended WEFTEC.09, the Water Environment Federation's (WEF) 82nd annual technical exhibition and conference held in Orlando, Fla. Particularly in this time of economic concerns, the strong showing reinforces the importance of water — its availability, treatment and reuse — in both industrial and municipal sectors.

At the show, leaders in the water-treatment arena shared their insights on the current state of water treatment and technologies. Chuck Gordon, president and CEO of Siemens Water Technologies Corp. (Warrendale, Pa.; www.water.siemens.com) emphasized the role of energy, "On average, a municipality spends about 30 to 40% of its energy bill on water and wastewater treatment, and much of the energy cost is for supplying aeration." He mentioned several solutions that his company offers for reducing energy use, not just for aeration, but also for reducing sludge and removing more water from sludge to reach high (~40%) solids levels. Gordon also says that the impact of the U.S. stimulus package has been positive, although only a small portion of it (~ 5% or $300 million) is targeted for water-treatment process equipment. About 70% of the projects Siemens is working on related to stimulus spending is for retrofitting, as opposed to new construction.

Klaus Andersen, executive vice-president of Veolia Water Solutions & Technologies (Saint Maurice, France; www.veoliawaterst.com) and CEO for the Americas and Australia, has been focused on reducing energy costs for some time. Some approaches provide significant savings he says, such as implementing anaerobic water-treatment in place of aerobic, which is what Veolia's Biothane group specializes in. Andersen further says that people are looking more and more at water reuse and recycling. He cites Veolia's recent contract with Diageo USVI for a washwater treatment plant for its rum distillery as an example (see *CE*, September 2009, p.63). Similar to the way many companies are now looking at carbon footprints, Andersen expects a water footprint to become common in the future.

The following products and services from these and many other companies are a sampling of what is currently offered for water treatment and reuse.

Reduce energy costs using this RO high-pressure pump

The high-pressure feed pump is an integral part of the reverse osmosis (RO) process. The new Model 3393 high-pressure ring section pump (photo) is capable of delivering 150 to 3,100 gal/min of feedwater (34 m^3/h to 700 m^3/h) depending on the size. The Model 3393 comes standard with i-Alert, an on-board monitoring device that constantly measures vibration and temperature, which provides a visual warning of potential operational issues. Benefits of the Model 3393 include: decreased power consumption and low total cost of ownership with high-efficiency hydraulic design; standard casing rings provide an easily replaceable wear surface to restore original efficiencies; impellers can be machined for impeller rings to extend the useful operating life of the pump; simplified maintenance and inspection because the involute balance drum is accessible and removable from the discharge side of the pump; and flexibility in plant layout resulting from multiple suction and discharge nozzle orientations. The Model 3393 RO pump will be available in sizes ranging from 2.5- to 6-in. discharge. — *ITT Corp., White Plains, N.Y.*
www.gouldspumps.com.

Upgrade performance with these cloth filters

AquaDiamond Filters (photo) provide the benefit of OptiFiber cloth filtration media in a lower profile, diamond configuration, with several design and performance advantages compared

Note: For more information, circle the 3-digit number on p. 62, or use the website designation.

Aqua-Aerobic Systems

Dow Water & Process Solutions

Siemens Water Technologies

to traveling-bridge-sand filters. These advantages include the following, says the manufacturer: 2–3 times the flow capacity with an equivalent footprint; up to 3 times higher solids loading capabilities per square foot of media; reduced backwash-water volume; an improved drive and tracking system prevents "crabbing"; and lower operation and maintenance costs. These filters can be retrofitted into existing concrete traveling bridge filters, or can be installed in new plants. — *Aqua-Aerobic Systems, Inc., Rockford, Ill.*
www.aqua-aerobic.com

This pressurized ultrafiltration module is the largest

Designed with increased area and length to yield cost savings on system design and fabrication, the new Ultrafiltration SFP-2880 (photo) is the largest pressurized ultrafiltration module on the market, says the manufacturer. Ideal for a wide variety of treatment applications including industrial wastewaters, the SFP-2880 adds 20 inches of length when compared to the SFP-2860, but still features the high strength PVDF hollow fibers with a nominal pore size of 0.03 microns. This unit allows flexibility in system design by reducing the number of modules, required piping, skid infrastructure, and the size of the compressed air and clean-in-place systems. The 0.03-micron-nominal-pore diameter allows for removal of bacteria, viruses, and particulate matter including colloids to protect downstream processes, such as RO. The polymeric hollow fibers provide high strength and chemical resistance for long membrane life. An outside-in flow configuration offers high tolerance to feed solids that help reduce the need for pretreatment processes. — *Dow Water & Process Solutions, Minneapolis, Minn.*
www.dowwatersolutions.com.

A membrane bioreactor system that is designed for the CPI

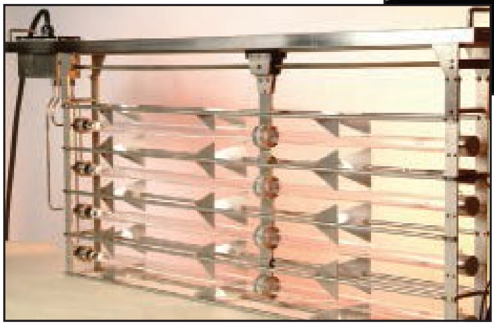
The Petro membrane bioreactor (MBR) system (photo) has been specially designed for the petroleum, petrochemical and other chemical process industries (CPI). It is a wastewater treatment process that combines various biological treatment processes with an integrated, immersed membrane system. Suited to a wide range of water treatment applications including water reuse, upgrades, retrofits and compliance-driven projects, the system offers the following features and benefits, according to the manufacturer: continuously controlled environment around the membrane system equalizes loading on each membrane bundle; positive two-phase (air and water) transfer into the fiber bundles keeps the membrane clean, extending life and reducing operating costs; cross-flow dynamics maximize scouring efficiency; small footprint; and continuous removal of oil and grease from the membrane operating environment. The automated, in-place membrane cleaning process can also mean reduced labor. — *Siemens Water Technologies Corp., Warrendale, Pa.*
www.water.siemens.com

Use this electromagnetic meter where no power is available

The Waterflux 3070 is an electromagnetic water meter for applications in the water and wastewater industries. Its 15-yr battery life makes it suited to applications where no power is available. The device also has the option of a GSM module for remote transmission of measurement data and status information. Thanks to extremely short inlet and outlet installation requirements, the Waterflux 3070 can be installed in very narrow wells and

Alfa Laval

Emerson Process Management



Calgon Carbon

chambers. As a magnetic-inductive meter it is accurate and stable, while also featuring a lower pressure drop than comparable mechanical water meters. For large diameters, the Waterflux 3070 has a price advantage compared to the lifetime cost of mechanical meters, which often require filters and rectifiers as well as significantly more maintenance and cleaning, according to the manufacturer. This company also offers the Optisound VU30 (photo, p. 52) and VU31 for level measurements in the wastewater industry. The Optisound is capable of liquid-level-measurement ranges up to 30 ft (9.1 m), with a 2-wire 4–20mA, HART output signal. — *Krohne Inc., Peabody, Mass.*
www.Krohne.com/northamerica

Sludge thickening and heat-transfer solutions

The Aldrum drum thickener (photo) provides very gentle sludge handling and recovery. The unit is a range of mechanical sludge thickeners and works on the principle of conveying polyelectrolyte-treated sludge through a slowly rotating drum filter. The sludge remains in the drum, while the water phase passes through the filter cloth. Sludge concentration can be regulated by adjusting the feedrate, angle and speed of the drum. Aldrum drum thickeners are equipped with a drum cleaning system consisting of a spray bar for water. The drum is cleaned using potable water, final effluent or treated filtrate, which reduces overall water consumption. The unit is available in four sizes and all are offered as separate components or as complete sludge thickening modules. This company also offers the Spiral Heat Exchanger for heating and cooling of sludge. The Spiral Heat Exchanger is intended for sludge applications in which heat is interchanged between sludge flows. It consists of a spiral — wound from sheets of metal strips — that forms two concentric spiral flow passages. The channels are alternately welded on opposite ends to form a hot and cold channel. The hot channel is then closed while the sludge channel is accessible for cleaning. The design is engineered to lower the required surface area through more efficient heat transfer and reduce fouling and plugging. — *Alfa Laval, Lund, Sweden*
www.alfalaval.com

This UV system is designed to efficiently treat water

The C3500 D (photo) utilizes 500-W ultraviolet (UV) lamps in a small footprint to provide overall efficiency and economic savings compared to other low-pressure, high-output (LPHO) systems, says the manufacturer. The high-wattage system relies on a patent-pending design, which hydraulically "mixes" water across three sets of delta-shaped (D) wings while minimizing the head loss and exposing the water to a high light dose to efficiently treat the water. The C3500 D utilizes calibrated UV sensors and flowrate to control the dose, helping to minimize operating costs and provide longer lamp life. — *Calgon Carbon Corp., Pittsburgh, Pa.*
www.calgoncarbon.com

Water facilities tackle cyber-security pressures

Documented security breeches at water and wastewater facilities worldwide are among the factors spurring calls by a number of organizations for increased cyber-security vigilance. The Ovation Security Center (photo) can help these facilities as they step up their cyber-security measures. Already proven in the power industry, the Ovation Security Center's centrally located console streamlines management of the following security applications: security event management; patch deployment and audit; malware prevention; event log storage and reporting; and vulnerability assessment and management. The Security Center's event-management capability provides a centralized event collection, event correlation, and threat identification function for security-related events in an Ovation control system. Security events are collected from each network device including network intrusion detection systems, firewalls, routers, switches, servers, workstations, controllers, and Security Center application modules. Periodic updates to patches, vulnerability databases and

security signatures are downloaded and standard-security-management reports are available for operations management and regulatory compliance. — *Emerson Process Management, Austin, Tex.*
www.emersonprocess.com

This biofilm treatment system offers high surface areas

Microorganisms in a biofilm wastewater-treatment process are typically more resilient to process disturbances when compared to other types of biological-treatment processes. In the AnoxKaldnes Moving Bed Biofilm Reactor (MBBR) technology, the biofilm growth is protected within engineered plastic carriers that are designed with high internal-surface areas. With this technology, it is possible to handle extremely high loading conditions without clogging. An aeration grid located at the bottom of the reactor supplies oxygen to the biofilm along with the mixing energy required to keep the biocarriers suspended and completely mixed within the reactor. Treated water flows from the reactor through a grid or a sieve, which retains the MBBR biocarriers within the reactor. Depending on the wastewater, the reactors may be equipped with special spray nozzles that prevent excessive foam formation. The MBBR biofilm technology can be used as a standalone process, or it can be used to enhance the treatment of activated sludge processes. — *Veolia Water Solutions & Technologies, Saint Maurice, France*
www.veoliawaterst.com/mbbr

Advanced cooling water solutions increase reliability

This company has recently debuted two advanced cooling solutions to help monitor, control and maintain cooling water systems with greater reliability and predictability. GenGard is a water-treatment technology for open recirculating cooling systems that can be applied in both neutral and alkaline pH scenarios. Gengard components are stable and retain their effectiveness in the presence of chlorine and other halogens. TrueSense Online for Cooling is a technology for applying the right amount of additive, at any point in time. The polymer that inhibits mineral scale and disperses suspended solids in cooling systems is measured and controlled. System performance is protected at an optimized total cost of cooling operations. The direct polymer measurement and control offers practical advantages, such as direct measuring, no dependence on tracers, no additional costs and a simple onsite singe-point calibration procedure. — *GE Water & Process Technologies, Trevose, Pa.*
www.gewater.com ■

Dorothy Lozowski

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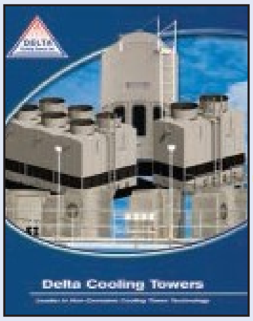

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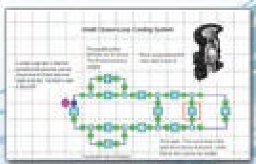

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BUSINESS NEWS

PLANT WATCH

BASF announces its intention to cease activities in Feluy, Belgium

October 22, 2009 — BASF Antwerpen N.V., a wholly owned subsidiary of BASF SE (Ludwigshafen, Germany; www.basf.com) has announced its intention to close its 115,000-ton/yr maleic anhydride (MA) production facility by the end of 2009 and to withdraw all BASF activities from its site in Feluy, Belgium. Unsatisfactory profitability due to overcapacity and resulting low margins together with the effects of the current economic crisis were cited as reasons.

Solvay and Huatai to build H_2O_2 plant

October 8, 2009 — Solvay S.A. (Brussels, Belgium; www.solvay.com) has struck an agreement with Huatai Group of China to establish a hydrogen-peroxide joint venture (JV). The JV company, Shandong Huatai Interox Chemical Co., will build a hydrogen peroxide plant at Huatai's new site in Dongying, Shandong Province, China, with a capacity of 50,000 metric tons per year (m.t./yr). The plant is expected to be completed by the end of 2011.

Two North American masterbatch sites to be closed by Clariant

October 2, 29009 — Responding to overcapacity in a market still affected by the economic downturn, Clariant (Muttenz, Switzerland; www.clariant.com) will close masterbatch facilities in Lachine, Quebec and in Milford, Del. Production from those sites will transfer to the company's existing sites, principally at Toronto, Ontario and Albion, Mich., respectively.

MERGERS AND ACQUISITIONS

Dow Corning establishes Middle East operations

October 22, 2009 — Dow Corning (Midland, Mich.; www.dowcorning.com) has established a Middle East headquarters and commercial entity in Manama, Bahrain. The Bahrain office, the company's first location in the Middle East, will house engineers, chemists and sales professionals with expertise in silicon-based technology. As many as 20 employees are expected to be working out of the office within the next year.

ChemPro and Mo-Fuel join forces for advanced cellulose ethanol technology

October 19, 2009 —The ChemPro Group, LLC (Boonton, N.J.; www,thechemprogroup.com), and Mo-Fuel (Rural Bio-waste; Sikeston, Mo.) have formed an alliance to commercialize a patented process that is expected to economically and efficiently produce ethanol from cellulose feedstocks. The process can handle a full spectrum of cellulosic feedstock, such as wood chips, pulp-and-paper-plant byproducts and corn stover. The technology, a continuous catalytic hydrolysis, produces a high conversion of biomass feedstock into fuel-grade ethanol and has a low residence time compared to other processes. The alliance will construct a mobile feedstock testing unit, which is expected to be operational in early 2010.

Milliken expands colorants portfolio through Rebus acquisition

October 14, 2009 — Milliken & Co. (Spartanburg, S.C.; www.millikenchemical.com) has announced the acquisition of the assets of Rebus, Inc., a North American provider of pigment and additive dispersions for the thermoset plastics and high-performance industrial coatings markets. Milliken will continue to operate Rebus's existing manufacturing facility in Aston, Pa. Terms of the acquisition were not disclosed.

Evonik acquires Eli Lilly's Tippecanoe manufacturing site

October 14, 2009 — Evonik Industries AG (Essen, Germany; www.evonik.de) has agreed to acquire Indianapolis, Indiana-based Eli Lilly and Co's Tippecanoe Laboratories manufacturing facility in Lafayette, Ind. The site manufactures active pharmaceutical ingredients (API) and precursor materials for the pharmaceutical industry. The Tippecanoe plant will be fully integrated into Evonik's global production and marketing network. The purchase price was not disclosed. The transaction is expected to close by the end of the year, pending approvals from regulatory agencies.

ADM acquires Czech oilseed processing plant

October 6, 2009 — Archer Daniels Midland Co. (ADM; Decatur, Ill.; www.admworld.com) has announced the expansion of its European oilseed processing capabilities with the acquisition of ViaChem Group's oilseed processing assets in Olomouc, Czech Republic. This facility consists of an oilseed crushing, refining and biodiesel production plant that produces oil and meal for the food, feed and energy markets.

Evonik and Cristal Material establish JV for LED glass lenses

October 5, 2009 — Evonik Industries AG (Essen, Germany; www.evonik.com) and Taipei, Taiwan-based Cristal Material Corp. have formed a JV to manufacture high-quality glass lenses for next-generation LEDs.

Wacker exits from solar-wafer business

September 30, 2009 — Wacker Chemie AG (Munich, Germany; www.wacker.com) will transfer its shares of its JV, Wacker Schott Solar GmbH (WSS), to its former partner Schott Solar AG. The reason for this move is Wacker's decision to focus its solar activities exclusively on its core competency, which is the production of hyperpure polycrystalline silicon. Schott Solar, on the other hand, concentrates on the downstream side of the photovoltaic value chain, the manufacturing of solar cells and modules.

BASF and CSM to develop biobased succinic acid

September 30, 2009 — BASF SE (Ludwigshafen, Germany; www.basf.com) and CSM N.V. (Diemen, the Netherlands; www.csm.nl) have announced the cooperation between their respective subsidiaries — BASF Future Business GmbH and Purac — for the development of the production of biobased succinic acid. Both partners have been working on the development of the industrial fermentation and downstream processing of biobased succinic acid and will start production of commercial quality and volumes in the 2nd Q of 2010.

A new company called Envirogen Technologies is formed

September 30, 2009 — The Amplio Group (London, U.K.) has announced the formation of Envirogen Technologies, Inc. (Kingwood, Tex.; www.envirogen.com), a technology and services provider with existing business in municipal and industrial water and environmental-treatment applications. Envirogen Technologies was formed from the assets of Basin Water, Inc., which were recently purchased by Amplio. The new company will offer a broad range of technologies and services for a number of environmentaltreatment applications, including potable water treatment, groundwater remediation, process water treatment, wastewater treatment, odor control and more. ■

Dorothy Lozowski

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

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FOR MORE ECONOMIC INDICATORS, SEE NEXT PAGE

Economic Indicators

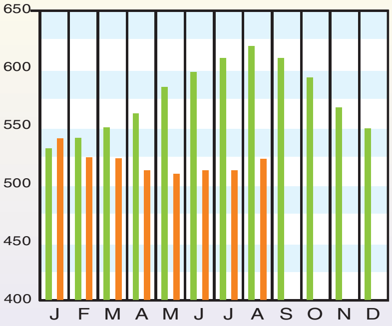
2009 2008

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

CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957-59 = 100)	Aug. '09 Prelim.	July. '09 Final	Aug. '08 Final
***CE* Index**	521.9	512.1	619.3
Equipment	615.7	601.2	761.0
Heat exchangers & tanks	560.9	542.8	784.2
Process machinery	599.1	589.8	680.7
Pipe, valves & fittings	752.0	732.1	881.5
Process instruments	399.8	387.8	457.8
Pumps & compressors	895.9	898.5	872.9
Electrical equipment	462.1	459.1	468.1
Structural supports & misc	630.8	615.9	843.9
Construction labor	327.7	327.5	325.3
Buildings	491.3	487.0	529.8
Engineering & supervision	346.0	346.5	352.3

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

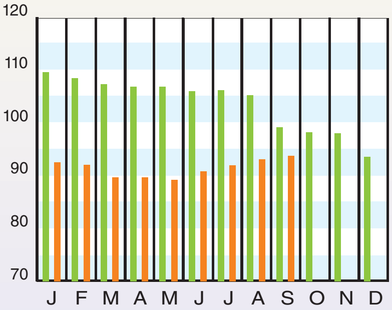


Starting with the April 2007 Final numbers, several of the data series for labor and compressors have been converted to accommodate series IDs that were discontinued by the U.S. Bureau of Labor Statistics

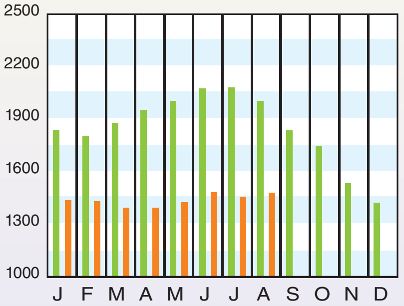
CURRENT BUSINESS INDICATORS

	LATEST			PREVIOUS						YEAR AGO		
CPI output index (2000 = 100)	Sep. '09	=	93.7	Aug. '09	=	93.0	Jul. '09	=	91.9	Sep. '08	=	99.0
CPI value of output, $ billions	Aug. '09	=	1,480.5	Jul. '09	=	1,454.9	Jun. '09	=	1,482.4	Aug. '08	=	2,000.6
CPI operating rate, %	Sep. '09	=	69.1	Aug. '09	=	68.4	Jul. '09	=	67.5	Sep. '08	=	72.4
Producer prices, industrial chemicals (1982 = 100)	Sep. '09	=	248.4	Aug. '09	=	236.9	Jul. '09	=	234.6	Sep. '08	=	312.3
Industrial Production in Manufacturing (2002=100)*	Sep. '09	=	97.5	Aug. '09	=	96.7	Jul. '09	=	95.6	Sep. '08	=	105.7
Hourly earnings index, chemical & allied products (1992 = 100)	Sep. '09	=	148.2	Aug. '09	=	148.0	Jul. '09	=	148.5	Sep. '08	=	144.3
Productivity index, chemicals & allied products (1992 = 100)	Sep. '09	=	135.3	Aug. '09	=	133.8	Jul. '09	=	131.8	Sep. '08	=	122.3

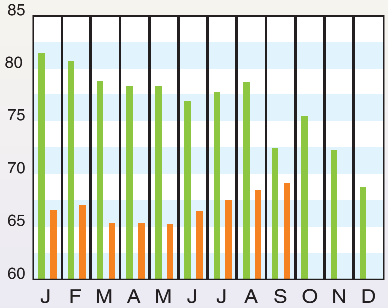
CPI OUTPUT INDEX (2000 = 100)



CPI OUTPUT VALUE ($ BILLIONS)



CPI OPERATING RATE (%)



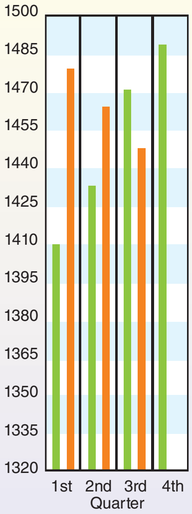
*Due to discontinuance, the Index of Industrial Activity has been replaced by the Industrial Production in Manufacturing index from the U.S. Federal Reserve Board.
Current business indicators provided by Global insight, Inc., Lexington, Mass.

MARSHALL & SWIFT EQUIPMENT COST INDEX

(1926 = 100)	3rd Q 2009	2nd Q 2009	1st Q 2009	4th Q 2008	3rd Q 2008
M & S INDEX	1,446.4	1,462.9	1,477.7	1,487.2	1,469.5
Process industries, average	1,515.1	1,534.2	1,553.2	1,561.2	1,538.2
Cement	1,509.7	1,532.5	1,551.1	1,553.4	1,522.2
Chemicals	1,485.8	1,504.8	1,523.8	1,533.7	1,511.5
Clay products	1,495.8	1,512.9	1,526.4	1,524.4	1,495.6
Glass	1,400.4	1,420.1	1,439.8	1,448.1	1,432.4
Paint	1,515.1	1,535.9	1,554.1	1,564.2	1,543.9
Paper	1,416.3	1,435.6	1,453.3	1,462.9	1,443.1
Petroleum products	1,625.2	1,643.5	1,663.6	1,668.9	1,644.4
Rubber	1,560.7	1,581.1	1,600.3	1,604.6	1,575.6
Related industries					
Electrical power	1,370.8	1,394.7	1,425.0	1,454.2	1,454.4
Mining, milling	1,547.6	1,562.9	1,573.0	1,567.5	1,546.2
Refrigeration	1,767.3	1,789.0	1,807.3	1,818.1	1,793.1
Steam power	1,471.4	1,490.8	1,509.3	1,521.9	1,499.3

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

Preliminary estimates indicate that in August there was nearly a 2% increase in capital equipment pries (as reflected in the Chemical Engineering Plant Cost Index) from the previous month. That reflects the largest increase since equipment prices bottomed out in May.

Meanwhile, the CPI output index and operating rate continue to climb, but each is still below its level of the same period one year ago.

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