CHEMICAL ENGINEERING

June 2009

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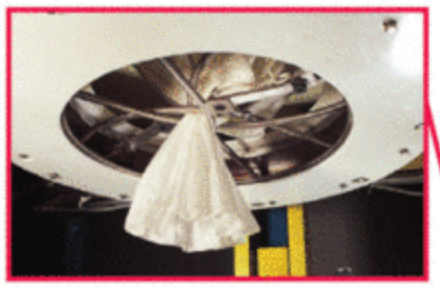
Revolutionary design eliminates 4 bulk bag unloading problems



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Prevent dead spots and promote flow with TELE-TUBE® telescoping tube*

The TELE-TUBE® telescoping tube pneumatically raises the SPOUT-LOCK® clamp ring* (at left) for connection to the bag spout, then allows it to lower, applying continual downward tension. As a result, the spout is kept taut at all times, preventing excess spout material from bulging outward (creating dead spots) or falling inward (creating flow restrictions). Works in unison with FLOW-FLEXER™ bag activators to promote flow.*

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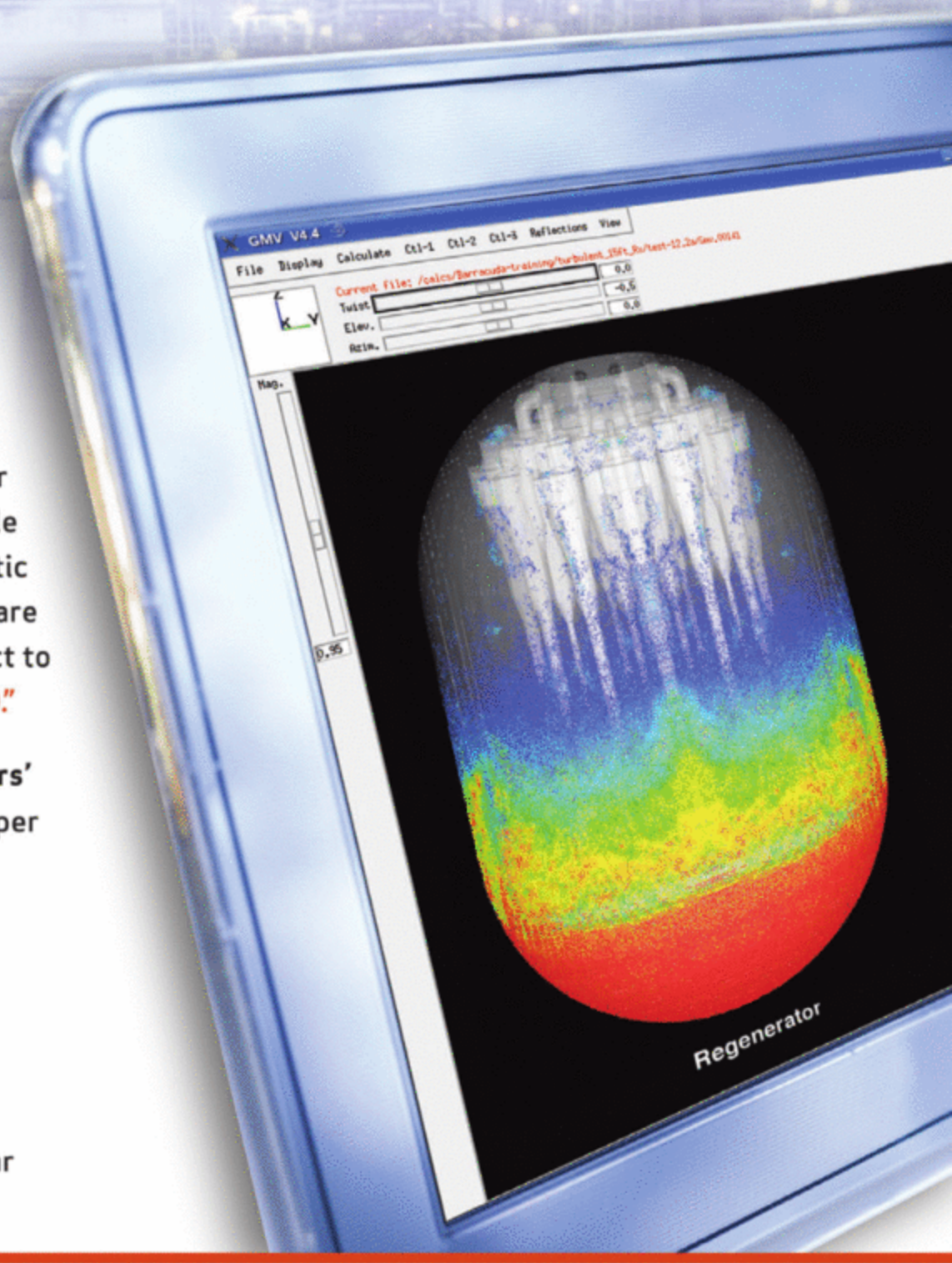

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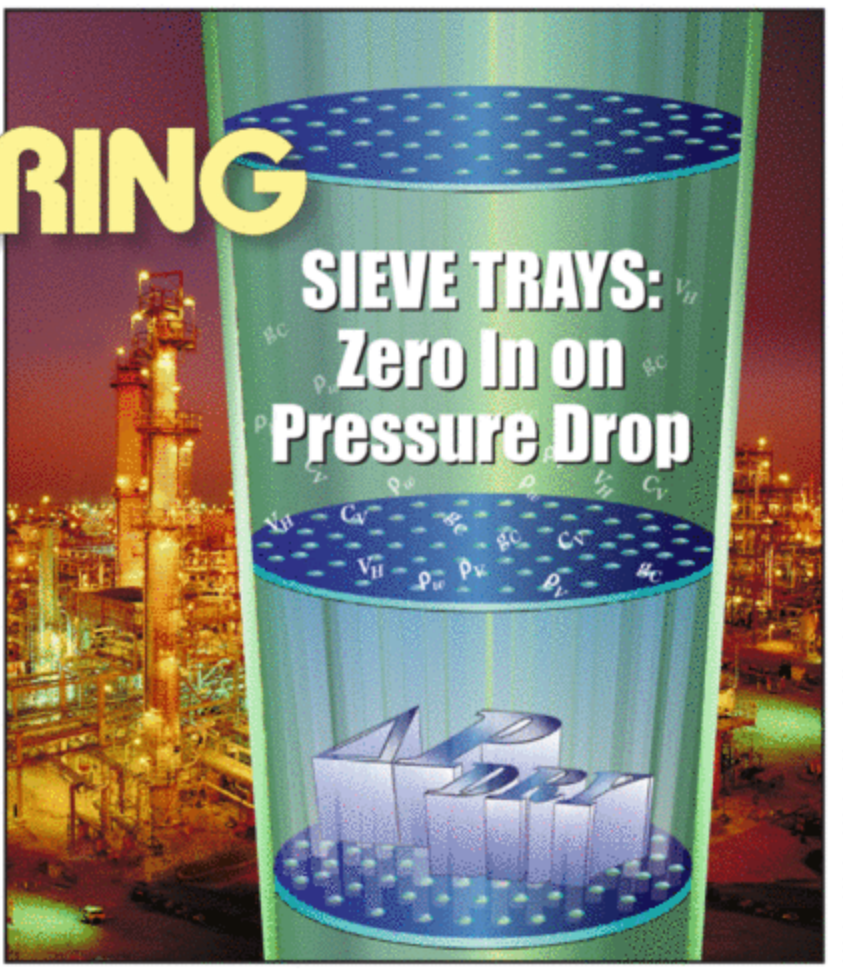

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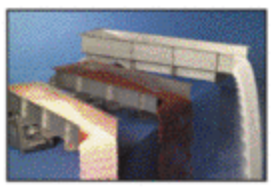

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Licensure around the globe

Chemical engineering principles do not differ by geographical location. The same cannot be said, however, about the established criteria for certifying that an individual has mastery of those principles. Requirements for obtaining a professional license or charter in the field vary widely from country to country, and in the U.S. they even vary from state to state. Such inconsistencies further complicate an initiative that has recently gained momentum — and criticism — in the U.S. and elsewhere: raising the educational prerequisite from a bachelor's to a master's degree.

While such requirements are common in continental Europe, the only English-speaking nation to presently stipulate completion of a master's degree is the U.K., which recognizes its engineers with chartered status. Other accreditation boards that are at least considering a similar move include signatories of the Washington Accord, which in addition to the U.K.'s Engineering Council (EngC) include IEAust (Australia), CCPE (Canada), IEI (Ireland), IPENZ (New Zealand), ABET (U.S.), HKIE (Hong Kong), ECSA (South Africa), JABEE (Japan) and IES (Singapore).

The U.S. is moving more quickly than the other nations represented in the accord, explains Dr. Winfred M. Phillips, chair of the Washington Accord, past ABET president and current vice president for research at the University of Florida. The charge is led by the discipline of civil engineering, which Phillips says is stimulated by the large numbers in private consulting. "Most of the other professional areas do not agree," he adds.

Indeed, in a recent statement, the American Institute of Chemical Engineers (AIChE; New York; www.aiche.org), says "While strongly encouraging chemical engineers to become licensed, AIChE leaders believe that the change is unwarranted, expensive, and won't provide any increased benefit or protection to the public. For chemical engineers, the B.S. degree, four years of practice, and passage of the P.E. exam are sufficient to assure a reasonable level of competence and protect the public."

In leading up to a call for action, AIChE's statement describes the situation as follows: The change in the Model Law of the National Council of Examiners for Engineering and Surveying (NCEES; Clemson, S.C.; www.ncees.org) requires a Master of Science degree or its equivalent beginning in 2020. That would be on top of the current requirements that you have graduated from a four year, ABET-accredited engineering program; have four years of work experience; and pass the Fundamentals of Engineering examination. State legislatures and governing boards are being urged to adopt this change by 2012, so it can be implemented in 2020.

AIChE is certainly not alone in its objection. In fact, AIChE, along with seven other societies, have endorsed an American Society of Mechanical Engineers' (New York; www.asme.org) position paper opposing the change. The Academy of Engineering Companies is also against it, AIChE says.

To concerned Ch.E.s, AIChE suggests the following: "Make your opinion known to the licensing board and appropriate committees of your state legislature. Also, make your management aware of the change. Finally, if you are a member of other engineering societies, for example, the National Society of Professional Engineers (NSPE; Alexandria, Va.; www.nspe.org), discuss the issue at local meetings. All [professional engineers] need to be aware of the change." Meanwhile, it points engineers to www.licensingthatworks.org.

The best case scenario for chemical engineers with this mission would probably be differing requirements among the disciplines. This is not ideal from at least one perspective. "Many of us wish this would be simplified and be more informed," says Phillips. ■

Rebekkah Marshall

Letters

Leaching Pb from glass?

I read your article Recycling Cathode Ray Tubes (CRTs; April, pp. 24–27) on how CRTs are being reprocessed and the technology associated therewith. Well done and well written; however, as a metallurgist, I recognize that glass is a very stable material when exposed to normal environments. The windshield on your and my automobile is unaffected by rain, sunshine, air pollution, an so on. I expect that glass buried in landfills 100 years ago is still there, no different than it was when it was buried. High-end glass crystal used to be (and still may be) made from PbO. Glasses that you put into the dishwasher will etch after hundreds of washings, but that alkaline and hot water environment is a far cry from that of a landfill. To the best of my knowledge, nobody has ever been stupefied by lead that was part of properly vitrified glass.

While we are very concerned about lead in landfills, I question the need for such concern when the lead is a chemically bound part of the stuff that makes up glass. I think this concern falls under the same technically incompetent concern that "environmentalists" have for free-machining brass (which contains 5–7 wt% lead to improve machining) in potable water systems: to contaminate the water passing through lead-containing castings, the lead would have to be extracted as part of the general corrosion of the castings, and if that happened at a rate high enough to measure the amount of lead in the water, brass castings would have a service life of only a few years. As we know, brass castings typically last the lifetime of the plumbing system in which they are installed.

How about a story explaining why leaded glass is a concern when it is put into a landfill. Please explain the mechanism by which lead is leached from glass, contaminating the ground around it — and the water supply.

Or maybe I've just missed something. If so, please send me a reference by a technically competent organization that explains why otherwise stable glass suddenly becomes soluble when placed in a landfill.

Walter J. Sperko, P.E.
Sperko Engineering Services, Inc., Greensboro, NC.

Editor replies:

The EPA has a toxicity threshold of 5 mg/L for the leaching of lead, and crushed CRT glass has been found to exceed this threshold, leaching 18.5 mg/L (in a study by the University of Florida). Though CRTs are often disposed of as whole units (from which lead does not readily leach, as you point out), it is the more extreme case of a finely broken down CRT that must be considered.

In any case, with regulations in place for the handling and recycling of CRTs, the focus of this article was to highlight the technology currently in place for the efficient processing of CRT glass.

The University of Florida report can be found here:
www.hinkleycenter.com/publications/lead_leachability_99-5.pdf ■

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Calendar

NORTH AMERICA

Oil Sands and Heavy Oil Technologies Conference & Exhibition. Pennwell Petroleum Events (Tulsa, Okla.). Phone: 713-963-6251; Fax: 713-963-6201; Web: oilsandstechnologies.com
Calgary, Alta. **July 14–16**

2009 World Congress on Industrial Biotechnology and Bioprocessing. Biotechnology Industry Organization (BIO; Washington, D.C.). Phone: 202-962-9200; Fax: 202-488-6301; Web: bio.org/worldcongress
Montreal, Quebec **July 19–22**

Microconstituent and Industrial Water Quality 2009 Conference. Water Environment Federation Specialty Conferences (Alexandria, Va.). Phone: 703-684-2441; Web: wef.org/ConferencesTraining/ConferencesEvents/MicroconstituentsIndustrialWaterQuality/
Baltimore, Md. **July 26–29**

11th International Conference on Liquid Atomization and Spray Systems. Institute for Liquid Atomization and Spay Systems(Denver, Colo.). Phone: 303-871-4843; Fax: 303-871-4450; Web: ilass.uci.edu/iclass2009/
Vail, Colo. **July 26–30**

9th Biennial ACEEE Summer Study on Energy Efficiency in Industry. American Council for an Energy-Efficient Economy (ACEEE; Newark, Del.). Phone: 302-292-3966; Web: aceee.org/conf/09ss/09ssindex.htm
Niagara Falls, N.Y. **July 28–31**

Shaping Innovation Leaders. Industrial Research Institute (Arlington, Va.). Phone: 703-647-2588; Web: iriinc.org
Chicago, Ill. **July 31–Aug 7**

4th Annual ISA Water/Wastewater Automatic Controls Division Symposium. The International Society of Automation (ISA; Research Triangle Park, N.C.). Phone: 919-990-1418; Web: isa.org/wwac
Orlando, Fla. **August 4–6**

7th International Corrosion Solutions Conference. ATI Wah Chang (Albany, Ore.). Phone: 541-926-4211, Ext. 6280; Web: corrosionconference.com
Park City, Utah **September 20–24**

Human Error Prevention; Root Cause Analysis Seminar; Nuclear Quality Requirements for Procurement of Design & Construction Services and

Components Seminar; and QEH&S Auditing/ISO 19000 Seminar (separate events). High Technology Seminars (Cold Spring, N.Y.). Phone: 845-265-0123; Web: hightechnologyseminars.com
Chattanooga, Tenn. **September 22–29**

OSHA Dust Explosion Inspection Preparatory Training Course. Chilworth Technology (Plainsboro, N.J.). Phone: 609-799-4449; Web: chilworth.com
Columbus, Ohio **September 24**

EUROPE

17th European Biomass Conference & Exhibition. ETA-Renewable Energies (Florence, Italy). Phone: + 39 055 5002280; Web: conference-biomass.com
Hamburg, Germany **June 29–July 3**

42nd IUPAC Congress: Chemistry Solutions. Royal Society of Chemistry (Cambridge, U.K.). Phone: + 44 (0) 1223 432254; Fax: + 44 (0) 1223 423623; Web: iupac2009.org
Glasgow, Scotland **August 2–7**

32nd Annual Advances in Emulsion Polymerization and Latex Technology. Lehigh University (Bethlehem, Pa.) and The University of Maryland (College Park, Md.); Phone: 404-894-3274; Web: davoscourse.com
Davos-Platz, Switzerland **August 3–7**

14th International Congress for Battery Recycling 2009. ICM AG (Birrwil, Switzerland); Phone: +41 62 785 10 00; Fax: +41 62 785 10 05; Web: icm.ch
Geneva, Switzerland **September 16–18**

ASIA & ELSEWHERE

7th MachinExpo Bangladesh 2009 International Expo. Conference & Exhibition Management Services Ltd. (Woodside, N.Y.). Phone: 347-543-5543; Web: machinexpoonle.org
Dhaka, Bangladesh **July 16–19**

CHoPS (6th International Conference for Conveying and Handling of Particulate Solids), ICBMH (10th International Conference on Bulk Materials Storage, Handling & Transportation), and BULKEX (Asia-Pacific Bulk Materials Handling Expo). The Powder/Bulk Portal (Benediktbeuern, Germany). Phone: 08857 69 89 60; Web: chops2009.org.au
Brisbane, Australia **August 3–7** ■

Suzanne Shelley

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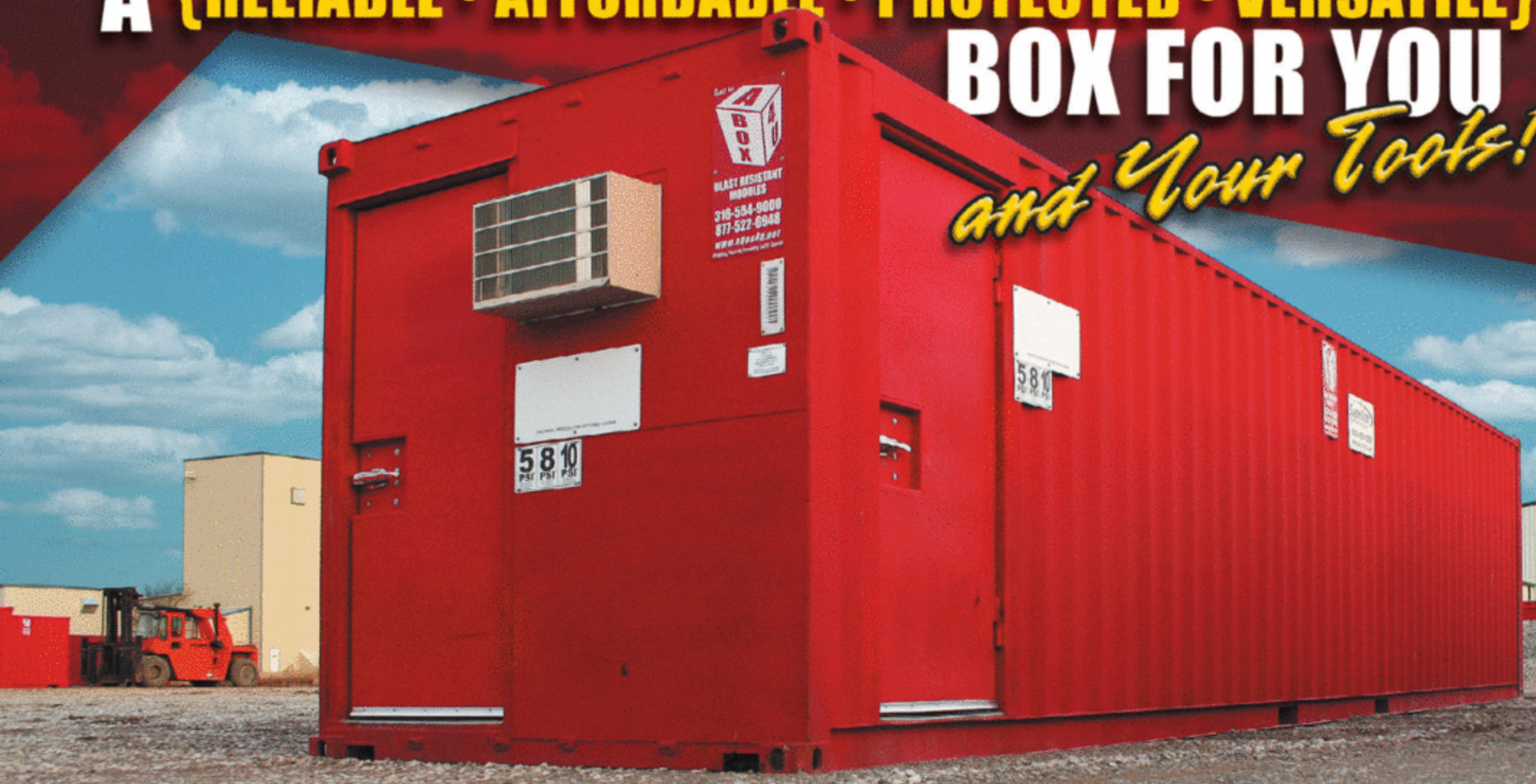

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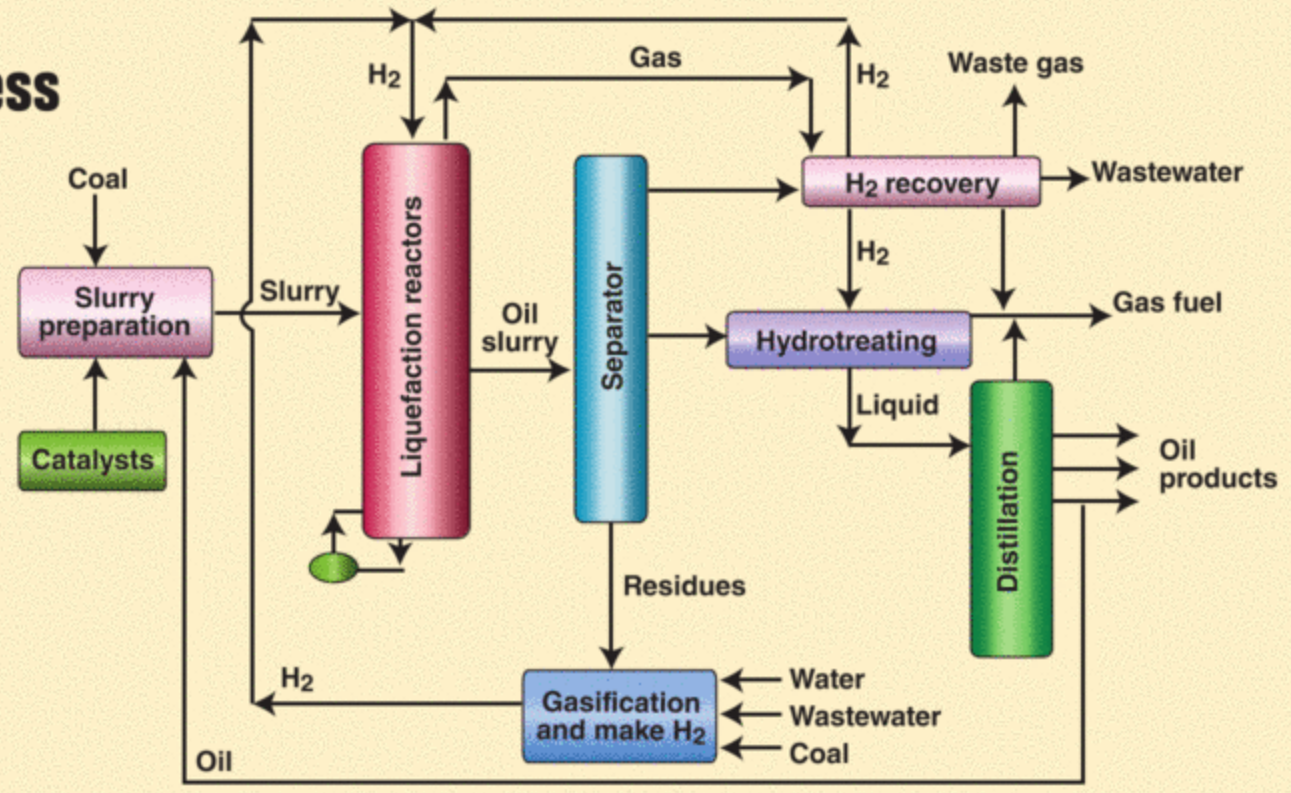
A direct coal-liquefaction process goes commercial . . .

The world's first commercial plant to produce liquid fuels by direct coal liquefaction is now being started up in Majata, Inner Mongolia, by Shenhua Group (Beijing). Designed to produce 25,000 bbl/d of syncrude from 4,300 metric tons per day (m.t./d) of coal, the plant was operated for a 300-h trial at the beginning of this year, then was shut down for modifications. If the current startup goes well, the plant will phase into regular commercial production and Shenhua will go ahead with plans to add two more trains, for a total capacity of 75,000 bbl/d.

Shenhua licensed the basic process from HTI (now Headwaters Inc., South Jordan, Utah; www.headwaters.com) and has since made modifications, some with the help of various international companies (see *CE*, August 2002, p. 25, and February 1997, p. 21). Powdered coal is dissolved in recycled process liquid at about 2,500 psig and 800°F, then liquefaction is completed in a second stage at a slightly higher temperature (flowsheet). Hydrogen is added in the first stage and an iron-based catalyst is dispersed in the slurry for both stages. The syncrude is refined into transportation fuels. Shenhua says its plant produces about 70% low-sulfur diesel fuel, plus naphtha and liquefied natural gas.

Hydrogen for the process is obtained onsite by coal gasification and steam reforming of the syngas, which coproduces a large, concentrated stream of carbon dioxide. A feasibility study for CO_2 sequestration in a nearby deep saline-water reservoir is being planned under an agreement between the U.S. Dept. of Energy (DOE; Washington, D.C.) and China's National Development and Reform Commission (NDRC).

DOE has supported the development of direct coal liquefaction for many years and collaborates with NDRC through the U.S.-China Energy Center at West Virginia University (Morgantown; www.wvu.edu). Qingyun Sun, the Center's associate director and a former consultant to Shenhua, estimated in 2005 that the Shenhua plant would produce liquid fuels for under $22/bbl, but now says that the current cost is roughly double that figure.



. . . and more plants are in the works

Meanwhile, Headwaters has done pilot tests for direct coal-liquefaction projects with two Indian companies, says Theo Lee, Headwaters' vice-president and chief technology officer (see previous story). In one case the company is doing a feasibility study for Oil India Ltd. (Duliajan) for a 44,000-bbl/d plant that would use Assam coal. The second project, with Reliance Industries Ltd. (Ahmedabad), is for a 20,000-bbl/d plant that would process a combination of residual oil and lignite. The plant would be located within a refinery and would substitute liquefaction for coking the resid, says Lee.

Add CaC_2 to improve the efficiency of steelmaking furnaces

An innovation that improves the steelmaking efficiency of an electric arc furnace (EAF) by adding calcium carbide to the process has been developed by NuFlux, LLC (Warren, Ohio), a producer of steelmaking fluxes, and Carbide Industries LLC (Louisville, Ky. ; www.carbidellc.com), which makes calcium carbide for acetylene production. The technology has been tested in commercial furnaces, and the companies have formed a partnership to commercialize it.

EAFs produce steel from scrap and account for about 60% of U.S. steel production. In an EAF operation, lime-based fluxes are charged to the furnace along with steel scrap

(*Continues on p. 12*)

Mercury sorbent

A palladium-on-alumina sorbent, designed to remove mercury from synthesis gas in coal-gasification plants, has captured more than 98% of the mercury contained in a sour syngas stream in a test conducted by Southern Co. (Atlanta, Ga.; www.southernco.com). The test showed that the sorbent's performance was unaffected by high sulfur levels, says Pannalal Vimalchand, a consulting engineer at the company's Wilsonville, Ala., Power Systems Development Facility, where the test was carried out. The syngas contained 1,400 ppm of H_2S, plus other sulfur species, says Vimalchand.

The sorbent technology is being developed by Johnson Matthey (Malvern, Pa.; www.matthey.com), which licensed it from the U.S. Dept. of Energy's National Energy Technology Laboratory (NETL; Pittsburgh, Pa.). The key feature of the sorbent is that it removes Hg at high temperatures, so it doesn't affect the thermal efficiency of the gasification process by requiring gas cooling. In the Southern Co. tests, performed at 500°F, the adsorbent also removed more than 99% of the arsenic and selenium in the gas.

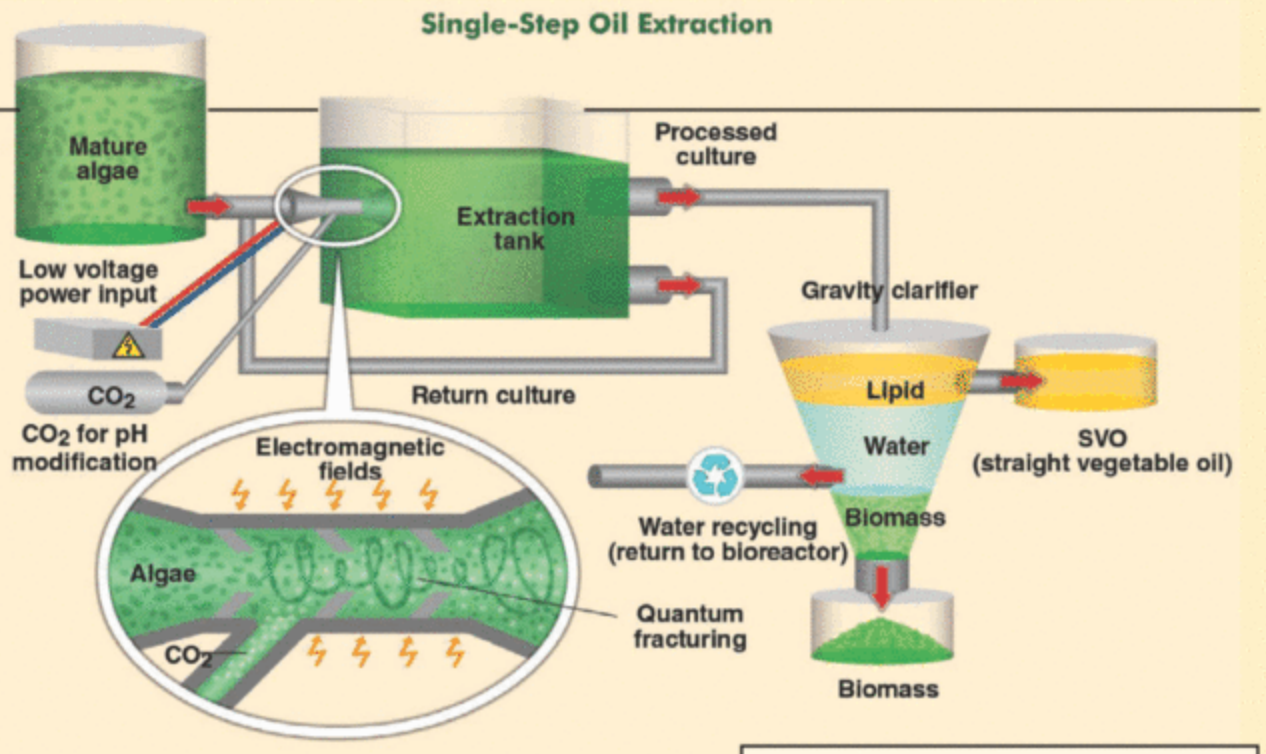
Note: For more information, circle the 3-digit number on p. 56, or use the website designation.

A one-step process for extracting oil from algae . . .

Algae offer a ubiquitous, renewable source of oil for fuels and various chemical products (*CE*, September 2008, pp. 22–25), but the extraction of oil from the algae cells is an energy-intensive process that involves dewatering and drying the biomass, followed by solvent extraction. Now, a one-step method that breaks the algae cells and liberates the oil without the need for dewatering or solvents has been developed by OriginOil, Inc. (Los Angeles; www.originoil.com). Riggs Eckelberry, the company president, says the process promises to cut energy costs by 90%, plus "substantial savings" in capital costs for solvent extraction.

In the new method, algae ready for harvesting are pumped into an extraction tank through a static mixer, which induces cavitation in the water. Simultaneously, a low-power, pulsed electromagnetic field is applied to the algae-laden stream, and CO_2 is introduced to lower the pH. The combination of these measures ruptures the cell walls and releases the oil, which rises to the surface in the tank while the biomass sinks. The final separation is achieved in a clarification tank.

OriginOil devised the separation method as part of its process to produce biofuels from algae, which is still under development. However, the company is in early discussions to market the separation process through a partnership with Desmet Ballestra (Zaventum, Belgium), which installs process systems for algae producers and other oil and fat processors.



. . . and a gasification process that gets methane from algae

Genifuel Corp. (Salt Lake City, Utah; www.genifuel.com) has taken a different route to producing fuel from algae (see previous item). The company has licensed a "catalytic hydrothermal gasification" process from DOE's Pacific Northwest National Laboratory (PNNL, Richland Wash.; www.pnl.gov) and is using it to convert algae to natural gas.

An aqueous slurry containing about 20% algae is pumped continuously into the bottom of a vertical stainless-steel reactor and converted to natural gas at about 350°C and 3,000 psi, using a ruthenium catalyst. The conversion is better than 99%, says Genifuel president Jim Oyler, and the product gas consists of about 97% methane, plus ethane, propane and hydrogen. The product gas exits the top of the reactor along with steam, which is used to preheat the feed, then condensed and recycled to the algae ponds.

PNNL has tested the process with terrestrial plants, kelp and water hyacinths, as well as algae, but Oyler says algae is an ideal feed because it is easy to convert to slurry form, so preprocessing is relatively inexpensive. Also, essentially all the heat in the steam is recovered. He adds that the process operates at about half the temperature of other gasification methods that don't use a catalyst. The present reactor produces about 100 ft^3/d of natural gas, but Oyler plans to work next with a reactor that is about four times larger. He says the process can be readily scaled up.

STEELMAKING FURNACES

(*Continued from p. 11*)

at the beginning of the melting cycle. During the process, the fluxes absorb silica, alumina and other impurities, forming a slag on top of the melt. Simultaneously, natural gas, granular coke and oxygen are injected via sidewall burners to supply additional energy, increase the scrap-melting rate and to create a foamy slag. The latter improves melting efficiency by submerging the electrode tips and helps protect the electrodes and furnace sidewalls, says Stewart Robinson, technical manager for Carbide Industries.

Ideally, the slag should have a chemistry and viscosity suitable for foaming throughout the melt cycle, he says, but in practice there is usually too much lime at the beginning and too little at the end of the cycle, as the chemistry of the slag changes during the process. The innovation minimizes this problem by injecting calcium carbide at intervals, along with other fluxing materials. The added CaC_2 reacts with the slag's FeO exothermically, thereby adding energy to the process as well as promoting slag foaming.

A new H_2SO_4 process

Now being commissioned at a lead smelter operated by Berzelius in Stolberg, Germany, is a new sulfur trioxide process developed by Bayer Technology Services (BTS; Leverkusen, Germany; www.bayertechnology.com). Conventional adiabatic contact or double contact conversion of SO_2 to SO_3 cannot handle SO_2 concentrations above about 13% because the catalyst limits reactor outlet temperatures to around 620°C. At Achema last month, project manager Torsten Weber of BTS explained that the new Bayqik process uses an isothermal tubular reactor, allowing inlet SO_2 concentrations of up to 50%. The process is suitable for new facilities, he says, but should be especially valuable as a retrofit to existing contact plants in the metallurgical industry. At Stolberg, Bayqik exhaust gas is mixed with raw gas to reduce its SO_2 level to 9%.

Batch manufacturing

Last month, Performix Inc. (Houston, Tex.; www.performixinc.com) launched the xMES Next Generation User Interface (UI) for plant floor operator execution. Designed with Rich Internet Application (RIA) technology and the flexibility to integrate data from existing business systems, plant floor devices and the xMES solution, this "first-of-a-kind" interface for a manufacturing execution systems (MES) solution provides manufacturers with a more efficient process for viewing and executing

(*Continues on p. 15*)

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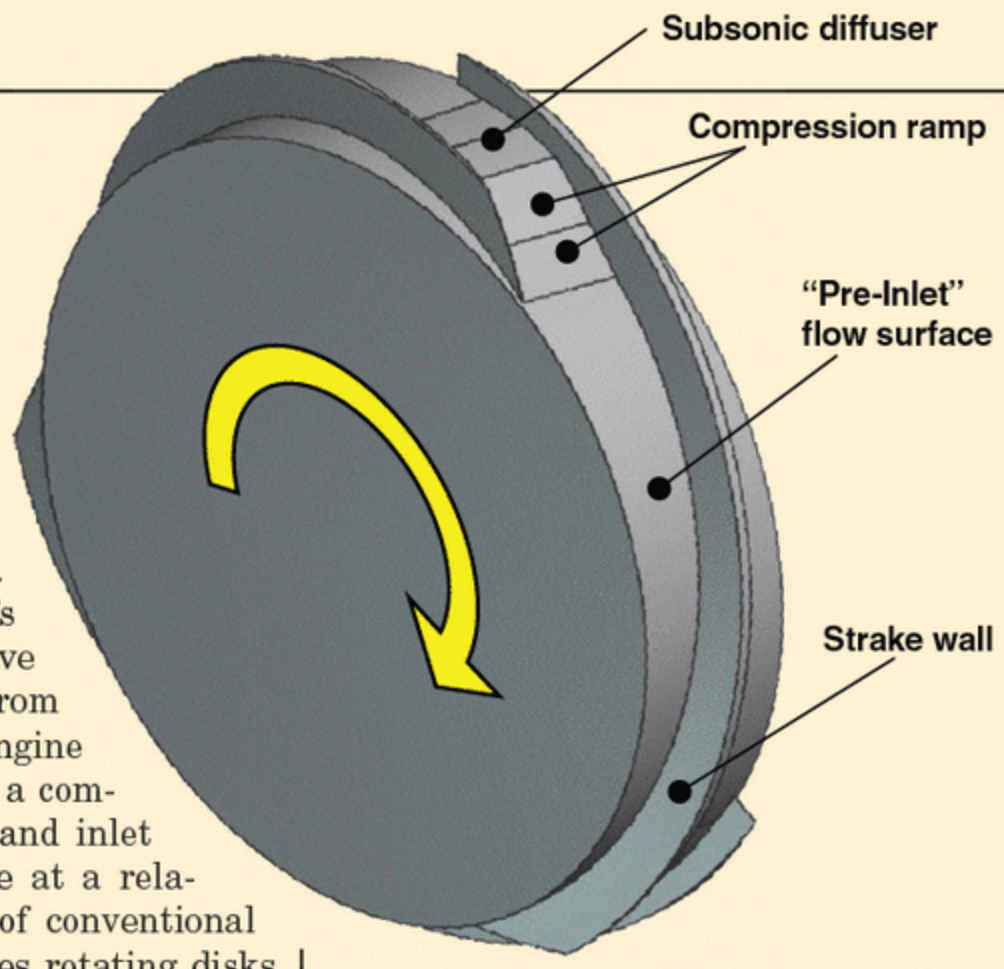
A shocking way to compress CO_2

Compressing carbon dioxide captured from power plants to 1,500–2,200 psia for pipeline transmission or underground injection is a challenge that requires eight stages or more, using conventional compressors. A compressor that promises to do the job in two stages, for 50–60% of the installed cost, is being developed by Ramgen Power Systems, Inc. (Bellevue, Wash.; www.ramgen.com).

Ramgen has been working on the compressor for some time, supported by the U.S. Dept. of Energy (DOE, Washington D.C.; see *CE*, June 2006, p. 16), but the project has received a boost from Dresser-Rand Group Inc. (Houston, Tex.). Dresser-Rand has committed to a staged investment in the company, says Ramgen president Peter Baldwin, who spoke at the recent Spring National Meeting of the AIChE in Tampa, Fla.

Baldwin notes that the inlet flow in conventional compressors is typically limited to a Mach number of below 0.90 at the inducer blade tip, to avoid generating shock waves in the blade passages. In contrast, Ramgen's "Supersonic Shock Wave Compressor" borrows from supersonic aircraft engine inlet technology, using a combination of rotor rpm and inlet vane design to operate at a relative Mach 2. Instead of conventional blades the machine uses rotating disks whose rims are contoured to form inlet compression ramps that mimic the inlet design of supersonic aircraft engines (diagram). The goal is to achieve a pressure ratio of 100:1 in two stages, each with its own separate drive.



In association with Dresser-Rand, Ramgen is working on a 13,000-hp (10-MW) second stage that could handle the CO_2 generated by a 250-MWe power plant. "The second stage is the high-pressure stage, so it's the critical one," says Baldwin. "We expect to have it running sometime in 2011." He adds that, besides CO_2, the compressor could be used for other heavy molecular weight gases and low-temperature applications.

Upgrading natural gas

A process that produces hydrogen-enriched natural gas, with carbon black as a byproduct, is being developed by Atlantic Hydrogen Inc. (Fredericton NB, Canada; www.atlantichydrogen.com). The company has piloted the process at a scale of 25 m^3/h of natural gas and plans to start up a demonstration plant that will produce 1,000 m^3/h of H_2-enriched natural gas (HENG) toward the end of 2010.

In Atlantic Hydrogen's process, called CarbonSaver, natural gas is flowed through a reactor, where a proprietary pulsed plasma torch dissociates hydrogen from the methane at 1,500–2,500°C. Simultaneously, carbon is released as a fine black powder. Following the reaction, the H_2 recombines with the natural gas (forming a richer H_2 mix after carbon removal), while the carbon is filtered from the flowing stream. CarbonSaver can be tuned to produce up to 30 vol% HENG, says David Wagner, president. Also, it can be operated at up to 150 psig, so that it may be installed at various locations in a pipeline system or at end user sites, such as industrial customers or power plants.

In commercial-scale combustion tests, 10–20 vol% hydrogen-enriched gas has reduced emissions of oxides of nitrogen by as much as 90% and carbon dioxide emissions by 7–9%, says Wagner. Also, in comparison with regular natural gas, 4–6% less fuel was required for the same energy output. Wagner says the economics of CarbonSaver are favorable, given that the process yields a high-quality carbon black.

A microreactor makes HMF from just sugar and water

Hajime Kawanami and colleagues at the AIST Tohoku Collaboration Center, Research Center for Compact Chemical Process, National Institute of Advanced Industrial Science and Technology (AIST; Sendai, Japan; www.aist.go.jp) have developed a continuous, one-step process for synthesizing hydroxymethylfurfural (HMF), a biologically active substance with promising therapeutic properties against metabolic syndrome, high blood pressure and diabetes. The process uses inexpensive sugars, such as glucose or fructose, and water as starting materials — no organic solvents or other additives.

The key to the process is a microreactor that can operate from ambient conditions up to 600°C and 300 MPa. The system has a reaction volume of 0.01–0.5 mL and a continuous production capacity (calculated) of 500 kg/yr. In this reactor, high-pressure (10 MPa) water and an aqueous solution of sugars are first instantaneously mixed, then the temperature rapidly (within 10 ms) increased to 400°C. After a residence time of 10 s, the mixture is rapidly (within 10 ms) cooled to 25°C. The system continuously produces HMF with 70% yield and purity of greater than 80%. In contrast, alternative methods to make HMF from glucose require two or more reaction steps and additional chemicals, such as ionic liquids or complex metal catalysts (chromium, for instance), and have yields of below 50%.

Kawanami says the crude HMF produced in the microreactor is slightly discolored due to impurities (acetic and formic acids, and char), but could already be used, without special purification steps, for de-inking or food applications.

(*Continued from p. 12*)

electronic work instructions while allowing users quick access to critical information based on different views provided, says the firm. Developed in close collaboration with Dow Corning, xMES Next Generation UI utilizes the Adobe Air platform, enabling users to deploy the solution on existing wireless handheld devices or on an operator's computer at the plant in a fraction of the time it takes with existing MES solutions, says Performix.

A gun that cures

The Car Refinishes businesses of AkzoNobel N.V. (Amsterdam, Netherlands; www.akzonobel.com) and EREA N.V. (Wijnegem, Belgium; www.erea.be) have developed a spray gun that simultaneously paints and cures the Sikkens Autoclear UV clearcoat. The handheld device has energy-efficient ultraviolet (UV) light emitting diodes (LEDs) fitted around the spray nozzle, which enables the curing process to begin as soon as the paint comes in contact with the repair surface. Whereas traditional bodyshop operations use ovens that have to be maintained at the proper curing temperature, the spray gun involves no warmup time or curing oven, so up to 25% less energy is used during the total repair, says AkzoNobel. AkzoNobel has patented the technology and will market the product, which EREA will manufacture, under the AkzoNobel and EREA brand. ❑

Another potential outlet for glycerin

Hiroshi Abe and colleagues at Biochemical Group of Research Institute for Innovation in Sustainable Chemistry, National Institute of Advanced Industrial Science and Technology (Tsukuba, Japan; www.aist.go.jp) have discovered a strain of acetic-acid bacteria (which normally oxidize ethanol into acetic acid) that effectively converts highly concentrated (22%) glycerin into D-glyceric acid. The researchers have developed a process to convert crude glycerin — a byproduct of biodiesel production, which contains up to 10% methanol and other impurities — into high-purity salt crystals of D-glyceric acid.

In the process, crude glycerin is first heated under reduced pressure to remove methanol, then treated with activated charcoal to remove other organic impurities. The concentrated glycerin is then fermented with the bacteria for about six days, which yields about 90 g/L of D-glyceric acid. An ion-selective membrane process is then used to remove about 90% of the impurities from the fermentation broth, including unreacted glycerin, dihydroxyacetone (a byproduct), and other ingredients from the culture medium. The resulting solution contains about 200 g/L of the acid, which can then be precipitated as high-purity salt crystals by adding calcium chloride. The scientists believe the technology has potential for utilizing the large volumes of glycerin produced around the world — approaching 1-million tons/yr (*CE*, September 2007, pp. 31–37), while providing a more economical route to D-glyceric acid.

A new static mixer delivers substantial cost savings

At Achema last month (May 11–15; Frankfurt, Germany), Sulzer Chemtech AG (Winterthur, Switzerland; www.sulzerchemtech.com) launched a new static mixer, the SMX plus. For homogenizing viscous fluid, the new SMX plus has about half the pressure drop of the company's standard SMX of the same diameter. As a result, significant cost savings can be achieved by using smaller pumps or through reduced diameters, says Katharina Hänsli, manager chemical industry, mixing and reaction technology. Energy costs, for example, can be reduced by 20–30% due to reduced pumping demands, she says.

The SMX plus is suitable for mixing viscous fluids (1,000 to 100,000 Pa s), such as polymer melts. Whereas dynamic mixers are typically used in batch applications, now processors can consider using a static mixer for continuous processing. One example that a customer has been testing with the SMX plus is for mixing two components, one with a high viscosity and another with a low viscosity, explains Hänsli.

The new mixer was designed to fit into the same pipe sizes as the SMX, so it is easy to install as a retrofit. It can also be designed and fabricated to different codes, such as ASME or AD2000. Scaleup is no problem, as the mixer is based on the well-known SMX.

Progress in underground coal gasification

The world's first demonstration plant combining underground coal gasification and gas-to-liquids (GTL) technologies in the same facility was officially opened on April 22 in Chinchilla, 350 km northwest of Brisbane, Queensland, Australia. The plant is operated by Linc Energy Ltd (Brisbane; www.lincenergy.com.au), which was formed to research, develop and commercialize the underground coal-gasification (UCG) process in Australia. The company has a technology agreement with two Russian institutions: the Skochinsky Institute of Mining (SIM) — the original creator and developer of UCG technology — and the Scientific-Technical Mining Assn.

At the Chinchilla UCG plant, two wells — the injection well and the production well — are driven into the coal seam. Linc Energy introduces only compressed air via the injection well. The coal is subsequently ignited at the bottom of the injection well and the product gas (syngas) moves under pressure toward the production well where it is extracted and cleaned. The syngas is then converted via Fischer-Tropsch (cobalt catalyst) into liquid hydrocarbons (syncrude), which are subsequently filtered and refined into LPG, naphtha, jet fuel and diesel. Linc Energy has an agreement to access the coal-to-liquids (CTL) technology of Syntroleum Corp. (Tulsa, Okla.).

The Chinchilla plant has been producing synthetic diesel and jet fuel from coal seams at average depths of 140 m since October 2008. Since then, 35,000 tons of coal have been gasified there, more than in any other UCG trial, says Linc Energy. The plant has a maximum gasification capacity of 80,000 Nm^3/h (or 675 ton/d of coal). It achieved 95% recovery of the coal resource with 75% recovery of the total energy.

The company says the combination of UCG clean-coal technology and CTL technology has the potential to economically convert Queensland's vast "stranded" coal deposits into ultra-clean liquid fuels. The company may also use the syngas produced from UCG as feedstock for gas turbines to generate electricity. ■

RENEWABLE FEEDSTOCKS: TRADING BARRELS FOR BUSHELS

Efforts to boost conversion rates and yields and improve separation efficiency are helping, but obstacles remain

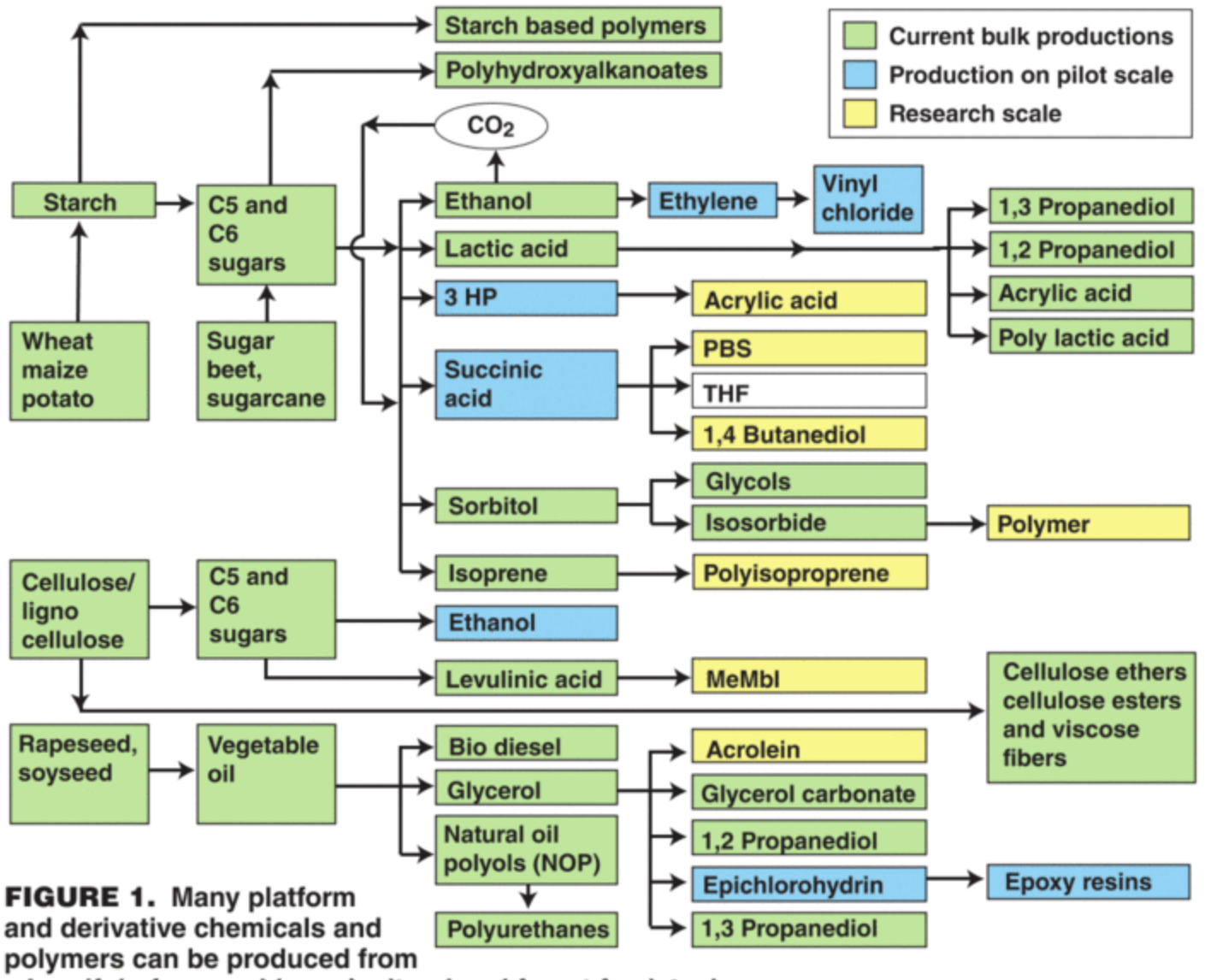


FIGURE 1. Many platform and derivative chemicals and polymers can be produced from a handful of renewable agricultural and forest feedstocks

Source: Frost & Sullivan

With traditional petroleum-derived feedstocks facing relentless economic and environmental pressures, it's no surprise that stakeholders throughout the chemical process industries (CPI) have been in hot pursuit of alternative routes for producing commodity and specialty chemicals and polymers from cheap, plentiful renewable feedstocks. The most promising routes are based on agriculturally derived, starches, sugars, fats, oils, lignocellulose, and proteins, and waste streams from fruit and vegetable processing plants, pulp-and-paper mills, and other biomass sources (Figure 1).[1]

Today, parallel efforts are beginning to bear fruit. According to market analyst Frost & Sullivan (London; www.chemicals.frost.com), the global market for renewably sourced commodity chemicals earned revenues of $1.63 billion in 2008, and this figure is projected to reach $5.01 billion by 2015.

Many of the most mature processes to date tend to be focused on the conversion of a single renewable feedstock into a single biobased chemical or polymer (a "one-to-one" concept). However, to realize the full techno-economic impact of using renewable feedstocks, the integrated biorefineries of the future will need to pursue a "one-to-many" concept — whereby each renewable feedstock will be converted into any number of basic building block chemicals (so-called "platform chemicals"), which would then serve as the interim feedstocks for the production of countless downstream, value-added chemicals, monomers and polymers, says Joseph J. Bozell, associate professor, Biomass Chemistry, Forest Products Center, University of Tennessee (Knoxville).

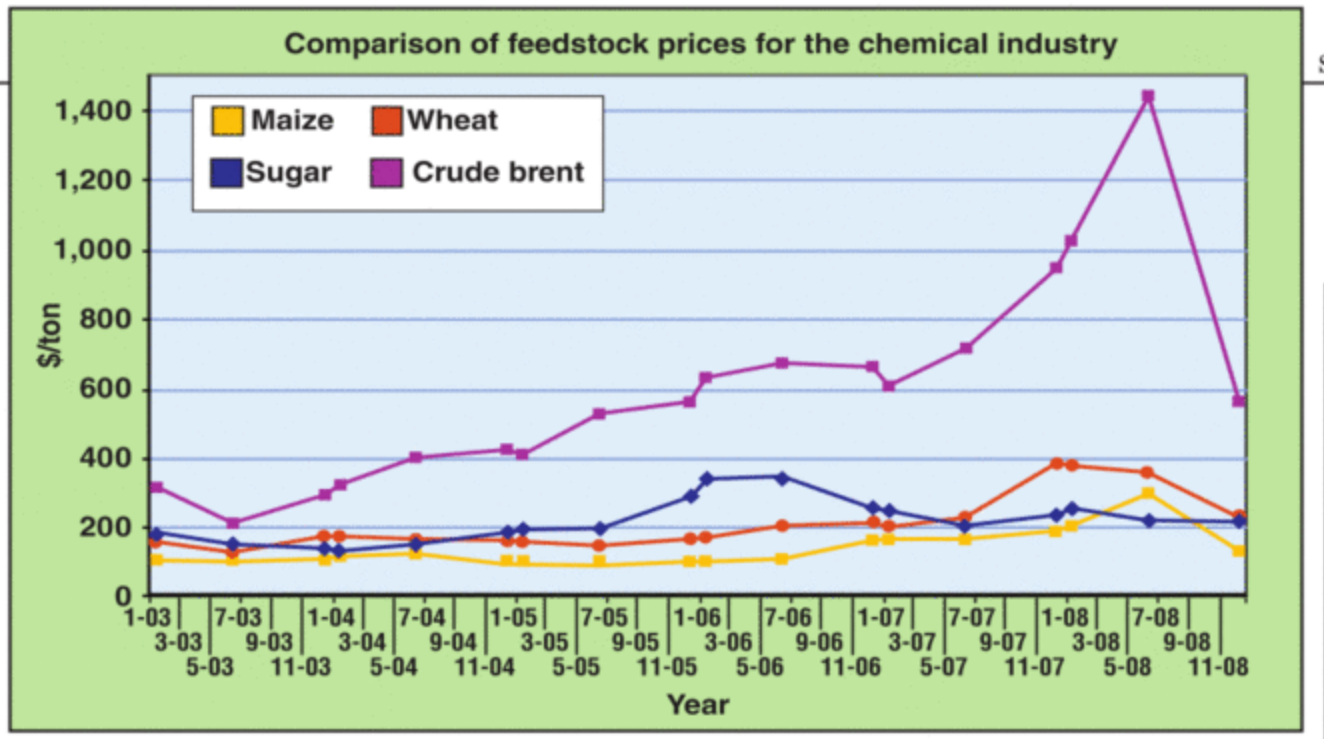
In 2004, the U.S. Dept. of Energy (DOE; Washington, D.C.; www.doe.gov) identified 12 platform chemicals that can be produced from sugars via biological or chemical routes — 1,4-diacids (succinic, fumaric and malic acids), 2,5-furan dicarboxylic acid, 3-hydroxy propionic acid, aspartic acid, glucaric acid, glutamic acid, itaconic acid, levulinic acid, 3-hydroxbutyrolactone, glycerin, sorbitol and xylitol/arabinitol. According to Frost & Sullivan, efforts to produce the platform chemicals lactic acid, succinic acid, glycerin, 1,3-propanediol (PDO), levulinic acid, and various cellulose and starch derivatives are furthest along on the developmental continuum today.

Still, challenges remain, because "no two technologies reside within any single company — every company has perfected its own single technology for producing single target products" says Phani Raj Kumar Chinthapalli, senior research analyst for Frost & Sullivan, who is based in Chennai, India.

Building blocks

"After nearly two centuries, petroleum refineries are able to use proven, optimized technologies to produce a spec-

1. A longer version of this article, which contains additional process details and market information, can be found online at www.che.com. Browse the June 2009 issue or search the editorial archives for this article title to access it.



Source: Frost & Sullivan

FIGURE 2. Three of the most viable renewable feedstocks have enjoyed greater price stability over the past few years than crude oil, the starting material for conventional petrochemical feedstocks

trum of platform chemicals that serve as chemical feedstocks for the downstream chemical industry," says Luc Moens, senior scientist, National Renewable Energy Laboratory's National Bioenergy Center (NREL; Golden, Colo; www.nrel.gov). For developers of renewable routes, efforts to take a page from the petrochemical refinery's playbook have not been as straightforward as some might hope.

"Many of the classical unit operations from the petrochemical refineries, such as distillation, cracking and conventional thermal processes such as gasification and pyrolysis just don't work as well for renewable feedstocks," says Bozell. "The high degree of oxygenation associated with these complex substrates hinders many conventional chemical catalyst systems," says Moens.

"This reduction either comes at the cost of energy (for example, hydrogen and natural gas) or through the loss of carbon as CO_2 and solid waste, all of which increase capital requirements and raw materials costs compared to petroleum-based routes," adds Bob Maughon, Hydrocarbons & Energy R&D director for Dow Chemical Co. (Midland, Mich.; www.dow.com).

Instead of conventional catalysts, many of the most well-developed, biobased chemical production routes in use today, such as fermentation, rely on microbial or enzyme-driven biochemical conversions, which are challenging theselves, "Enzyme-based processes have advantages [for renewable feedstocks], but they also have some disadvantages," says Maughon. "They tend to be slower than chemical processes, they almost always require water to be present, and they frequently suffer product inhibition." He adds: "Wresting products like alcohols and acids out of water often requires massive amounts of energy, and frequently requires steps to overcome difficulties such as azeotropes."

As a result, process developers have been pursuing not only advanced enzymes to improve microbial and fermentation processes, but advances that will allow classical chemical process and refinery techniques (such as the use of thermal cracking, and acid or base catalysis using homogeneous and heterogeneous catalysts) to be adapted for renewable feedstocks, as well. "Once perfected, such techniques are expected to offer advantages over purely biological processing methods of biomass," says Bozell.

Looking at lignin

"Lignin is unique among its biomass counterparts, in that it is the only renewable source of aromatics — an important, high-volume class of compounds," says Bozell. "The ability to carry out direct, efficient conversion of lignin to low-molecular-weight aromatics (including the BTX chemicals benzene, toluene and xylenes) is an attractive goal, but it is particularly challenging due to the difficulties associated with separating lignin from lignocellulosic feedstocks."

According to DOE, process developers working with lignin have had promising early success using gasification to convert lignin into syngas (carbon monoxide and hydrogen) and eventually mixed alcohols, and pyrolysis to convert lignin into gasoil and other pyrolysis oils. These efforts have fueled interest in the development of other processes and improved catalysts to convert plentiful lignin into downstream chemicals.

One key to using lignin is the separation of biomass into its three main components (lignin, cellulose and hemicellulose). Today, effective upfront separation remains a huge challenge for any biorefinery. One classic approach (dilute acid pretreatment) removes a significant portion of the hemicellulose, but leaves the remaining two fractions (cellulose and lignin) commingled, and "thus not available in as useful a form," says Bozell.

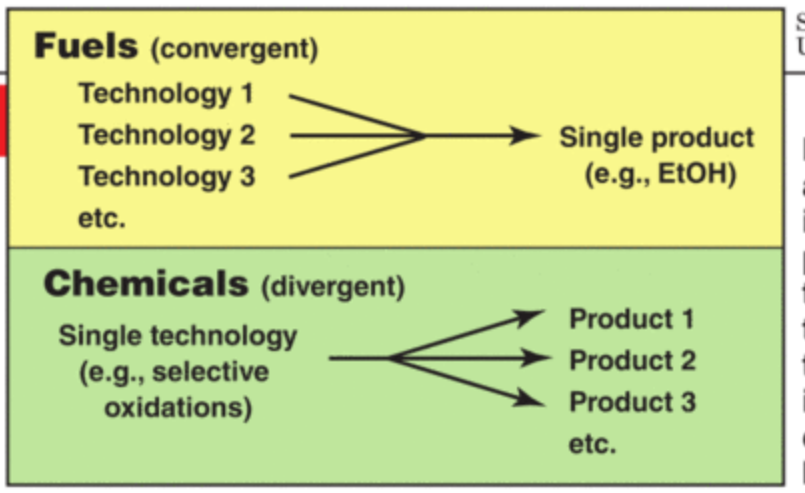
Advances in the use of acid or base treatments, steam treatment and solvent fractionation "appear to offer good access to the components in biomass and help to reduce the complexity of the heterogeneous starting materials, yielding simpler molecules, carbohydrates, lignins and plant-based hydrocarbons," says Bozell.

One solvent-based process developed by NREL, called Clean Fractionation (CF), is able to isolate and purify chemical-grade cellulose from lignocellulosic materials. Designed as a front-end pretreatment step for biorefineries, the process separates the previously commingled lignin/hemicellulose streams, making both available for chemical production.

First, the cellulosic feedstock is treated with a ternary mixture of methyl isobutyl ketone (MIBK), ethanol and water in the presence of a dilute acid promoter such as sulfuric acid, and the mixture is heated at 140°C for less than one hour. The solvent mixture selectively dissolves the lignin and hemicellulose components, leaving the cellulose as an undissolved solid material that can be washed, fiberized and further purified.

The soluble fraction containing both lignin and hemicellulose is treated with water, resulting in a phase separation into an organic phase containing the lignin, and an aqueous solution containing the hemicellulose-derived sugars (pentosans). More than 95% of the components in the starting feedstocks can be isolated, says Moen. The process normally gives a cellulose yield of about 47–48 wt.%, in comparison to maximum yields of about 40% using conventional pulping processes.

The CF process also allows for 99%



Source: Dr. Joseph Bozell, University of Tennessee (Knoxville)

FIGURE 3. While the 'single-product' approach has dominated the commercialization of many biobased chemicals and plastics processes to date, many say that the cost-effective biorefinery concept of tomorrow will be predicated on the ability to convert key renewable feedstocks into intermediate 'platform chemicals,' which can be further processed to produce a broad slate of value-added chemicals

recovery of the organic solvents, and produces no odorous emissions, says Bozell (who led the CF process development at NREL for 10 years before moving to the University of Tennessee). "This provides new opportunities for the use of sugar cane bagasse and other lignocellulosic feedstocks as chemical feedstocks," adds Moens.

Levulinic acid

Levulinic acid (LA) is a diverse platform chemical. This five-carbon compound, traditionally produced from maleic anhydride and other petrochemical feedstocks, has historically found use in the manufacture of adhesives, rubber, plastics, and synthetic fiber products.

Today, it can be produced through the acid-catalyzed hydrolysis of cellulose (using, for instance, sulfuric acid). "Levulinic acid should receive much more attention than it has, because it is such a versatile and reactive molecule, from which numerous derivatives can be synthesized," says Moens. "When you consider how many chemicals can be made from levulinic acid — including levulinate esters, N-methylpyrrolidone, 1,4-butanediol, succinic acid, pyrrolidine, lactones, acrylic acid, and furans, to name a few — you see the versatile nature of this chemical. And the ability to produce this cellulose-derived platform chemical from waste materials, such as sugar cane bagasse and other lignocellulosic feedstocks provides a compelling driver for process developers."

Biodiesel's downstream bounty

During the production of biodiesel, the transesterification of feedstock vegetable oils and animal fats produces one pound of glycerin for every nine pounds of diesel (or, stated another way, 1.25 lb of glycerin is produced for every gallon of biodiesel). Swift growth in worldwide biodiesel capacity in recent years has created an abundant supply of byproduct glycerin, which has fueled interest in processes to convert glycerin into propylene glycol (1,2-propanediol; PG; see also *CE*, Outlets for glycerin, Sept. 2007, pp. 31–37). Traditionally made from fossil feedstock propylene oxide, PG is used in the manufacture of various plastics and plasticizers, solvents, hydraulic fluids and lubricants, heat-transfer fluids, and more.

To take advantage of this sudden availability of excess glycerin supply, at least a half dozen chemical companies (including Dow Chemical, Huntsman Corp., ADM and others) are working in parallel to build grassroots chemical plants to convert biodiesel-derived glycerin into PG.

However, "while near-term crude glycerin is in excess, the longterm view could change, as next-generation biodiesel processes make no glycerin and renewable processes are already consuming this surplus," says Maughon of Dow. He also notes that many of the technologies known today still have competitive cost issues and product quality issues (especially around pharmaceutical grades) that must be reconciled before they can be used more broadly on a commercial basis.

Epichlorohydrin production

Today, several major chemical companies are also developing and commercializing processes to produce epichlorohydrin — a high-volume commodity chemical used largely in the synthesis of epoxy resins — from biodiesel-derived glycerin. The conventional route relies on propylene and chlorine as the primary raw materials, but has particularly low chlorine-atom efficiency, so it produces unwanted byproducts hydrogen chloride or waste chloride anions that are expensive to dispose of, says John Briggs, chemistry and catalysis scientist for Dow.

Dow's two-step glycerin-to-epichlrohydrin (GTE) process provides a variety of advantages over the multistep incumbent process, including (but not limited to) fewer unit operations, smaller environmental footprint and overall cost, reduced equipment requirements, shorter residence times, fewer reaction byproducts and a purer final product, says Briggs. The process also reduces wastewater generation by over 90% and consumes 30% less energy compared to the conventional technology. Dow has had a GTE demonstration unit running at its Stade, Germany, site since 2006, and in 2008 announced plans for its first commercial-scale GTE facility in China.

Similarly, in April 2007, Solvay Chemicals (Brussels; www.solvay.com) started up a 10,000-m.t./yr plant that produces epichlorohydrin at its Tavaux, France, site, from biodiesel-derived glycerin, using the company's patented Epicerol process (for more, see *CE*, March 2006, p. 14, and April 2006, pp. 27–30). The company is now moving forward with a 100,000-metric ton (m.t.)/yr Epicerol production facility in Map Ta Phut, Thailand, with startup slated for 2010.

PDO and bioplastics

Two different renewable routes (based on corn sugar and glycerin) have been commercialized for another widely used propanediol — 1,3-propanediol (PDO), a premium-price intermediate used in the production of polymers, cosmetics, liquid detergents, antifreeze, de-icing and heat transfer fluids and other products. Details about the corn-sugar-based route from DuPont Tate & Lyle Bio Products LLC (Wilmington, Del.; www.dupont.com), and the glyerin-based route from Metabolic Explorer (Metex; Clermont-Ferrand, France; metabolic-explorer.com) and Institut Francais du Petrole (IFP; Rueil-Malmaison) can be found in the longer version of this article.[1] Several facilities that are already producing plastics from ag-based starting materials are also discussed.

As interest in renewable feedstocks continues to grow, many stakeholders are channeling the spirit of the fairy tale Rapunzel — spinning straw and other low-cost, renewable agricultural and forest products into value-added chemicals that are worth their weight in gold. ■

Suzanne Shelley

STRENGTHENING THE WEAKEST LINK

New materials and designs help seals and gaskets evolve into components that can overcome today's CPI challenges

Garlock Sealing Technologies

FIGURE 1. Style 212-ULE valve stem packing is said to outperform engineered sets, meeting global emission standards

Chemical processors rely on seals and gaskets to stand up to aggressive media, high temperatures and high pressures. However, due to leaks and failures, seals and gaskets are often considered the weakest link in chemical processing systems. But seal manufacturers are strengthening this link via new materials and designs in an effort to make seals and gaskets as robust as the rest of the system.

"Processors are looking for seals and gaskets that can operate in more difficult environments with little or no failure," notes John Kerwin, materials technologist with Precision Polymer Engineering (PPE), Ltd. (Blackburn, England). "They need these components to work at a variety of temperatures and pressures and in more chemically aggressive environments. As a result, we, as manufacturers, must develop materials with broader operating ranges and better chemical resistance to extend the life of the seal and increase system uptime."

New materials and designs

In the past, a processor may have had a vessel or reactor that was used only for one process, but now many in the chemical process industries (CPI) need to use that same equipment over a broader range of applications in order to get more production from existing systems. "One reaction vessel might have only operated at one temperature with one chemical, but now it's expected to be used for a completely different range of temperatures with completely different sets of chemicals," explains Kerwin.

Typically, running a variety of chemicals at higher or lower temperatures would require engineers to use different seals on the equipment each time. "However, they can't take the time to change out the seals and gaskets between every run, so that means that those components have to be much more capable over a broader range of temperatures and chemicals," says Kerwin.

This situation is especially common in the extreme conditions of the oil and gas industry, he adds. For this reason, PPE has developed new, explosive decompression resistant elastomers. The EnDura family of elastomer seals handles temperature extremes, higher pressures and greater levels of hydrogen sulfide and other chemicals encountered during oil and gas processing. The FKM, HNBR and TFE/P materials offer a wide operating temperature range, from 45 to 225°C, as well as excellent chemical resistance and mechanical properties.

Precision Polymer Engineering

FIGURE 2. The EnDura family of seals was developed to cope with temperature extremes, increasing pressures and higher levels of hydrogen sulfide in the oil and gas industry

These characteristics should help increase uptime. Trials of the EnDura seals on a leading gas compressor model have shown that the elastomer lasts at least three times as long as existing seals, significantly reducing the incidence of seal failure, says Kerwin.

Outside the oil and gas industry, the need for seals that are compatible with a variety of chemicals, temperatures and pressures is often coupled with the requirement of maintaining a sanitary environment, says Colin Macqueen, director of technology with Trelleborg Sealing Solutions (Fort Wayne, Ind.). While elastomer O-rings are a common choice for sealing in a multitude of applications, there is a risk of leaching, which leads to contamination, an unacceptable situation in many chemical processing applications. Elastomers can also deteriorate quickly when subjected to the aggressive media and gases in some systems, says Macqueen.

Turcon, the proprietary PTFE-based material from Trelleborg Sealing Solutions, provides an alternative sealing option where a sanitary environment is necessary. It has the benefit of being compatible with most chemical media, combined with wear resistance, high-friction characteristics and the ability to withstand extreme operating temperatures.

However, since PTFE has no elasticity, the Turcon Variseal product is energized with a spring fitted into the seal profile. In most applications the open spring of the standard Turcon

Variseal is acceptable. However, in some applications, where cleanliness is paramount, there is a risk of metal extractables entering the system, which can lead to contamination. For such cases, the company also offers an enclosed design in the form of the Turcon Variseal Ultra-Clean. In this design, the spring required to activate the seal is fully enclosed within a Turcon case, allowing no metal extractables to enter the processing system.

In other sanitary applications, seals and gaskets must not only avoid contributing to contamination, but also must stand up to the stringent cleaning processes and chemicals present, notes Macqueen. "Cleaning regimes in the pharmaceutical and food-and-beverage industries are extremely stringent and often include a sterilize-in-place (SIP) practice," he says. In these instances, the long-term performance of standard FKM seals is limited. They tend to fail in steam at operating temperatures of 100°C, which is much lower than steam cleaning temperatures of 130°C. In addition, due to their vinylidene-based polymer composition, FKMs are acidic and show weakness in alkaline-based media.

With these issues in mind, Trelleborg began investigating the possibility of engineering an FKM material with a higher resistance to clean-in-place (CIP) and SIP regimes. To do this, two compounds were formulated based on a completely different polymer architecture, which combined with an elevated fluorine level, meant they had an almost non-polar structure. The resulting materials were Resifluor 500 and V8T41. Both materials have excellent steam resistance: Resifluor 500 withstands temperatures up to 150°C, while V8T41 is capable up to 170°C. In addition, Resifluor 500 demonstrates chemical stability with high-performance characteristics in both polar and non-polar CIP media, including the most aggressive solvents. Both products also have full compliance with FDA requirements, 3-A Sanitary Standards, USP Class VI and culminate in Cytotoxicity test-

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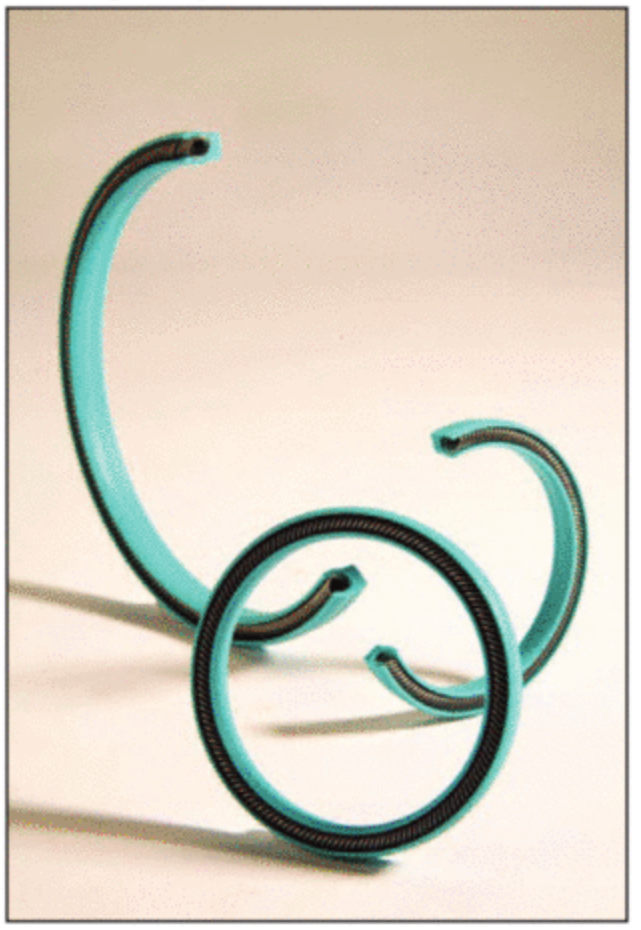

FIGURE 3. Designed to prevent contamination, the Turcon Variseal operates in extreme temperatures from –253 to 260°C and withstands high temperatures to enable use in a variety of applications where an ultra-clean environment is necessary

ing where suppliers must prove that products are completely non-toxic.

Recession-related challenges

Today's economy is putting additional pressure on seals and gaskets. Many chemical producers are postponing or shutting down processes in an effort to balance the supply of product with the lower demand, says Rob Haywood, product specialist with W.L. Gore & Associates (Elkton, MD). "Whenever you are shutting down and restarting a process, that creates a challenge for the seals to maintain those kinds of dynamic conditions and it requires a seal with high integrity to withstand repeated shutdowns and start ups," says Haywood.

To deal with this issue, Gore has been working to create expanded PTFE gaskets with improved creep resistance. "If the gasket technology can resist creep, it has a better chance of maintaining the seal during restarts," he explains.

The company now offers The Universal Pipe Gasket, as well as GR sheet gasketing, to help in this area. Used to seal all types of flanges in chemical process piping, the pipe gaskets are unaffected by aggressive chemicals and deliver superior bolt load retention, which provides exceptional creep resistance for reliable sealing of steel piping flanges. The universal design allows them to be used in steel, glass-lined steel and fiberglass-reinforced plastic (FRP) systems.

Gore GR sheet gasketing provides the benefits of conventional PTFE sheet without the creep and cold flow that is commonly associated with that material. The 100% expanded PTFE material is dimensionally stable, yet conformable, allowing it to compress into a gasket that creates a tight, long-lasting seal suitable for use with aggressive chemicals.

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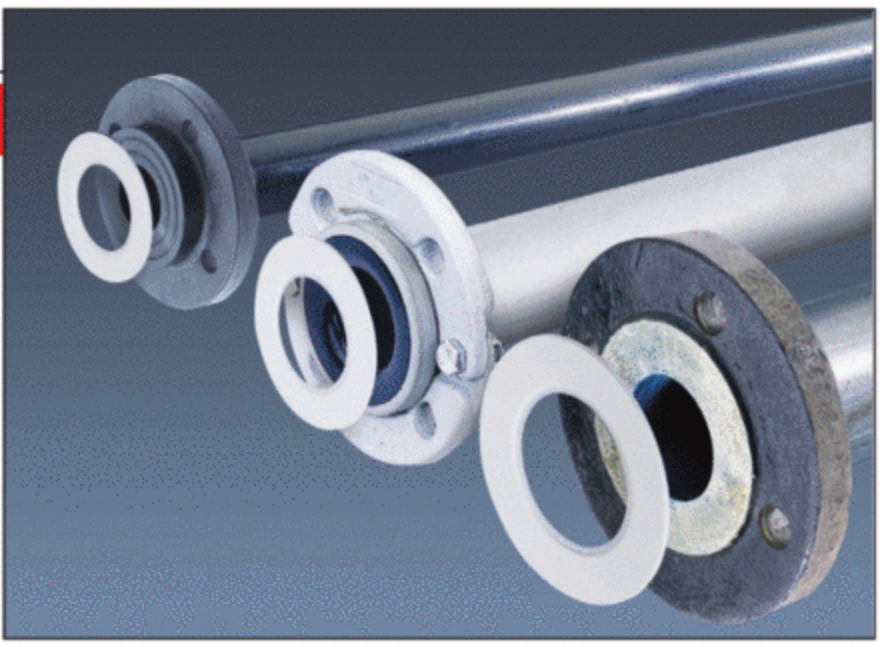


FIGURE 4. Gore GR sheet gasketing is made from 100 percent ePTFE, providing a level of high-temperature and blowout resistance while preventing creep and cold flow

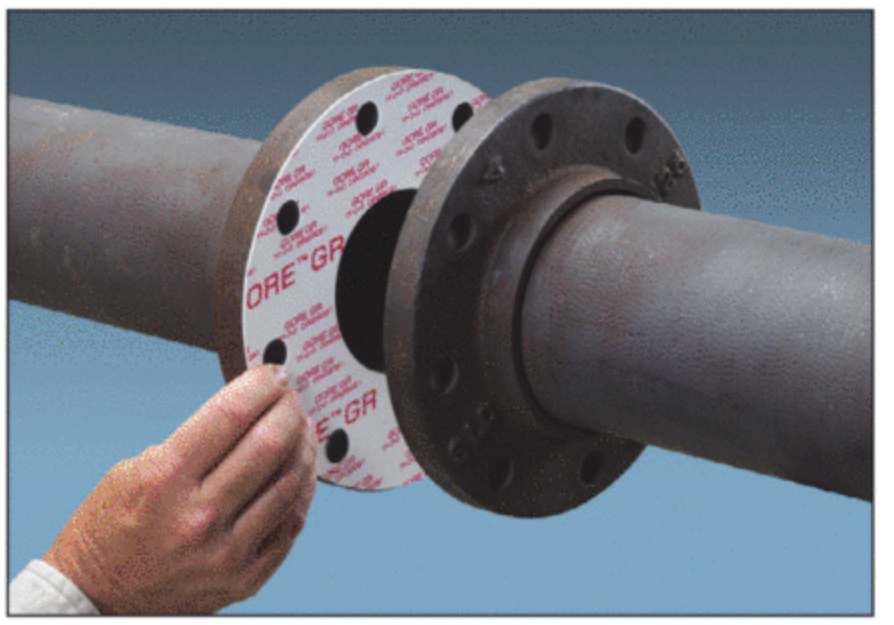


FIGURE 5. Unaffected by aggressive chemicals, Gore Universal Pipe Gaskets combine all the properties of ePTFE with exceptional sealability, bolt load retention and creep resistance

Regulations/designs

Tightening environmental regulations are also affecting seals. "It used to be that the processor would fix the seal when it leaked, but that is no longer acceptable as environmental regulations grow more stringent," notes Trelleborg's Macqueen. "Because of this, chemical processors need seals and gaskets with proven long life."

Jim Drago, manager of business development with Garlock Sealing Technologies (Palmyra, N.Y.), agrees that this is a growing issue for CPI. "The EPA [U.S. Environmental Protection Agency (Washington, D.C.)] is really starting to level their gaze on the chemical processing industry, much in the same way they did with hydrocarbon processors and [petroleum] refineries in the recent past," he says. "At the same time there is a real push from the regulators regarding leak detection and repair programs. Leaks can no longer just be monitored, they must be sought out and eliminated."

Now, he says, it is up to seal manufacturers to provide the latest technologies in seals so that leaks are no longer an issue. "The products must come with guarantees and warranties so processors have some sort of assurance that the seals they are using will meet regulations."

One such product includes Garlock's Style 212-ULE, a new ultra-low emission, high-temperature, valve-stem spool packing designed to simplify leak detection and repair in both the hydrocarbon and chemical process industries. Tested by a hydrocarbon processor, the packing delivered emissions performance of less than 20 ppm average leakage, according to Garlock.

Able to withstand operating temperatures of –200 to 1,200°C in steam and non-oxidizing environments and up to 455°C in media containing free oxygen, the valve stem packing has a maximum pressure rating of 4,500 psig and a pH rating of 0–14, except for strong oxidizers.

"This is such an environmentally valuable product for processors because research has shown that 60% of the leakage of VOCs in chemical processing plants comes through valve stems," says Mike Faulkner, product manager with Garlock. "This product will help them chase down and eliminate the biggest contributor to the problem."

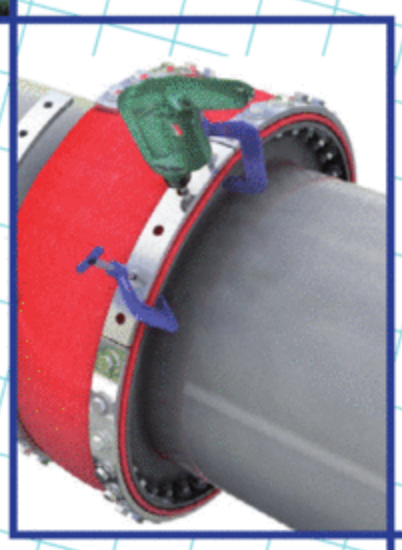
This improvement and the others mentioned above are helping chemical processors to run their equipment for the longest possible time between repairs in a continually changing and challenging processing environment without the additional burden of seal contamination, leakage or failure.

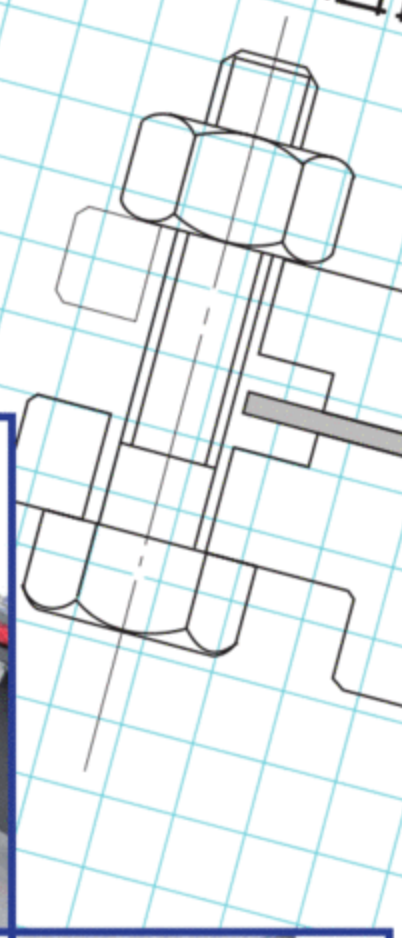
"These are all things that come down to dollars at the end of the day, and seals and gaskets are evolving in such a way that they actually will help processors extend the time between refitting these components in their equipment," says Macqueen. ■

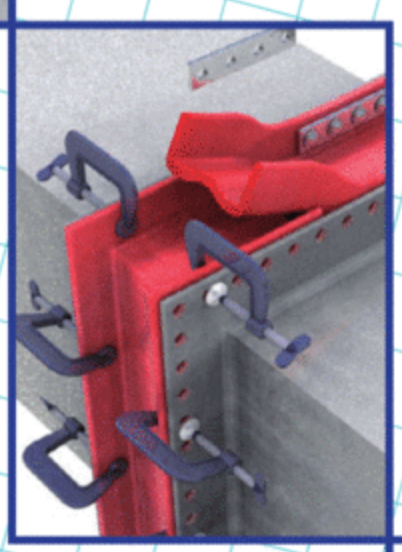
Joy LePree

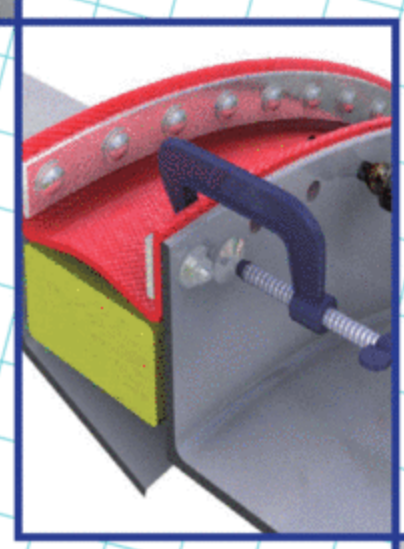
CHEMICAL ENGINEERING

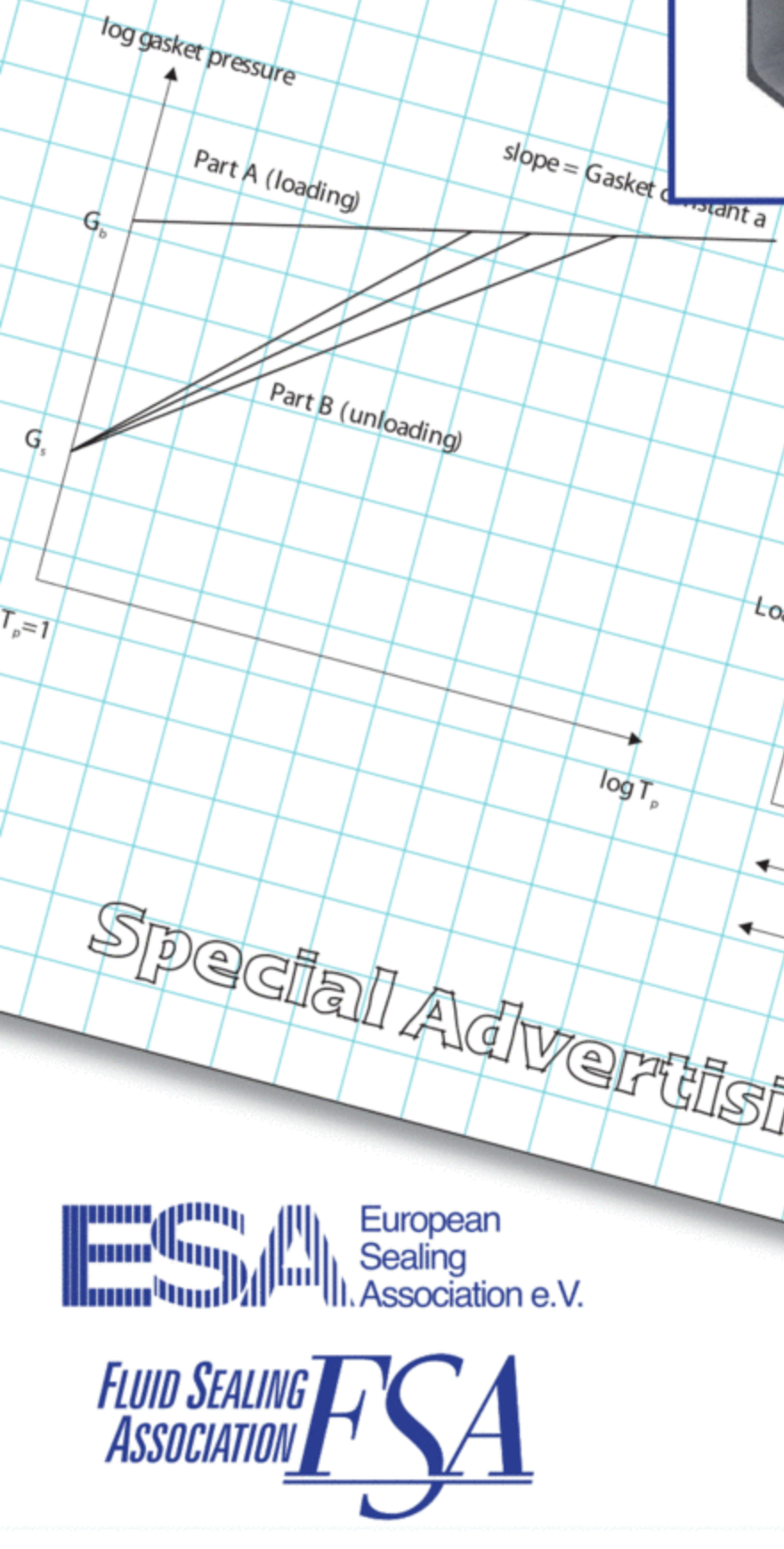
Sealing Technology

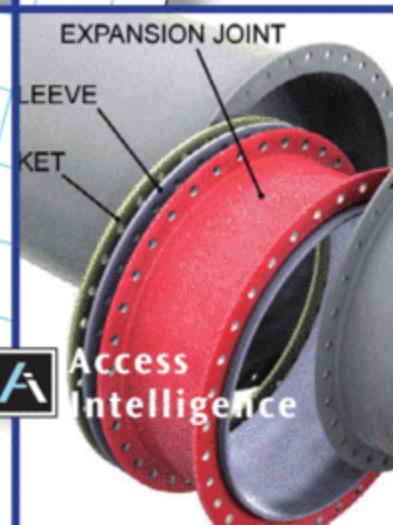












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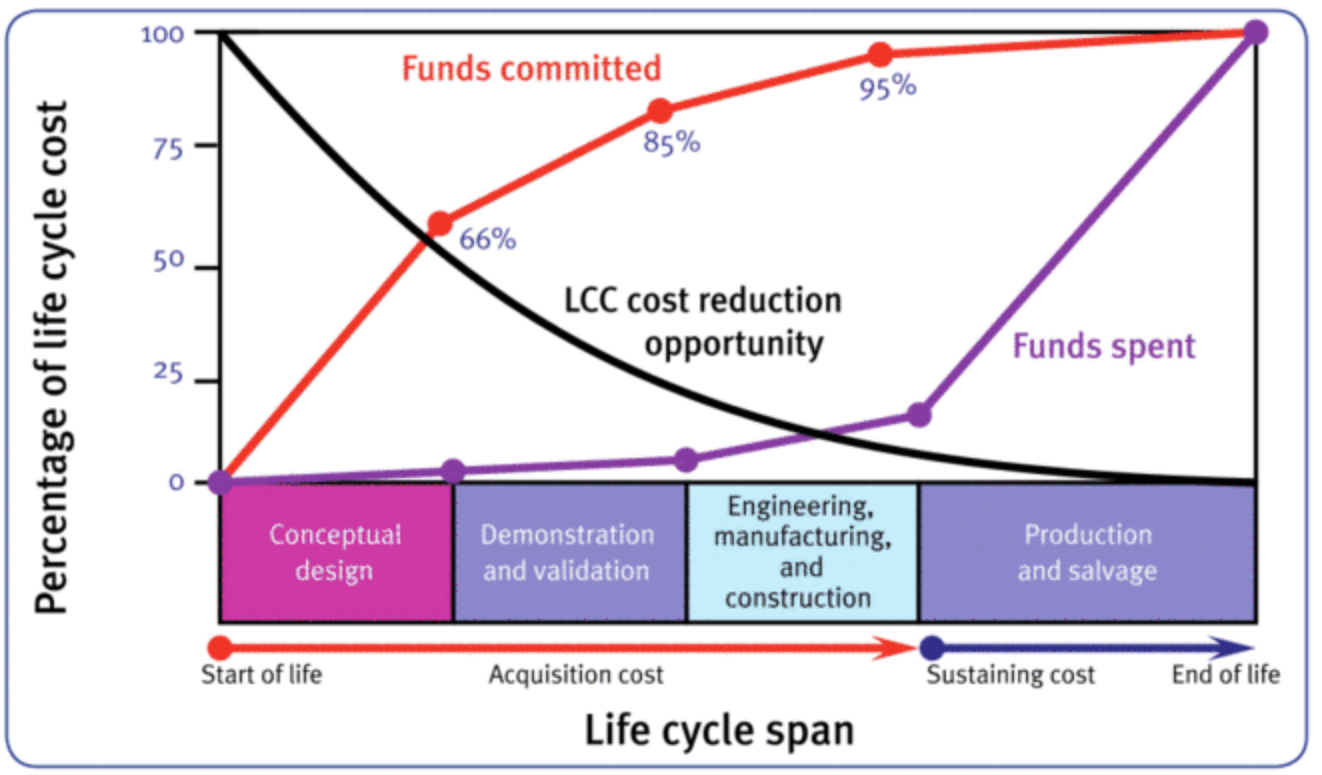
Weighing up lifetime costs

In a tough economic climate, it's even more important to make the right choices when choosing pumps and seals



Life cycle costing (LCC) should ideally be done at the design stage. Once equipment has been installed, most costs are committed and there is little room for improvement

When money is tight, value for money is essential. This is certainly true of pump systems, where the lifetime costs of electric power, maintenance, and lost production due to breakdowns can dwarf the up-front investment.

A typical 55-kW pump will cost around $750,000 over its 20-year lifetime — with purchase and installation accounting for less than 20% of this sum, says Bill Adams, president of the **Fluid Sealing Assn.** (FSA; www.fluidsealing.com). Factors influencing pump operating costs include the system's hydraulic design and the use of variable-speed drives. Also important is the choice of sealing system, which can affect efficiency, environmental costs, direct maintenance costs, and the knock-on costs of reliability.

To get this message across to engineers and purchasing managers, the FSA and sister organization the **European Sealing Assn.** (ESA; www.europeansealing.com) are continuing their work with the **Hydraulic Institute** (HI; www.pumps.org) on the Pump Systems Matter campaign, which highlights the advantages of life cycle costing (LCC). "Engineers need to start thinking like MBAs," Adams explains. "Choosing a pump or sealing system is about understanding time and money."

The first step in LCC is to gather information about costs: of buying and installing the pump, operating it under actual process conditions, monitoring and maintaining it, dealing with downtime and environmental performance, and finally decommissioning it. Armed with these figures, engineers can then calculate and compare lifetime costs, using the concept of net present value (NPV) to express the fact that $1 now is worth more than $1 in the future.

Not unusually, says Adams, paying more now for a pump or seal can produce big savings — tens or hundreds of thousands of dollars — over several years. The HI book *Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems* gives more detail. ■

Packings manual pioneers new printing technology

Holding stocks of many different technical publications is expensive, notes ESA general secretary Brian Ellis— not to say wasteful when documents are revised before the previous edition is sold out. To mitigate the problem, the ESA and FSA are embracing downloadable documentation and digital "print-on-demand" (POD) technology. Pioneering the latter is a new edition of the *FSA + ESA Compression Packing Manual*, explains the FSA's Pete Petrunich. Lower costs, up-to-date information, and customized manuals are among the benefits of POD, Ellis notes. ■

Developments in documentation

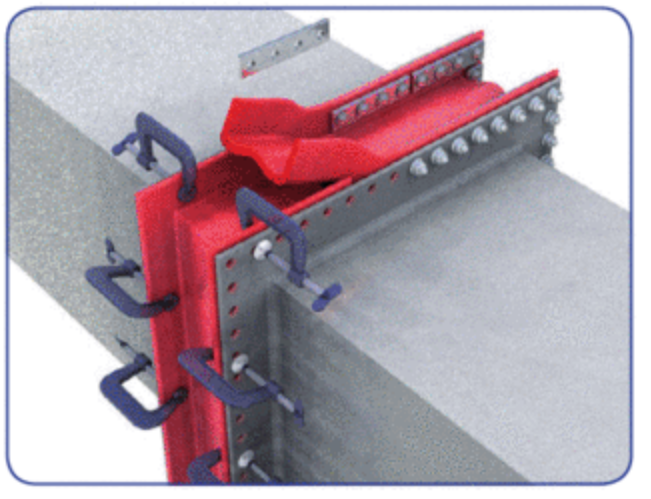
Gaskets, packings, mechanical seals and expansion joints are not only surprisingly complex, but also subject to changing rules, points out ESA general secretary Brian Ellis. As a result, both the ESA and the FSA are working to update and improve their technical publications.

Very soon to be published is a new edition of the *ESA+FSA Flange Gaskets Glossary* reflecting changes in standards, especially the move away from European national standards towards those harmonized by CEN (www.cen.eu). "It's unbelievably complex," says Ellis, "and there have been a lot of changes to U.S. standards too." The new *Glossary* will help engineers in multinational companies understand and accommodate differences between the U.S. and European rules, he says.

Available later this year, the ESA-led publication *Successful Sealing with Elastomers* will help users avoid seal failure when standardizing O-rings and lip seals between manufacturers, materials or applications.

Also to be released in the next few months are a series of joint ESA/FSA pocket-sized pamphlets ("Fitter's Flyers") on ductwork expansion joints, which provides clear guidance for field technicians (illustration, below). With expansion joints available in a range of designs, in diameters up to 3 m and more, this topic alone requires 44 different pamphlets, Ellis says.

Expansion joints of another kind feature in a revised *FSA Piping Expansion Joint Handbook*, says FSA technical director Pete Petrunich, while there are new Chinese (Mandarin) and Polish-language versions of another Fitter's Flyer title: *FSA+ESA Gasket Installation Procedure*. ■



Easily explained: clear 3-D graphics in new ESA and FSA publications help technicians make sense of installation procedures for expansion joints

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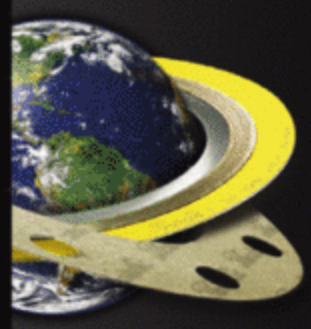

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Two of Flexitallic's most popular products are Thermiculite and Sigma. Derived from vermiculite, a natural mineral that resists both chemicals and heat, Thermiculite has solved a wide variety of customer problems, especially in high-temperature environments where competitors' products have failed. Unlike graphite-based products, Thermiculite resists oxidation, a primary cause of seal failure.

Thermiculite is available in two grades. The 800 Critical Service Series is specially made for extreme-temperature applications, from cryogenics to 1,800°F. It's manufactured as tanged sheet, spiral-wound, and kammprofile facing. The 700 Performance Grade Series, designed for more-moderate temperatures, is available in coreless sheet and spiral-wound styles, suitable for replacing aramid, glass, and carbon fiber as well as PTFE and graphite.

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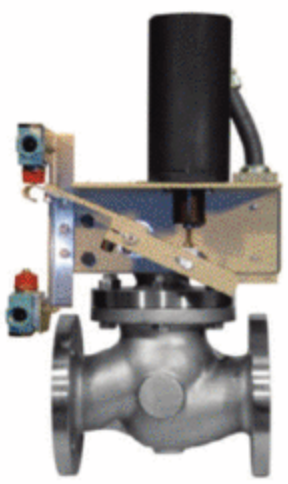

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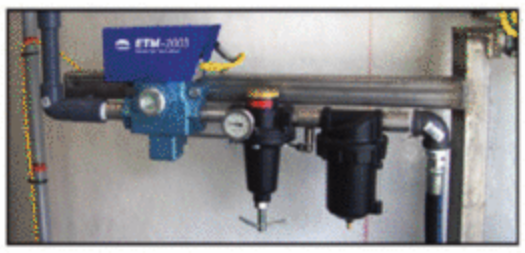

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Product Catalogue – Jet pumps, Mixers, Heaters, Vacuum Systems

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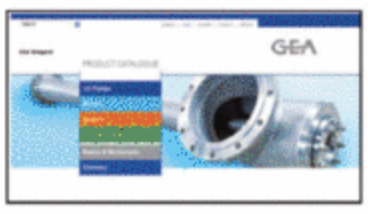

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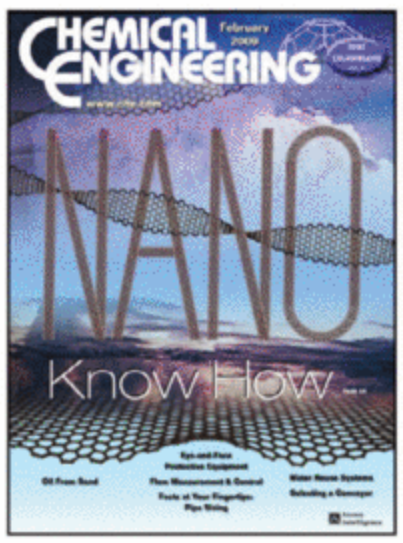

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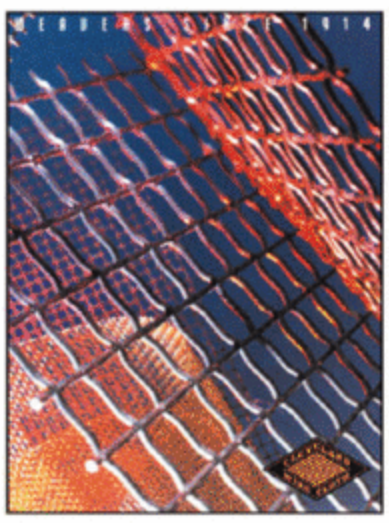

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WHO'S WHO


Oosterveer


Thorne


Matlas


Pillion


Lostak

Peter Oosterveer becomes president of energy & chemicals for **Fluor Corp.** (Irving, Tex.), based in Haarlem, Netherlands.

RathGibson (Lincolnshire, Ill.) names *Kirk Thorne* vice-president of sales and marketing.

Matcor (Doylestown, Pa.) names *Matt Matlas* senior managing corrosion engineer.

IRISS (Bradenton, Fla.) appoints *Marv Maddox* senior technical advisor for training and business development.

EagleBurgmann U.S. (Houston) names *Marcus Pillion* president.

Richard G. Campbell joins **CH2M Hill** (Denver, Colo.) as vice-president of engineering technology for the firm's power group.

Dow Microbial Control (Buffalo Grove, Ill.), a business unit of the Dow Chemical Co., appoints *Mark Henning* general manager.

Mark Lostak becomes president of **Air Liquide Industrial U.S.** (Houston); *Etienne Lepoutre* becomes chief operating officer of **Air Liquide**'s Industrial Merchant business line.

Bill Harvey becomes director of logistics engineering for **ChemLogix LLC** (Blue Bell, Pa.).

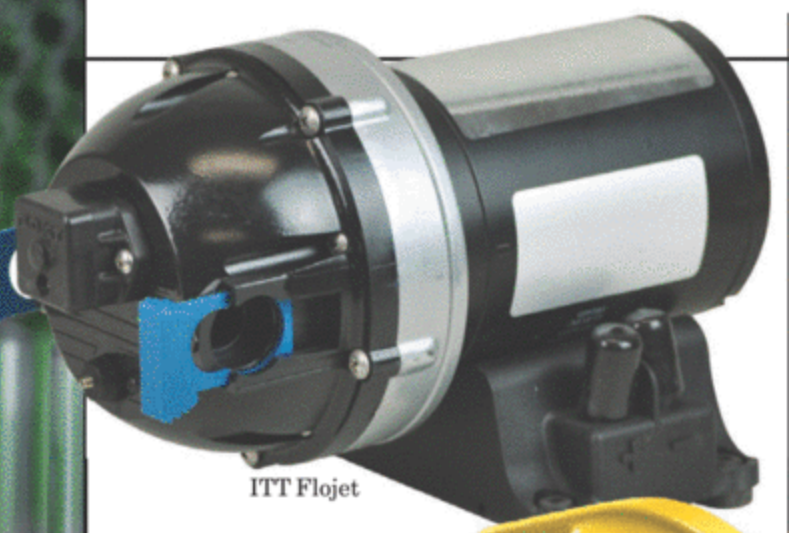
Mike Brandes becomes vice-president of operations for **Universal Package Systems** (Dale, Ind.). ■

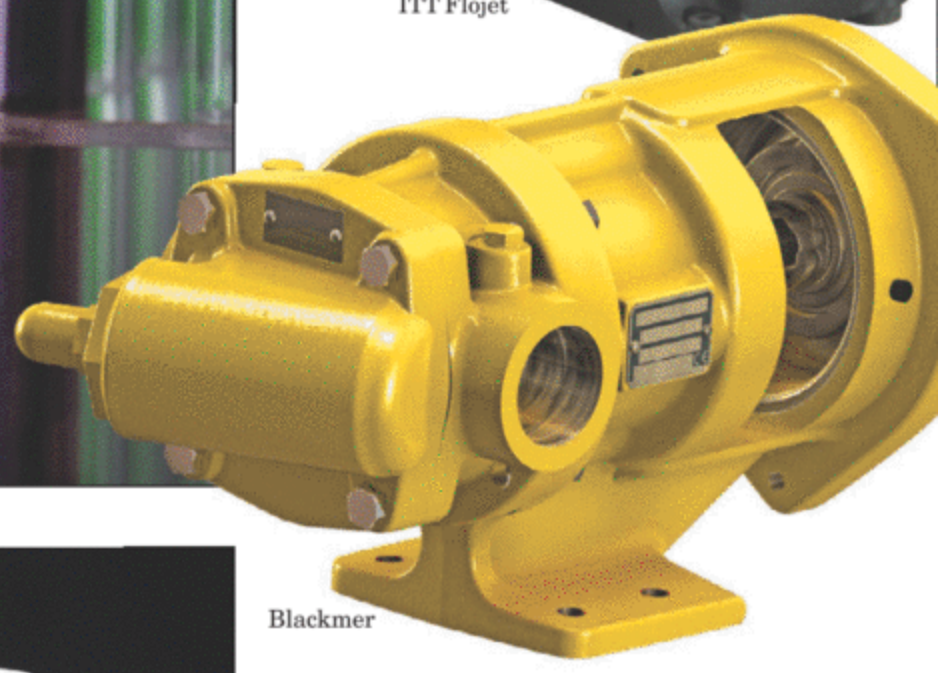
Suzanne Shelley

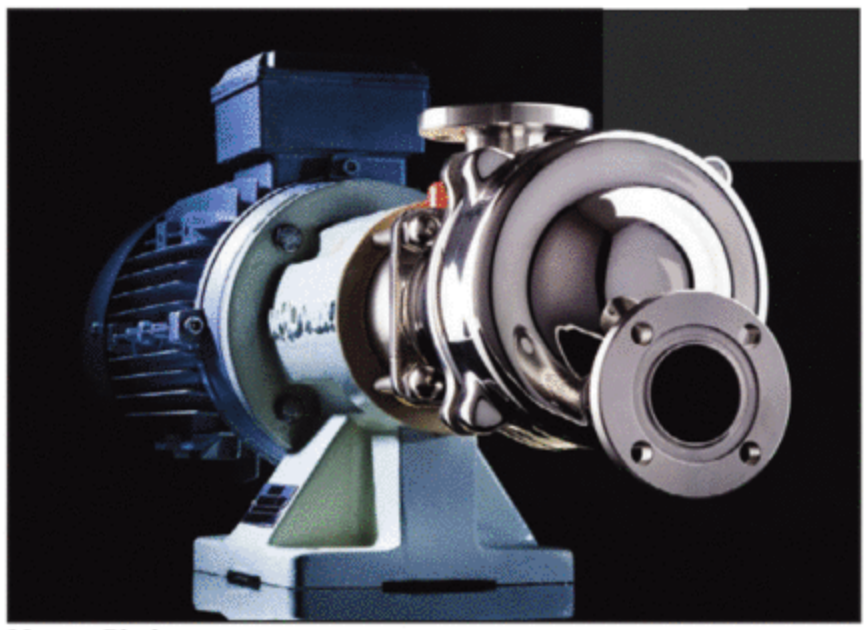
FOCUS ON

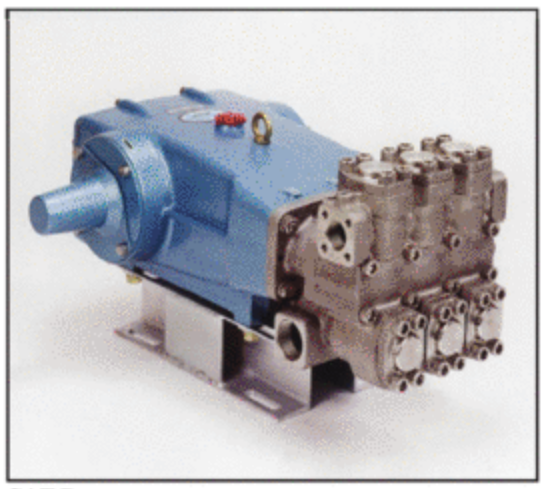
Pumps


Valco Instruments


ITT Flojet


Blackmer


Mouvex-Blackmer


CAT Pumps

A positive displacement alternative for syringe pumps
Cheminert Models M6 and M50 liquid handling pumps (photo) are a new option for precision handling of liquids and gases, producing a bidirectional, pulseless flow with a range of over six orders of magnitude (10 nL/min to 10 mL/min for the M6 Pump; 50 µL/min to 50 mL/min for the M50 Pump). Said to be an excellent replacement for syringe pumps, the Cheminert pumps offer better performance and eliminate the need for refill cycles and syringe changes. The M6 and M50 are positive displacement pumps, which means they are self-priming and tolerant of any gas that may find its way into the fluid lines. There is no separate fill cycle, and the capacity is said to be unlimited. RS-232 and RS-485 communication protocols are incorporated into the microprocessor-driven controller. — *Valco Instruments Co., Inc., Houston, Tex.*
www.vici.com

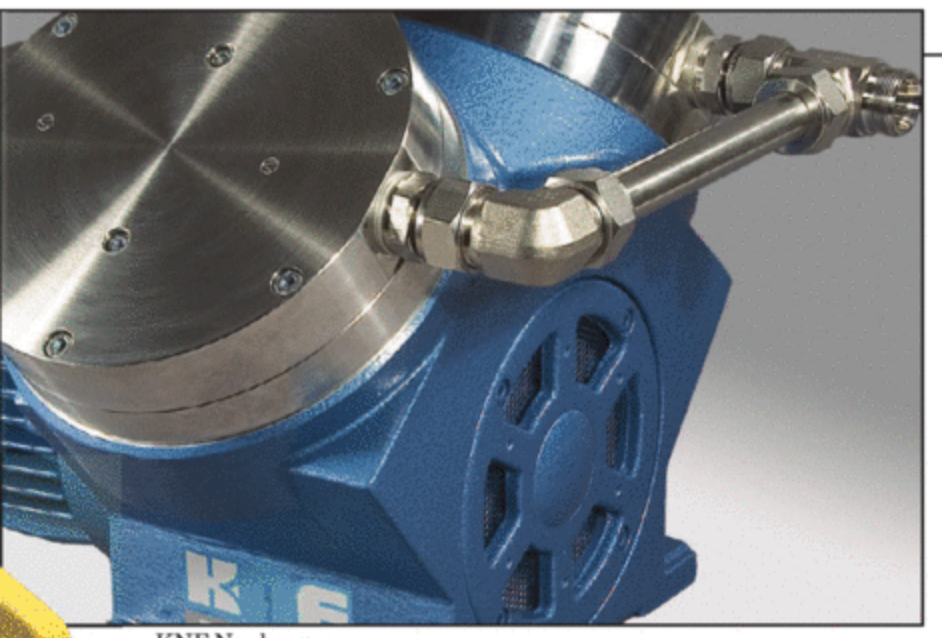
Breakthrough performance for high pressure applications
Pentaflex Series 7.0 GPM High Pressure Pumps (pohto) are engineered and constructed with the latest co-injection mold diaphragm technology, which virtually eliminates potential leak paths. The unique, five-chamber design allows these pumps to operate at pressures exceeding 60 psi. At the same time, Santo-EPDM and Santo-Viton construction makes them capable of handling tough chemicals without corroding. — *ITT Flojet, Santa Ana, Calif.*
www.flojet.com

Eccentric disc pumps compensate for mechanical wear
On display for the first time at Achema 2009, last month, SLC-Series eccentric disc pumps (pohto) offer lower ongoing operations and maintenance costs in the transfer of various chemicals due to superior volumetric efficiencies. Unlike gear and lobe pumps that lose efficiency as they wear, SLC-Series pumps are designed to self-compensate for mechanical wear and maintain consistent flow over time. With sealless construction, the self-priming characteristics also boast the ability to run dry for up to five minutes. Other benefits include low shear and agitation of the pumped product, capability of handling solids and abrasives and clean-in-place capability. The line is available in stainless steel and ductile iron models capable of handling up to 10,000-cst (46,000-SSU) liquids and working pressures up to 130 psi (9 bar), depending on the model. — *Mouvex-Blackmer, an operating company within Dover Corp.'s Pump Solutions Group, Auxerre, France*
www.mouvex.com

Plunger pump expands its flow range to 75 gal/min
This manufacturer's 60 Frame triplex plunger pumps (photo) have now expanded to capacities of 75 gal/min. The new range is available in three models — brass, stainless steel and NAB (Ni-Al-Br) — to cover a variety of industrial liquid applications such as desalination-reverse osmosis and liquid transfer systems. A special guided valve design provides added strength and durability under high flow operation. — *CAT Pumps, Minneapolis, Minn.*
www.catpumps.com

Vane pump offers extended bearing life, lower energy costs
ProVane Motor Speed Vane Pumps (photo) rely on a Hydrodynamic Journal Bearing feature to eliminate shaft-to-bearing contact by hydroplaning above the bearing surface on a cushion of liquid. In this hydrodynamic condition there is no metal-to-metal contact or wear, and bearing life can be indefinite, says the manufacturer. The pumps offer operating speeds up to 3,600 rpm with capacities from 6 to 100 gal/min (379 L/min) in sizes ranging from 3/4 to 2 in. Designed for continuous-duty op-

Note: For more information, circle the 3-digit number on p. 56, or use the website designation.



KNF Neuberger

erations, this pump offers the self-priming, low shear, superior line stripping and fluid transfer efficiency of traditional vane pumps with the added benefits of higher operating speeds, longer bearing life, and one mechanical seal. ProVane pump does not require a gear reducer, so it offers upfront equipment, installation and energy cost savings, in a smaller footprint. — *Blackmer, an operating company within Dover Corp.'s PSG, Grand Rapids, Mich.*
www.blackmer.com

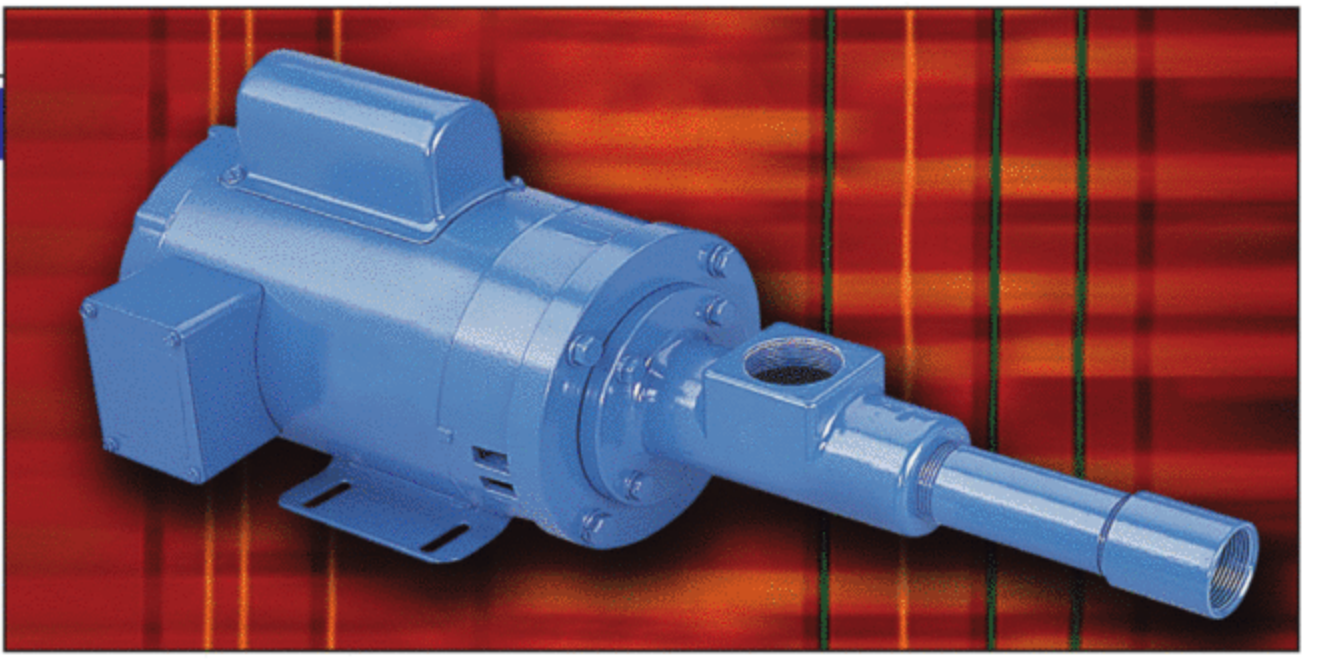
This pump is smart enough to order its own replacement parts

The Imo TX2020 is an intelligent concept pump with the ability to monitor its performance, adjust to changing conditions and order its own replacement parts — all without human supervision. The TX2020 rotary positive-displacement, three-screw pump continually monitors flowrate, pressure, liquid viscosity and energy consumption. If it determines adjustment is necessary to maintain flow, it can change speed or heat the liquid, to lower its viscosity. Software includes a preventive maintenance calendar and — based on foreseen needs or detected problems — the ability to determine which parts need replacement and issue a purchase order for them. — *Colfax Corp., Richmond, Va.*
www.colfaxcorp.com

Aggressive gases are no problem for these diaphragm pumps

KNF corrosion-resistant diaphragm process pumps (photo) are designed for sampling, transferring, evacuating or compressing aggressive gases in a wide range of challenging industrial applications. These electrically operated and oil-free pumps boast reliable and contamination-free performance. The design combines high-grade steels and solid PTFE (or other inert materials for the wetted head portion) with a laminated layer of corrosion-resistant material over the diaphragm. Such a combination imparts the desired resistance to corrosion and contributes mechanical and thermal resistance, high tensile strength and resistance to pressure, which add up to increased pump flexibility and longer service life. Specialized versions include heated-head and heat-resistant pumps for exhaust emission and stack-gas sampling; explosion-proof motors; and secondary safety diaphragms for handling rare and dangerous gases. Flowrates up to 300 L/min (10 scfm), maximum vacu-

Moyno



ums up to 29.8 in. Hg, and maximum pressures up to 176 psig are possible. — *KNF Neuberger, Inc., Trenton, N.J.*
www.KNFprocess.com

Metering pump provides precise control in low-flow applications
The Moyno Metering Pump (photo) is designed for economical and efficient performance when metering low-flow liquids in a wide range of processing applications. The progressing cavity design results in a smooth flow, free from pulsations and variations in velocity and volume, which prevents material waste or mixture imbalance. Sealed universal joints offer longer life, and there are no valves to clog, stick, or vapor lock. Meanwhile, power consumption and operating costs are both said to be low. A wide variety of materials of construction are available for units that support pressures up to 300 psi and flowrates from 0.1 to 190 gal/h. The pump is available in bare-shaft, close-coupled and motorized configurations. All models are capable of handling a wide variety of fluids from clean, clear liquids to abrasive, corrosive fluids, solids in suspension and viscous materials. — *Moyno, Inc., Springfield, Ohio*
www.moyno.com

Hose pump boasts lower total cost of ownership
Series LPP pumps incorporate a unique operating principle that, among other benefits, offers preferred energy efficiency. Thanks to the rolling hose contact, no excess friction and thus, no excess heat, is generated. In fact, less risk of overheating means that the LPP pump can produce the same flow as conventional hose pumps but with a smaller motor. Meanwhile, in LPP pumps, hose compression takes place only once during 360 operating cycle, whereas conventional hose pumps compress the hose two times. This design nearly doubles the lifetime of the LPP hose, says the manufacturer. Also, since LPP pumps cause less friction, they can require as little as one-fifth the lubricant needed by other hose pumps. — *Larox Flowsys Oy, Lappeenranta, Finland*
www.larox.fi/flowsys ■

Rebekkah Marshall

CHEMICAL ENGINEERING
FACTS AT YOUR FINGERTIPS
Department Editor: Kate Torzewski

Specialty Metals

One of the most important factors to consider when evaluating a specialty metal for use in valves, fittings and instrumentation is its corrosion resistance or corrosion rate of the metal in the target media. Each material discussed here has its own niche, and depending on the processing environment and the needs of the application, the metal's strengths and weaknesses may or may not be suitable. In either H_2SO_4 or HCl solutions, the corrosion resistance of tantalum is second to none, followed by zirconium, nickel alloys and titanium. Thermal expansion coefficient and melting point data for each metal are given in the table.

Metal	UNS Number	Coefficient of Thermal Expansion (10^{-6} mm/(mm°C)	Temperature range, °C	Melting temperature, °C
Nickel alloy 200	N02200	13.3	20–90	1,440–1,450
Titanium	R50250	8.6	0–100	1,705
Zirconium	R60702	5.2	0–100	1,860
Tantalum	R05200	6.5	0–200	2,996

TANTALUM

The physical properties of tantalum are similar to those of mild steel, although tantalum has a higher melting point. Tantalum is the most corrosion-resistant metal that is in common use, due to its tenacious oxide layer. Its superb corrosion resistance is comparable to glass and is practically inert to most oxidizing and reducing acids, except fuming sulfuric acid, hot alkalis and HF. While tantalum is an ideal choice from a corrosion-resistance point of view, it is typically cost prohibitive, even when cladded. Only in process conditions where no other material will perform adequately is tantalum a material of choice, at least in its traditional forms. This limits tantalum's use to heating coils, bayonet heaters, coolers and condensers operating under severe conditions. When economically justified, larger items of equipment, such as reactors or tanks, may be fabricated with tantalum liners. Since tantalum linings are usually very thin, very careful attention to design and fabrication details is required.

Tantalum can typically be found in applications that deal with hot concentrated acids. Due to its negligible corrosion rate, it is ideal for use in the pharmaceutical and food manufacturing industries [*2*].

Recently, tantalum has been processed to create a surface alloy on valves and other fittings, instrumentation and equipment. This relatively new option exhibits all the chemical properties of tantalum, allowing excellent corrosion resistance without the high costs. However, this option is not suitable for slurries or solutions that contain abrasive particles that could lead to mechanical erosion and abrasion of the surface.

ZIRCONIUM ALLOYS

Zirconium alloys exhibit excellent resistance to corrosive attack and work well in many organic and inorganic acids, salt solutions, strong alkalies, and some molten salts. It owes its corrosion resistance to the natural formation of a dense, stable, self-healing oxide film on its surface. Unalloyed zirconium has excellent resistance to H_2SO_4 up to 60% concentration at the boiling point, and has excellent corrosion resistance in HCl. Zirconium is also highly resistant to most alkali solutions up to their boiling point.

Zirconium's corrosion resistance could be compared with titanium in many ways, but it is much more robust than titanium in withstanding organic acids, such as acetic, citric, and formic at various concentrations and elevated temperatures. However, zirconium can still be corrosively attacked by fluoride ions, wet chlorine, aqua regia, concentrated sulfuric acid (above 80%), and ferric or cupric chlorides [*3*]. Zironium has excellent resistance to reducing environments, but oxidizing agents frequently cause accelerated attack. Commercial-grade zirconium, which contains up to 2.5% hafnium, is often used in hydrogen peroxide production, rayon manufacture, and the handling of phosphoric acid, sulfuric acid and ethyl benzene.

TITANIUM

Titanium is an established metal when dealing with corrosive applications. Titanium is available in a range of different alloys with the most-corrosion-resistant grades being titanium *7*, 11 (containing 0.15% Pd), and 12 (containing 0.3% Mo and 0.8% Ni). Titanium and its alloys offer good corrosion resistance that is due to a strong oxide film. The oxide film formed on titanium is more protective than on stainless steel, and it often performs well in media such as seawater, wet chlorine and organic chlorides. While titanium offers good corrosion resistance to these solutions, it certainly is not immune to them, especially at elevated temperatures (for example, seawater at temperatures greater than 110°C) [*3*]. It has a number of disadvantages as well, as it is not easy to form, it has a high springback and tends to gall, and welding must be carried out in an inert atmosphere.

Titanium metal can be found in a variety of industries, including chemical processing, pulp and paper, and marine applications. It is also used extensively in the production of chlorine.

NICKEL ALLOYS

Nickel alloys are commonly used when typical steel materials don't offer the corrosion performance that is needed. To enhance the performance of nickel in aqueous-solution service, the most important alloying elements are Fe, Cu, Si, Cr and Mo. Cr and Mo play a major role in nickel's corrosion resistance. Varying the concentrations of these elements in the nickel alloys changes the corrosive environments in which nickel alloys can be successfully applied, but they are typically used in a range of acid, salt and alkali applications. The addition of Cr (15–30%) improves the corrosion resistance to oxidizing solutions, while the addition of Mo (up to 28%) improves the resistance to non-oxidizing acids.

The nickel alloys C-22, C-276, and B-2 all have good corrosion resistance in a variety of media. In the case of HCl, the corrosion resistance of these alloys depends greatly on the Mo content. The alloy with the highest concentration of Mo, B-2, exhibits the best corrosion resistance.

In solutions such as nitric acid (HNO_3), Cr is an essential alloying element for providing corrosion resistance. Nickel alloys' weaknesses revolve around their interaction with the media and their environment in the form of impurities. Under ideal testing conditions, these alloys (for example, B-2), work well in pure de-aerated H_2SO_4 and HCl, but deteriorate rapidly when oxidizing impurities, such as oxygen and ferric ions, are present. Another consideration is the presence of chlorides (Cl^-), which generally accelerate the corrosion attack at different degrees for various alloys.

Having a wide range of applicability in acids, salt solutions, and caustic environments, nickel alloys have found their way into a variety of industries, such as chemical, petrochemical, oil and gas, nuclear, conventional power generation and paper.

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2. Burnstein, G.T., others, "Corrosion Volume 1 & 2", Butterworth Heinemann, Oxford, 1994.
3. Roberge, P.R., "Handbook of Corrosion Engineering", McGraw Hill, New York, 2000.
4. "Perry's Chemical Engineers' Handbook," 8th ed. New York: McGraw Hill, 2008.

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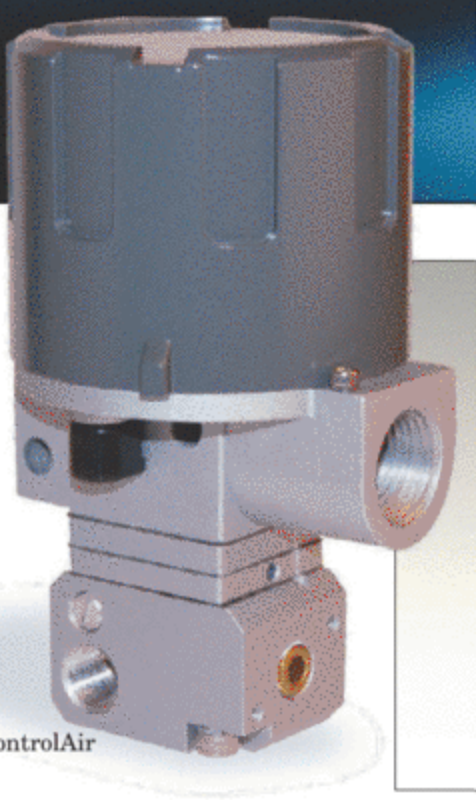

ControlAir

Yokogawa

This mist collector requires fewer cleanings

The MSH mist collector is the newest addition to the Smog-Hog line of electrostatic precipitators (ESP; photo). Measuring at only 27 X 21 X 20 in., the compact MSH is equipped with the largest capacity ESP collection cell in the industry, which captures three to four times the amount of fume than other similar systems, says the firm. The Smog-Hog MSH utilizes a variable, speed drive motor producing air volume up to 500 ft^3/m. Additionally, the MSH uses a heavy-duty mist-stop coalescing pre-filter and metal mesh after-filter for maximum contaminant collection. The Smog-Hog MSH is ideal for mist collection applications such as metal drilling, CNC machining, screw machines, plastic extruding and finishing. — *United Air Specialists, Inc., Cincinnati, Ohio*
www.uasinc.com

Current-to-pressure transducer is vibration and position insensitive

The Type-595XP Explosion-Proof Current-to-Pressure I/P Transducer (photo) is small and lightweight, yet is less sensitive to shock, vibration and position change than other I/Ps. The unit has a low power consumption and is intrinsic safe and explosion-proof, making it suitable for hazardous environments in remote locations. The conversion technology, utilizing open-loop control, provides a high level of accuracy and repeatability for the operation of actuated valves. A low mass control circuit provides reliable linear output in difficult applications. The Type-595XP transducer has an input signal of 4–20 mA and output ranges of 3–15, 3–27 and 6–30 psig. The maximum supply pressure is 22 psi for 3–15 output and 42 psi for other outputs. Flow capacity is 2.4 ft^3/min, and air consumption is 0.1 ft^3/min. — *ControlAir, Inc., Amherst, N.H.*
www.controlair.com

Temperature controller with embedded PLC ladder-logic control

The UTAdvanced Hybrid Temperature Controller (photo) combines PID control with an embedded ladder-sequence control. The new feature supports 84 ladder commands, four analog inputs, three analog outputs and allows up to 400 ladder steps that can be programmed and run together with the PID control. The PLC capability allows the use of a temperature controller along with a mini PLC to obtain the same control functionality in one package at the cost of just the temperature controller. The UTAdvanced includes a high-intensity LCD display and a simple user interface. Communication platforms include Ethernet, Profibus DP and RS485. These platforms support Modbus/TCP, Modbus RTU, peer-to-peer, master/slave and a proprietary protocol. — *Yokogawa Corp. of America, Newnan, Ga.*
www.yokogawa.com

A combined vortex flowmeter for steam, gas and liquids

The Sitrans FX300 vortex flowmeter series (photo) is equipped with a temperature sensor and an optional pressure sensor. Through the combination of these sensors into one unit, the vortex principle is used to measure the temperature, pressure and flow of steam, gases and liquids. The Sitrans FX300 with Hart communication is designed for applications requiring reliable flow measurement independent of dynamic pressure, temperature, viscosity and density variations. The sensor is fully welded and does not require wear-prone internal gaskets.

Note: For more information, circle the 3-digit number on p. 56, or use the website designation.

The operating temperature range is from –40 to 464°F. For flowrates of 2–80 m/s, the accuracy is 1.0%, and for flowrates of 0.4–10 m/s, it is 0.75%. The nominal internal diameter range is DN15 to DN300 (0.5–12 in.). — *Siemens Energy and Automation, Inc., Atlanta, Ga.*
www.sea.siemens.com

This system tests small, uncatalyzed membrane samples

The Model 740 Membrane Test System (MTS) is the first commercial instrument designed specifically for measurement of the through-thickness resistance and conductivity of ionomer and polymer electrolyte membranes. Only a small sample of bare (non-catalyzed) membrane is required, eliminating the time-consuming and costly requirement of catalyzing the membrane, and assembling and running a fuel cell. The MTS is a compact, bench-top unit and uses membrane samples that can be easily loaded with membrane compressions up to 400 psi. The environment in the closed cell can be controlled between 30–120°C, relative humidity (RH) from dry to 95% and pressure from 1–3 atm absolute. — *Scribner Associates, Southern Pines, S.C.*
www.scribner.com

Scribner Associates

Inline air tightness checker saves time and money

To meet food manufacturers' stringent standards of freshness and quality, this firm introduces the SealTester, a rugged instrument that checks packaging for air and gas tightness inline. The key advantage of the SealTester is its saving in personnel costs compared to random physical sampling and testing. Another benefit is its extremely high level of dependability and consistency when checking for air or gas leaks, without any loss of the product being tested. The SealTester uses a powerful servo control to direct its six servo motors. The control manipulates three measuring belts in such a way that the flexible bags in the production line do not collide with each other nor with the belts. — *Sartorius Mechatronics Corp., Bohemia, N.Y.*
www.sartorius-usa.com

This control module is coupled with digital mass flowmeters

The Compod programmable control module, coupled with Smart-Trak mass flowmeters (MFMs) and control-

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Sierra Instruments

Thayer Scale

lers (photo), greatly simplifies basic flow control installations and permits networking of multiple instruments using open-source Modbus RTU protocol. The unit can be configured for a variety of process controls, including: gas mixing and blending; gas ratio control; simple batch processes; triggering alarms; starting or stopping gas flows automatically under user-defined conditions; and gas flow totalization. The Compod controls simple processes without the need for external PLCs or computers. It monitors the operation of instruments, providing potential problem alerts, and is available with a LCD display for local monitoring. — *Sierra Instruments, Monterey, Calif.*
www.sierrainstruments.com

Handle fluidizable materials with this rotary feeder

The LWY-SC-RF Loss-In-Weight (LIW) Rotary Feeder (photo) is designed to handle extremely free-flowing and fluidizable materials. Ideally suited for applications discharging into pneumatic conveying systems, the feeder system is available in a range of sizes and can be configured for either continuous LIW feeding or batch. Weighing is done through a patented low-deflection, non-wearing FMSS (Force Measurement Suspension System) flexure scale, which measures vertical loading and can take high-load directed overloads (1,000%). The FMSS Scale design uses counterweights to negate the tare weight of the support structure, feeder and bin, allowing 100% of the scale capacity to be used to weigh material. — *Thayer Scale, Pembroke, Mass.*
www.thayerscale.com

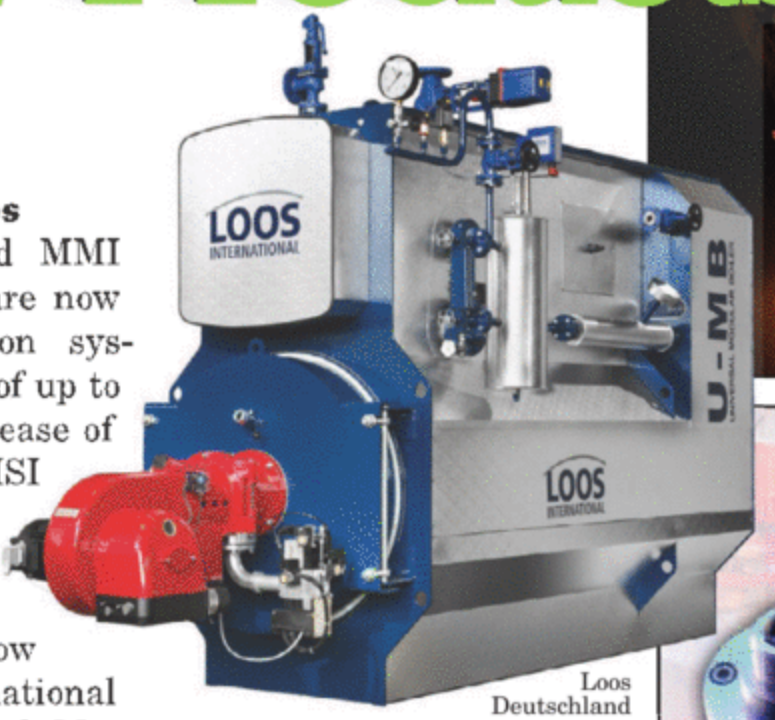
These strainers are available in a choice of fluropolymers

A line of fluoropolymer strainers with Tri-Clamp connections is now available for ease of removal and cleaning. Available in both PTFE and Kynar PVDF, the product line encompasses both Y-strainers in nominal pipe size up to 4 in. and basket strainers up to 3 in. Utilizing Tefzel PTFE meshes and FEP encapsulated O-Rings, the strainers feature 100% fluoropolymer-wetted surfaces, easily removable cartridges, and drain plugs for less maintenance. Standard Tefzel meshes range from 300 to 1,800 microns, but this firm provides a variety of other mesh sizes and materials. Other custom options include "mix and match" end connections and drilled holes rather than mesh. — *Micromold Products, Inc., Yonkers, N.Y.*
www.micromold.com ■

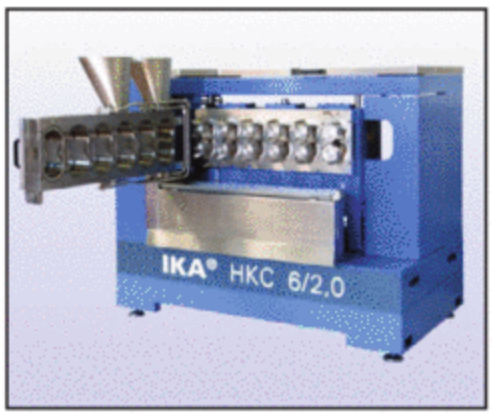
Kate Torzewski

JUNE
New Products


Siemens



Loos Deutschland



IKA Werke


Pump Engineering

Belt scales for very large flowrates
Milltronics MSI and MMI Belt scales (photo) are now available for use on systems with flowrates of up to 12,000 ton/h, an increase of 7,000 ton/h. The MSI and MMI, combined with a Milltronics BW500 Integrator and speed sensor now have OIML (International Organization of Legal Metrology) and MID (Measuring Instrument Directive) approval, which guarantees the belt scales meet strict requirements for weights and measures applications in accuracy and repeatability. The MSI is used for rugged applications in process and load-out control. It provides instant response to belt loading and overload protection to 300%.The MMI is a high-accuracy, multi-idler belt scale consisting of two or more MSI scales. Used for critical process and load-out control, the MMI-2 offers an accuracy of up to ±0.25%. For greater precision, the MMI-3 can be used for applications requiring accuracies up to ±0.125%. The MSI and MMI models can be installed without the use of cranes or other high-cost resources. — *Siemens Industry Sector, Industry Automation Div., Nuremberg, Germany*
www.siemens.com

Match the needed modules to meet your boiler requirements
The Universal Modular Boiler U-MB (photo) steam-boiler series uses the shell structure with three-pass technology in the performance range of up to 2,000 kg/h. The boiler consists of several modules that are selected specifically per order. The heat generating component — the steam module and the Economizer module — are configured to suit the emissions and steam quality requirements. The basic equipment includes technology for teleservicing capability and an intuitive LBC TouchScreen control. An automatic startup mechanism means that the steam generator can be started up automatically at the press of a button or using an external starter from the cold state. Overload protection ensures high-quality steam irrespective of consumer behavior. — *Loos Deutschland GmbH, Gunzenhausen, Germany*
www.loos.de

Process viscous material with this kneading extruder
The Conterna (photo) is a continuous kneading and extrusion machine designed for processing highly viscous materials, such as plastic compounds with a high percentage of fillers. Besides plastics, the Conterna is also used in the food and chemical industry for manufacturing rubber, master batches, glues, sealants and other products. The system normally has six kneading chambers, but allows for the arrangement of as many chambers in line as necessary. Discharge units, such as a gear pump or an extruder, can be mounted to the last kneading chamber. The machine is available for throughputs from approximately 10 to 4,000 L/h. — *IKA Werke GmbH & Co. KG, Staufen, Germany*
www.ikaprocess.com

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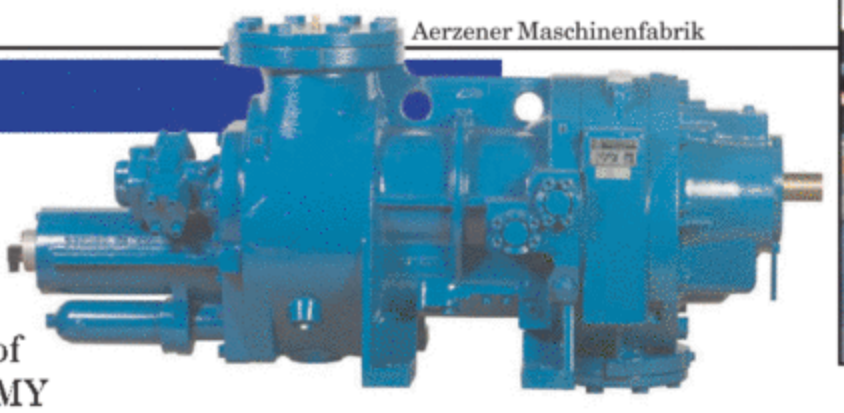
The CSF Steam Water Mixer (photo) provides a safe, simple and reliable source of hot water delivered at the correct temperature and pressure, so it is suitable for cleaning and washdown applications. These mixers are constructed from stainless steel and are capable of delivering up to 10,000 L/h of water at temperatures up to 95°C. They are simple to install because existing steam and cold water supplies can be used. Running costs are minimal because the design of the mixer ensures that all the heat energy in the steam is transferred to the water. — *Pump Engineering Ltd., Littlehampton, U.K.*
www.pumpeng.co.uk

A new generation of compressors is now available
VMY '56 is the official designation of the new generation of this firm's

Note: For more information, circle the 3-digit number on p. 56, or use the website designation.



Aerzener Maschinenfabrik

Spectro Analytical Instruments

refrigeration and process-gas compressors (photo). It is the synthesis of 35 years of experience with former VMY series and will replace the well-known series VMY '46 in the medium term. Designed for all common refrigerants, the VMY compressors are especially applied in the industrial refrigeration technology as well as for mixed gas and process gas in the chemical- and petrochemical industries and in power plants. At present, the first sizes VMY 256 M HR and VMY 256 M NR are available, reaching a conveying volume of 911 m^3/h up to 1,375 m^3/h at 50 Hz as well as a maximum pressure difference of 25 bar. In addition, the serial production of the size VMY 156 M — also available as male and female drive and with a volume flow of 444 m^3/h up to 678 m^3/h — will start in short time. The rotors of the new compressor stage are made of surface-hardened special steel for long service life. The profile 4 + 6 developed by Aerzen for the secondary rotor drive has been proven by its high reliability. The first rotors with this material and the drive on the secondary rotor side have been in operation quite successfully for more than ten years. — *Aerzener Maschinenfabrik GmbH, Aerzen, Germany*

www.aerzener.com

Elemental analysis in the palm of your hand

Since it was launched last September, Spectro xSORT's original metal analysis capabilities have been expanded to include applications for RoHS (Restriction of Hazardous Substances) Directive compliance and lead screening as well as for the examination of soil in environmental testing and the direct analysis of ores, concentrates and tailings. The xSORT (photo) is an analytical instrument for rapid, non-destructive XRF (X-ray fluorescence) screening analysis. The device analyzes the content of all of the important elements between sulfur and uranium contained in the sample with measurement times of a few seconds. The silicon drift detectors used in xSORT process signals up to ten times faster than the detectors conventionally used in handheld XRF instruments, says the firm. — *Spectro Analytical Instruments GmbH, Kleve, Germany*

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Monitor/diagnose Profibus networks with this coupler

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Hans Turck

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coupler (photo) with integrated web-server software and diagnostics functionality. For the first time ever, users can monitor a large number of operating Profibus networks in a parallel and continuous manner. The coupler can easily be integrated into existing fieldbus networks where they autonomously establish a communications and diagnostics infrastructure for convenient remote maintenance over the internet — regardless of the number of networks being monitored. The coupler can be configured as a class II master. Actively participating in the fieldbus communication, the interface allows clients to be diagnosed and logged via additional OPC-Server software, or to be configured and parameterized via AMS-Suite. — *Hans Turck GmbH & Co. KG, Mühlheim an der Ruhr, Germany*
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This flowmeter is designed for monitoring stack emissions

The MT Series of Multipoint Mass Flowmeters (photo) are designed for gas and air applications, including continuous emissions monitoring systems, and thus are suitable for measuring and monitoring stack emissions. The flowmeters are ISO 14164:1999 (E) Annex B compliant and specifically designed for combustion air and fluegas measurement and monitoring in large ducts with irregular velocity profiles. Accuracies of ±2% of reading and repeatability of ±0.5% are possible thanks to the flowmeter's ability to average up to 16 individual flow sensors at temperatures up to 450°C. The devices include continuous auto-test function and alarm diagnostics. Other features include averaging filters, which dampen response to rapid process fluctuations; RS 232C serial ports, to enable communication with field instruments; and menu-driven control for ease-of-use. — *Allison Engineering, Basildon, U.K.*
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Make uniform slurries with this inline mixer

The QC Combination Recirculation & Stirring Head is a patented, inline tool for stirring or mixing of slurries and similar chemicals to achieve and maintain the best possible uniform particle distribution. No additional mechanical stirrer is needed. The device has no moving parts, provides infinite adjustment of the liquid flowrate as required to achieve the desired mixture and particle distribution level, and securely connects through the dip-tube head — no further parts are needed. The system ensures safe handling of fluids without dripping and avoids operator contact with the chemicals. The unit is constructed of polyethylene with Kalrez seals. — *AS Strömungstechnik GmbH, Ostfildern, Germany*
www.asstroemungstechnik.de

A popular alignment tool is now ATEX approved

This firm has released its ATEX-approved intrinsically safe version of its alignment system, Optalign smart. This system also complies with IEC Ex requirements for use in potentially explosive atmospheres. Optalign smart is a modular, mid-range alignment system that can cover both shaft and geometric applications. Its intuitive, ergonomic design and loaded features make it especially suitable for maintenance of rotating machinery, such as pumps, motors, gearboxes and compressors. — *Prüftechnik Alignment Systems GmbH, Ismaning, Germany*
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Dry Tray Pressure Drop Of Sieve Trays

A new correlation that matches most commercial trays

Daniel R. Summers
Sulzer Chemtech USA, Inc.

The sieve tray has been in the distillation market place for many decades. It has been used extensively in distillation columns worldwide as a highly efficient vapor-liquid-contacting device. Many people have examined dry tray pressure-drop data for sieve tray decks and there have been several attempts to correlate these data. But the error of such correlations is high.

This article — a supplement to the author's earlier article on the dry tray pressure drop of movable and fixed valves [*1*] — presents a new correlation for sieve tray pressure drop that incorporates tray thickness, hole diameter and open area, and is compared to data. The improved equation matches — within a 15% accuracy — experimental data from three different sources, and can be used for most commercial sieve-tray applications. Limitations on this new equation are also discussed.

Existing methods

Dry tray pressure drop is an extremely important hydraulic parameter that aids the tray designer in many different ways. Obviously, it is one of the major contributing parameters in the overall tray pressure drop. But more importantly, its magnitude can tell an experienced designer whether he or she is near flood, is at turndown, has a stable tray or may be approaching spray fluidization. Finally, it can be used to understand the overall behavior and performance of a tray. Dry tray pressure drop is a fundamental building block of most other hydraulic parameters, and its accuracy (or inaccuracy) has far reaching consequences.

The hydraulic parameter is quite a simple concept. For fixed opening devices, the dry tray pressure drop can be reduced from Bernoulli's principles taking on the form of the following equation:

$$\Delta P_{DRY} = \frac{12\rho_V \left(\frac{V_H}{C_V}\right)^2}{2g_C\rho_w} \quad (1)$$

Where,

ΔP_{DRY} = Dry tray pressure drop, in. of water
V_H = Hole velocity, ft/sec
ρ_V = Vapor density, lb/ft^3
C_V = Hole (orifice) coefficient
ρ_w = Water density = 62.428 lb/ft^3
g_C = Acceleration of gravity = 32.174 ft/s^2

If one combines all the constants from Equation (1) into a single constant C_p, the equation becomes very simple:

$$\Delta P_{DRY} = C_P V_H^2 \rho_V \quad (2)$$

Where,

$$C_P = \frac{1}{334.76C_V^2} \quad (3)$$

Even though Equation (2) appears to be quite simple, the orifice coefficient is, in reality, quite complex. Many people have attempted to determine a correlation for the orifice coefficient but all appear to have deficiencies in accurately determining this value for the full range of opening sizes, tray thicknesses and hole pitch. Lockett [*2*] notes that there are over 20 correlations available in the literature for the determination of the orifice coefficient. Kolodzie and Van Winkle [*3*] as well as Smith and Van Winkle [*4*] have performed extensive work and defined a very detailed orifice coefficient for sieve tray devices. These two sources indicate that there is also a hole Reynolds number effect. Stichlmair and Mersmann [*5*] also considered the Reynolds number in their correlation. Liebson and others [*6*], however, ignored the Reynolds number and determined a function of the orifice coefficient that utilizes simply the opening size, tray thickness (*TT*) and hole pitch.

Figure 1 shows the difference between the above-mentioned three sources. One can see that all three show a higher C_V at increased deck thickness to hole diameter (*DP*) ratios. However, only Stichlmair and Kolodzie indicate that there appears to be two discrete orifice coefficient values with a transition region between.

Lockett indicates that previous authors argue the *vena-contracta* of the vapor leaving thin trays is well above the tray deck. As a result, there is a pressure drop associated with the vapor circulating back in the bulk vapor above the tray. For thicker trays, the *vena-contracta* lies within the hole itself and as a result, the back-circulation of vapor is reduced.

Sieve tray, dry-pressure-drop data were obtained from several sources. These would include laboratory data from the author's employer [7] and dry tray pressure drop data from Fractionation Research, Inc. (FRI) [*8*]. In addition, Biddulph and Thomas [*9*] plotted several data points for a deck thickness to hole diameter ratio of 1.11.

A comparison of these data to the predicted values from Stichlmair and Mersmann is shown via parity plot in Figure 2. A comparison of these data to the predicted values from Liebson and others is shown in Figure 3. A comparison of these data to the predicted values from Kolodzie and van Winkle is shown in Figure 4. In all three cases

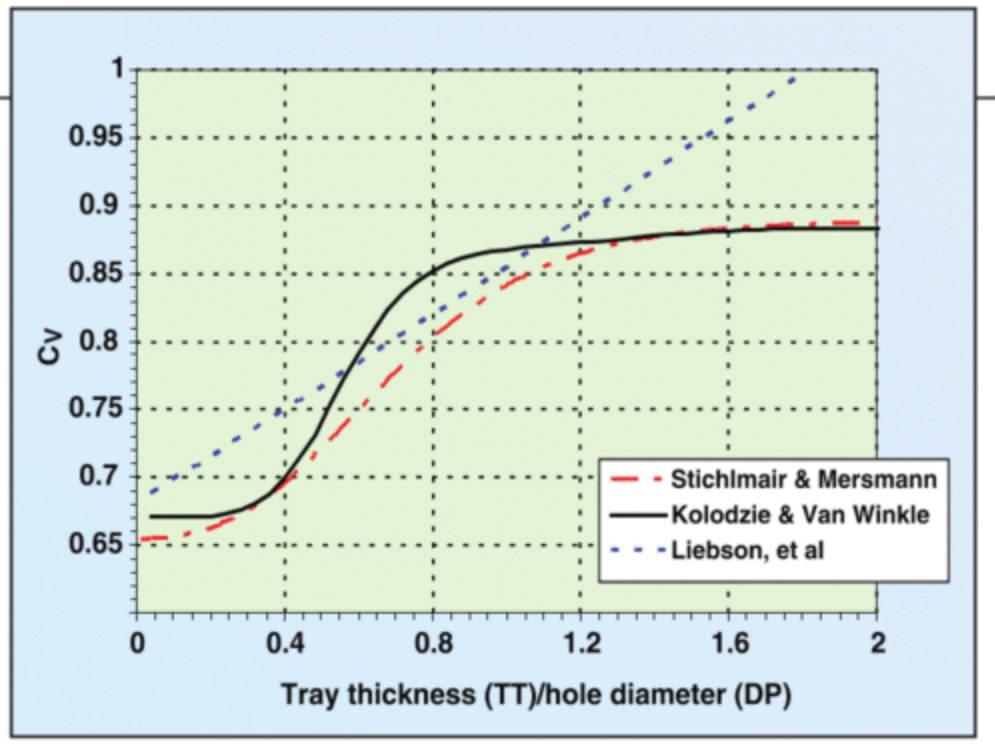

FIGURE 1. A plot of sieve tray orifice coefficient at 12% open area and high Reynolds Number for three sources

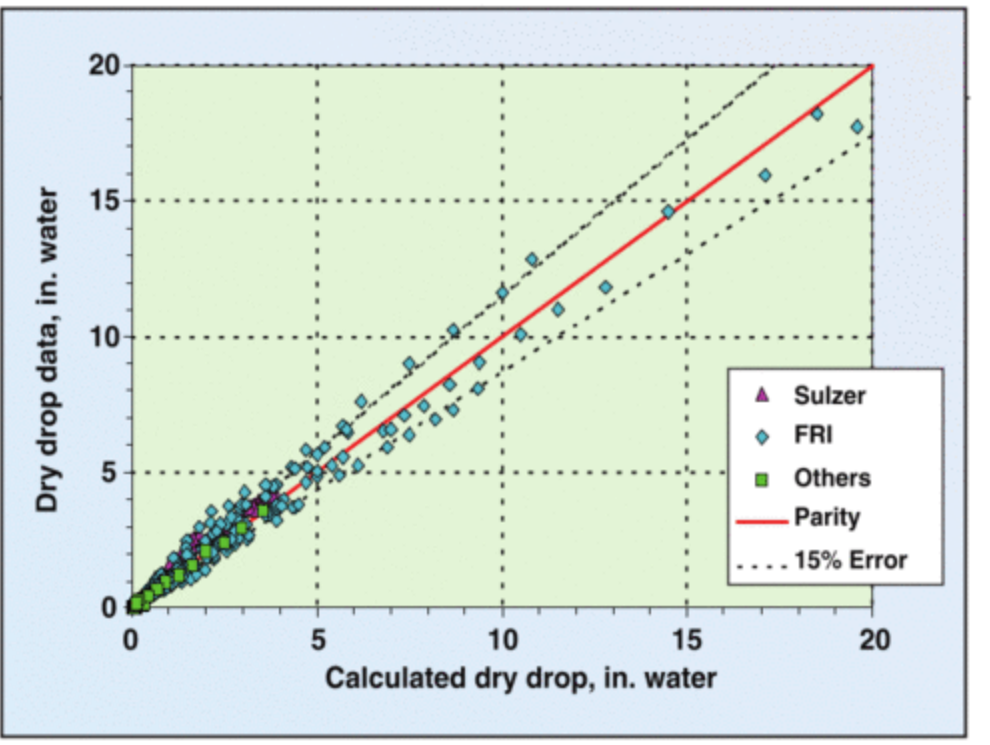

FIGURE 2. Parity plot of accumulated data versus the correlation of Stichlmair & Mersmann

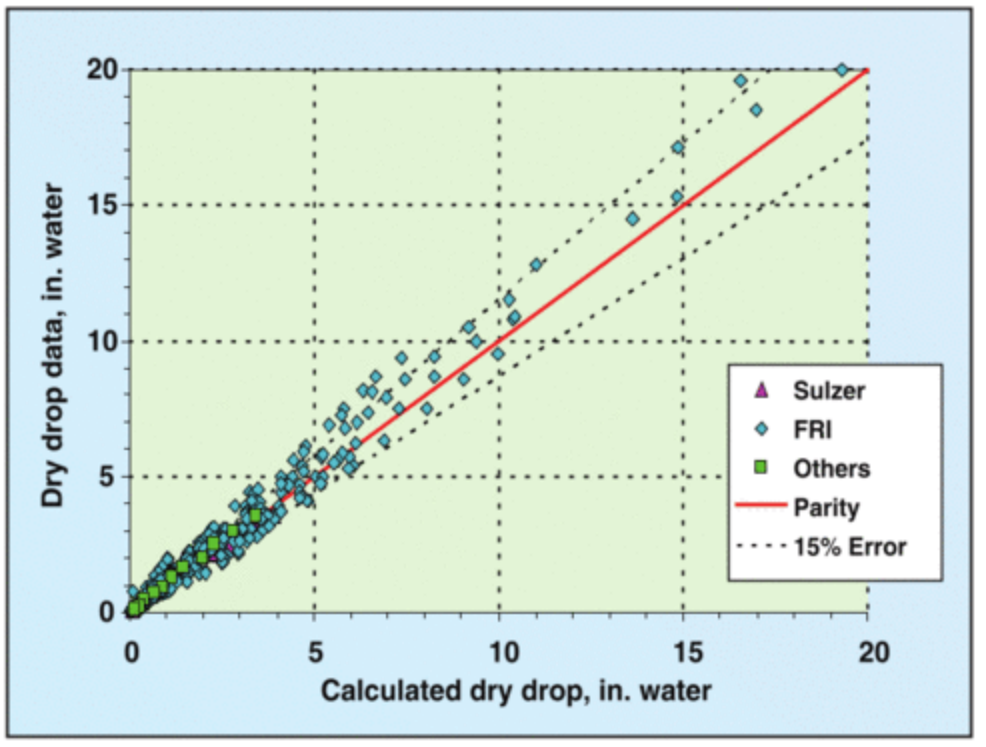

FIGURE 3. Parity plot of accumulated data versus the correlation of Liebson and others

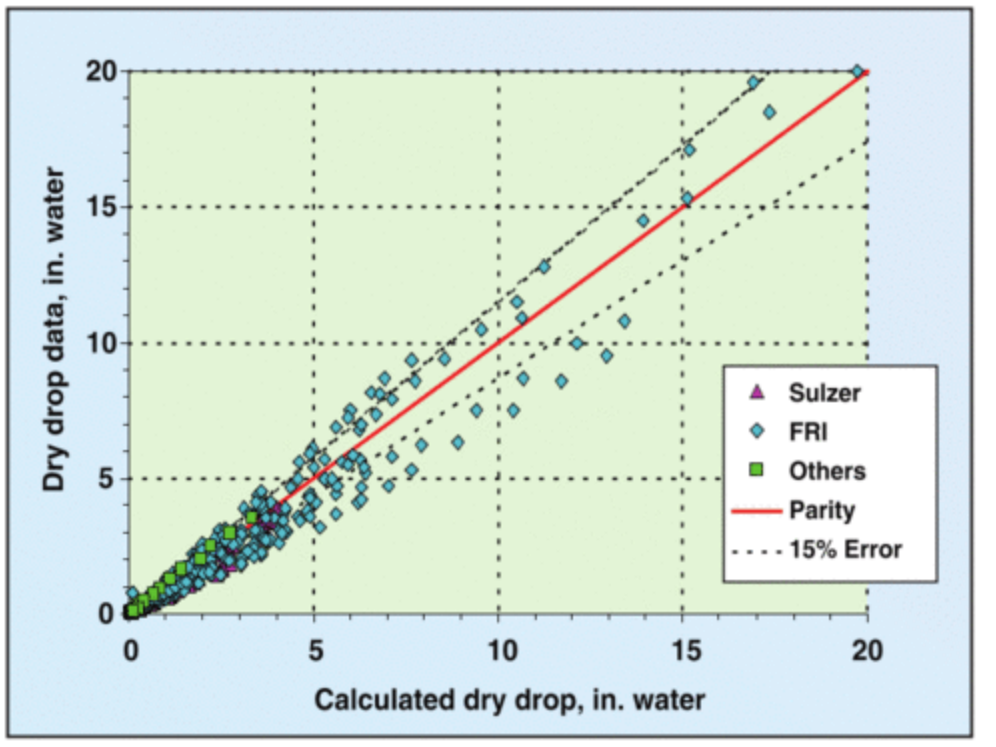

FIGURE 4. Parity plot of accumulated data versus the correlation of Kolodzie and Van Winkle

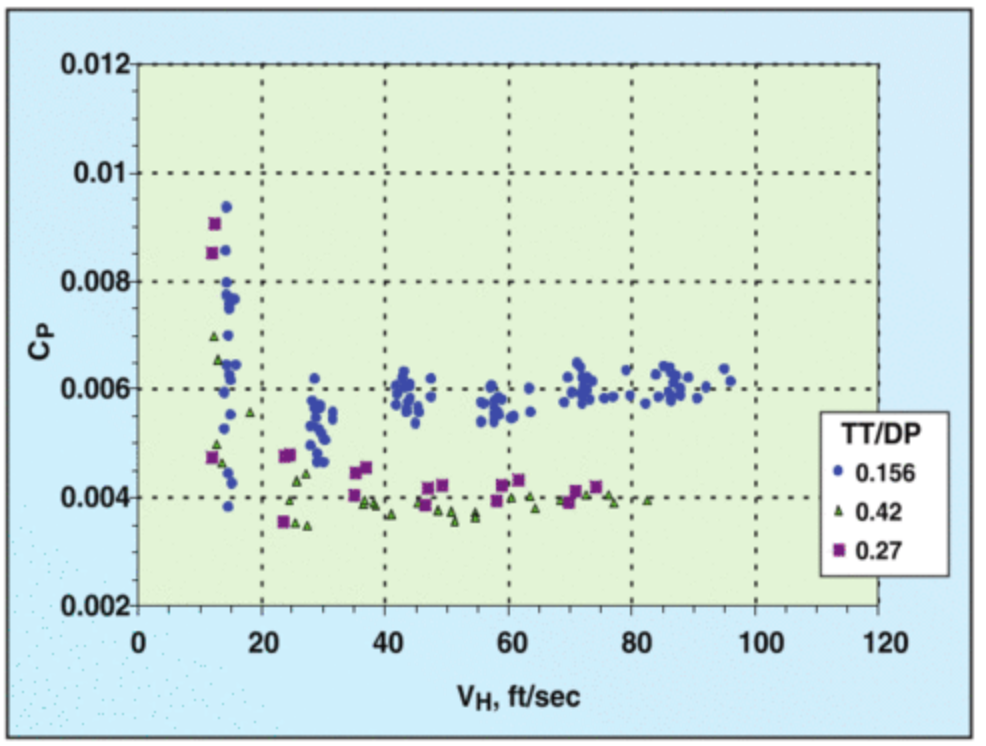

FIGURE 5. Sulzer dry tray pressure drop data

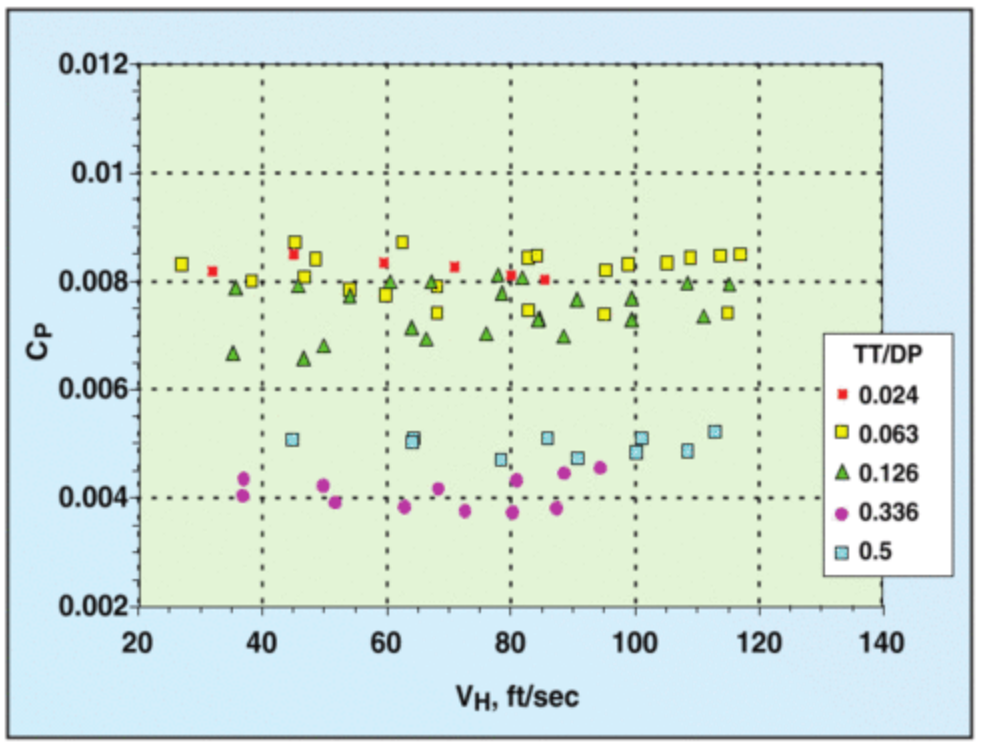

FIGURE 6. FRI dry tray pressure drop data

there is considerable data that lie outside the 15% error band, especially at low pressure drop values. The standard deviation of the Kolodzie and van Winkle data is over 26%.

An examination of the dry tray pressure drop data showed that the orifice coefficient C_P had a constant value over the bulk of vapor velocities (V_H) through the experimental orifice plates. Figures 5 through 7 show these constant values for the Sulzer, FRI and Biddulph data, respectively.

The constant values shown in Figures 5 through 7 are then plotted in Figure 8 to show a relationship between the orifice coefficient C_P and tray thickness divided by hole diameter. After converting C_P into C_V, Figure 9 was generated.

The Kolodzie and Van Winkle relationship was used as a basis to establish a new correlation. Their work seemed to encompass the largest com-

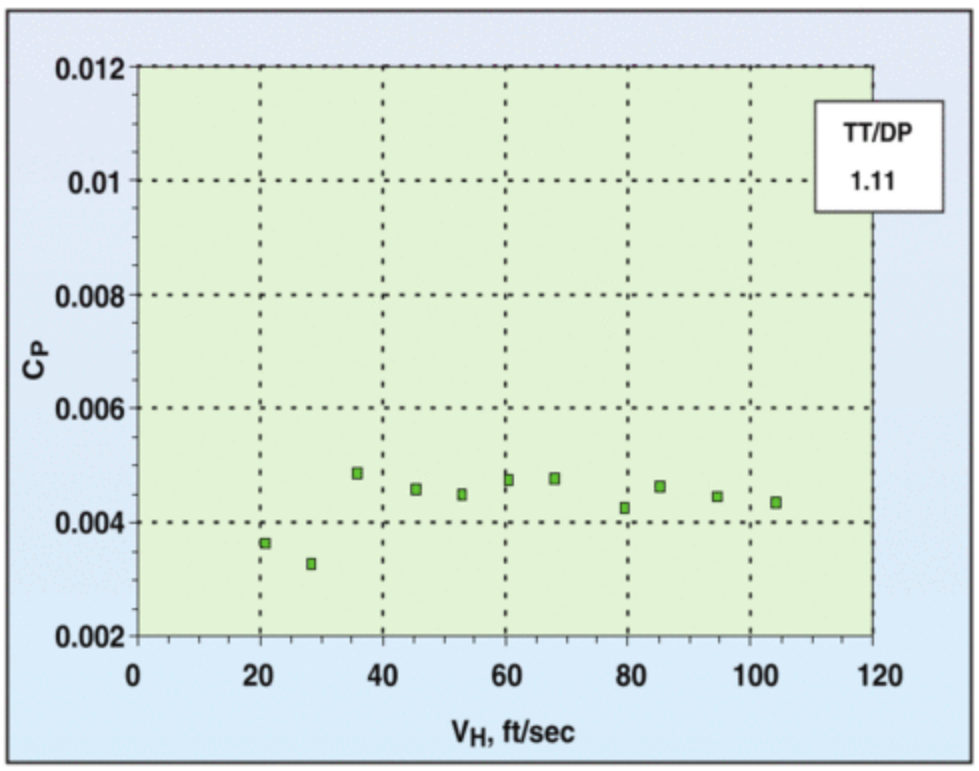

FIGURE 7. Biddulph dry tray pressure drop data

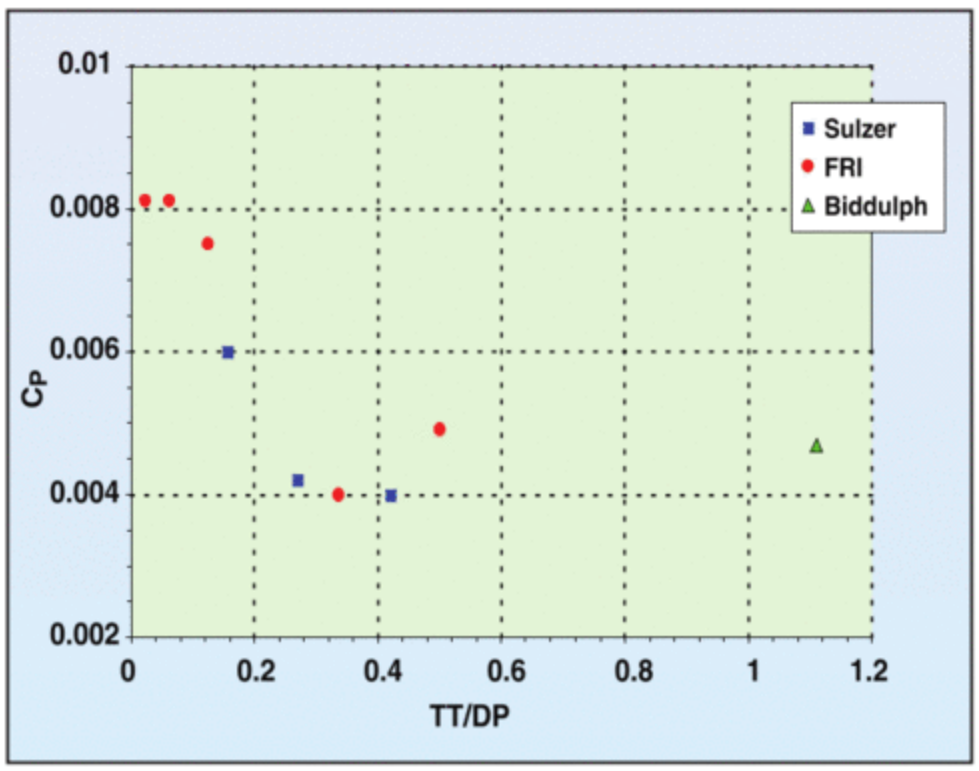

FIGURE 8. The relationship between the orifice coefficient and tray thickness

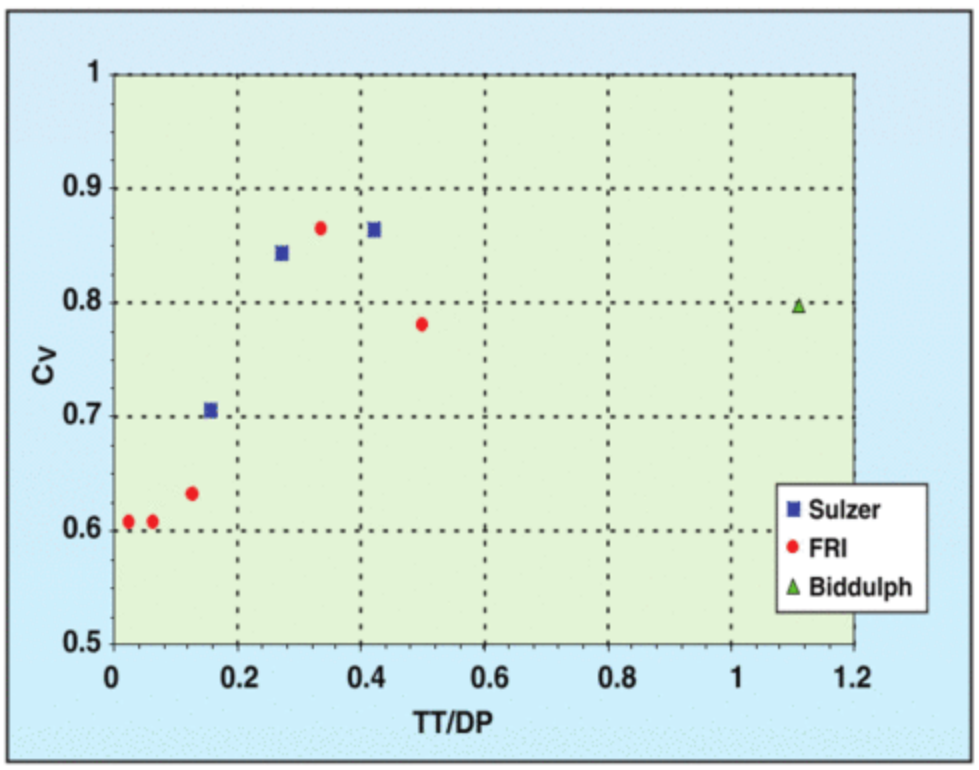

FIGURE 9. The data of Figure 8 after converting C_P into C_V

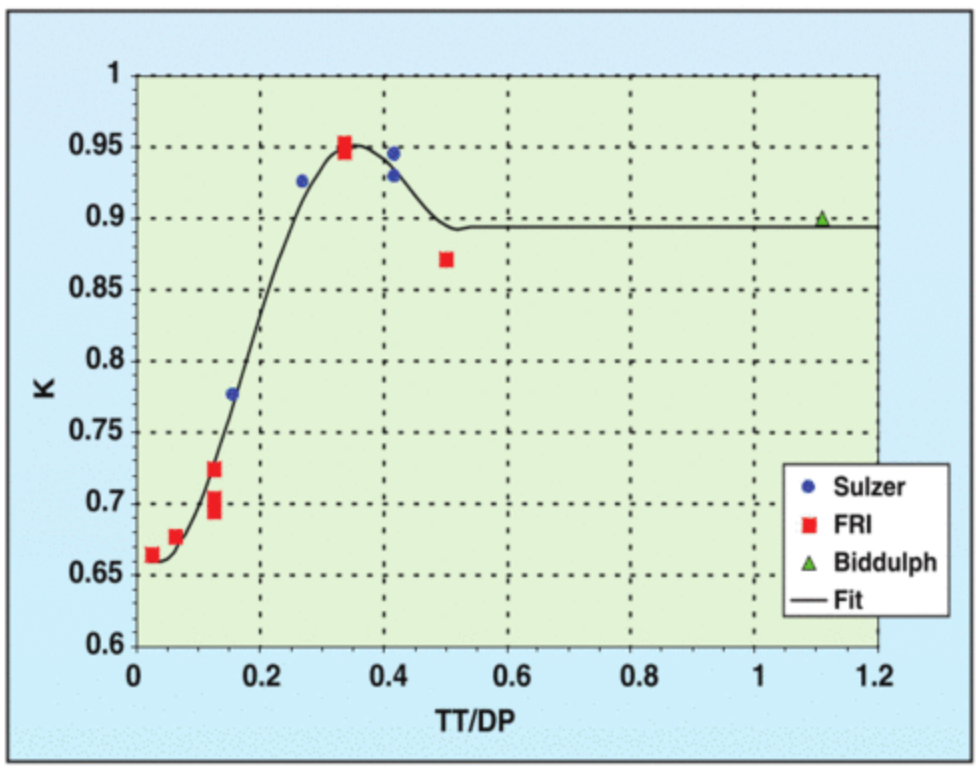

FIGURE 10. The best fit of the data to the *K* equation of Kolodzie and Van Winkle

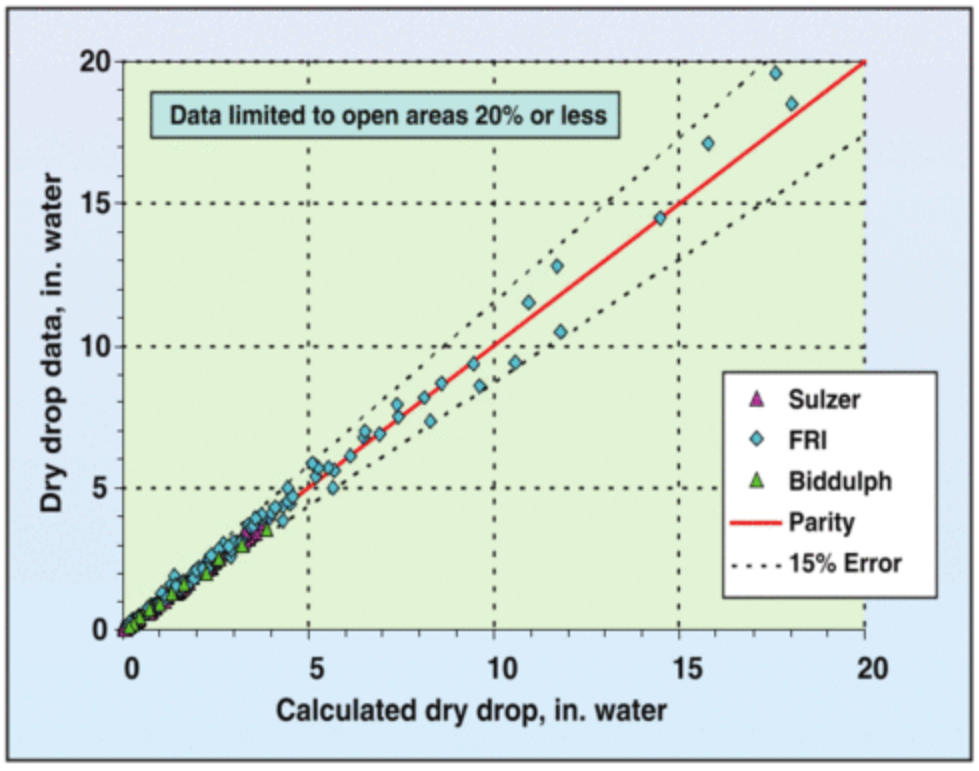

FIGURE 11. The improved Kolodzie and Van Winkle correlation presented in this article

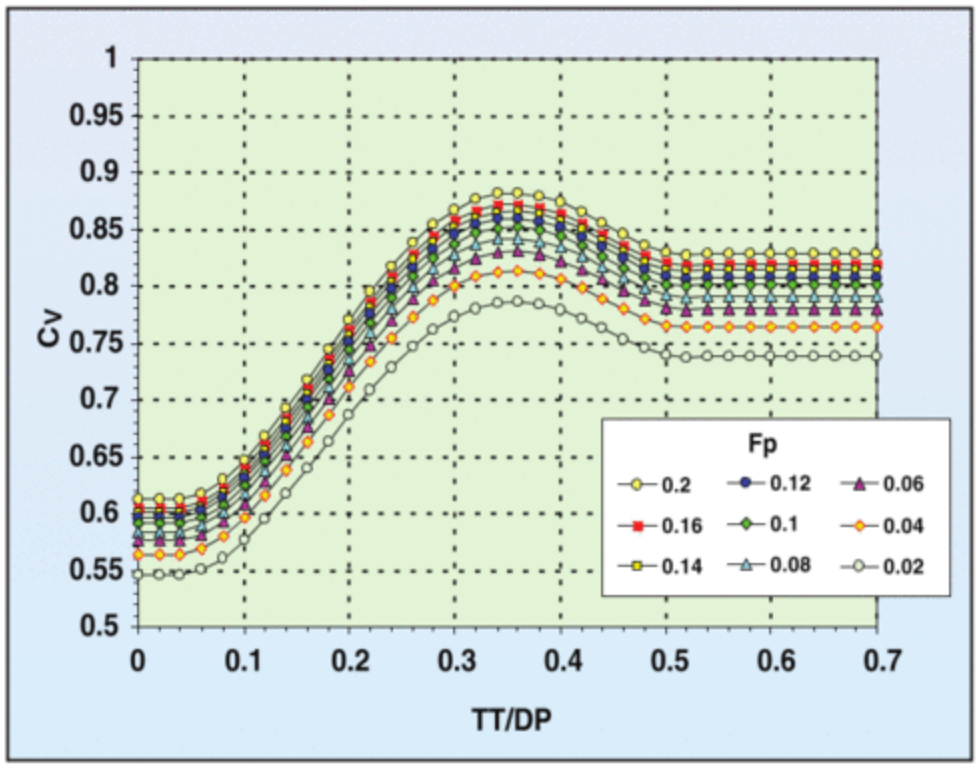

FIGURE 12. Final results from the improved correlation

bination of open area, tray thicknesses and hole diameters.

Kolodzie and Van Winkle used a term K to represent the effect of open area, namely hole diameter over hole pitch. Pitch is the distance between adjacent hole centers in a triangular pattern. This relationship is shown in Equation (4).

$$K = C_V \left(\frac{DP}{Pitch} \right)^{-0.10} \quad (4)$$

Improved method

In this new method, K was then plotted in Figure 10 and a curve was generated to best fit these data. The least squares curve fit is shown in Equation (5).

$$K = 0.6766 - 0.9417\left(\frac{TT}{DP}\right) + 14.6\left(\frac{TT}{DP}\right)^2 - 31.4\left(\frac{TT}{DP}\right)^3 + 30.85\left(\frac{TT}{DP}\right)^5 \quad (5)$$

Limitations and exceptions

There are, however, some limitations on this K equation. For any value of thickness/hole diameter less than 0.04, the value of K should equal 0.66. For any value of thickness/hole diameter greater than 0.52, the value of K should equal 0.894. In addition this equation is only good for hole Reynolds numbers greater than 4,000. For most applications this will be true. Keep in mind however that when the hole Reynolds number is low, the dry tray pressure drop is also very low and the accuracy of its value becomes insignificant in comparison to the total tray pressure drop.

Please note that in the improved K equation, when the thickness to hole diameter ratio exceeds values of 0.5 the equation is highly dependent on the single point from Biddulph [9]. Additional data from commercial sieve trays with tray thickness to hole diameter ratios above 0.5 are needed to refine this correlation further. Typically however, there are few commercial applications where the thickness to hole diameter ratio exceeds 0.5. The closest application would be where ¼ in. holes are placed on 10 gage (0.1345-in. thick) tray decks, which is rare. Therefore, this equation can be used with confidence in most commercial sieve tray applications.

Figure 11 was generated by applying the improved K equation to the above mentioned data, but limiting those data to open areas that are 20% of the active area or less. This figure clearly shows that the improved correlation is superior to the original Kolodzie and Van Winkle curve shown in Figure 4.

The standard deviation of the data here is 13.1%. This has been cut in half from the original correlation. Finally, the orifice coefficient C_V is generated for the most commonly applied tray thicknesses, hole diameters and fraction open area (F_P) and shown in Figure 12. ■

Edited by Gerald Ondrey

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Author

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Feature Report

Beyond Flowmeter Selection:
Consider Some of the Most Overlooked Criteria

The whole-product-lifecycle approach presented here encompasses more than basic selection

Jerry Spindler, Endress + Hauser, Inc.

Typical discussions of flowmeter selection address specifications, technologies, accuracies and performance, but there are many other steps that are not normally considered. This article focuses on these often overlooked criteria, which inevitably have far-reaching and costly implications over the life of the flow-measurement instrument chosen.

In the current economic environment, every aspect of a flowmeter that impacts an organization's bottom line must be given consideration, even if it does not appear to affect the original purchase price. There are several less-than-obvious issues to review with any supplier you are doing business with that have cost-saving implications. Failing to pay attention to these factors early in the discussion could lead to greater costs in the long run. It pays to take the time up front to ensure you have made the proper selection.

The selection process proposed here involves a whole-product-lifecycle approach to flowmeters that takes into account several steps from engineering through many years of operation. This article takes a "business-minded" approach, in that the full economic impact of the instrument's life is considered.

Each step of the instrumentation-selection process can be supported with modern tools that are designed to improve processes and lower the total cost of ownership. This is real game-changing technology that many users are not aware of, as such tools are outside the obvious realm of the flowmeter itself. The selection process is not as much about picking a certain type of meter for a given application based on how that certain flowmeter works, as it is about a bigger picture. Considering all aspects of this full approach has a significant longterm impact on operational efficiency and related budgets.

Proper flow technology selection

While choosing the proper flow instrument for an application is a very important step, it is also shortsighted to believe that the selection process is done when the instrument is chosen (Figure 1). Rather than discussing this topic in detail, it can simply be said that the best recommendation is to utilize one of the several existing programs now available to help eliminate much of the guesswork (For more on flow technology, see Evaluating Industrial Flowmeters, *CE*, April 2007, pp. 54–59).

New technology. Software tools for instrumentation selection can either run on a computer desktop or be accessed via the Web. These recently perfected tools take advantage of the experience gained over many years of successful implementation of different measurement techniques. It is best to employ a tool that takes a vast array of available instrumentation into account to ensure that as many options as possible are considered and compared. In addition, the latest Web-application interface developments enable these tools to integrate directly with existing computer-aided engineering (CAE) and design engineering packages to improve the documentation and recordkeeping involved in the design phase of an entire process facility. The quality of information and the improved efficiency of this process can have a dramatic impact on the completion cycle while reducing associated errors.

Cost implication. Most of these tools are available from a number of sources for use at no charge, so there is little risk in giving one a try. The impact of selecting the wrong technology can be costly, due not only to the money wasted on the improper meter, but the re-engineering, lost production, and rework from removal and replacement that could have been avoided with proper selection.

FIGURE 1. Choosing the best flowmeter for the application is important, but it is only the first step in proper selection

Sizing tools

Beyond selecting the correct technology, it is also critical that a correctly sized meter is installed in order to get the most from an investment. The best measurement technology cannot overcome poor installation. A high percentage of early troubleshooting problems is the result of issues that were not taken into account before the purchase. Discovering a problem after it is too late compounds the problem and may result in the need for a complete replacement, which may have been prevented if care had been taken at the beginning. Calculations involving pump rates, flow velocities, pipe sizes, pressure drops, bends, obstructions and so on, can get very involved and time consuming, but help is available.

New technology. Accurate calculations and outcome predictions involving all aspects of an installation can

FIGURE 2. New procurement tools allow integration with a supplier's order-entry system, or even live access to the manufacturer's configuration system. These tools allow users to view a complete comparison of flowmeter types and sizes, offering a full array of available models and options. From left to right, vortex, electromagnetic, thermal mass and Coriolis flowmeters are shown

be performed using tools that determine performance based on inputted conditions. Many different "what-if" scenarios can be executed to see how they impact results, and these models can even be used to help make piping design decisions very early in the process development.

Cost implication. By performing a sufficient amount of analysis and installing the correct size instrument from the beginning, the time wasted later reviewing the application and implementing fixes can be eliminated. Fewer surprises will occur if time is invested initially using readily available tools designed to correctly size meters. On the other hand, if fixes are not made and an improperly sized meter is left in the process, quality and performance will suffer, adding up to losses over the life of the device.

Procurement tools

Because standard purchasing processes have been based on manual paperwork in the past, the procurement step is often overlooked. In the last ten years, however, there have been major advancements in procurement systems, including emerging methods that cut down the hours required to place orders. This has been driven by the need to reduce internal costs for purchasing, cut down on the amount of paper generated, and collaborate with innovative vendors that have the e-business capabilities to help buyers realize areas for cost reductions.

New technology. Advanced platforms now extend what was once only available on a powerful enterprise resource planning (ERP) system to a local CD-ROM tool. Such platforms can integrate fully with a supplier's order-entry system. In some cases, live access via secure account login to the manufacturer's actual configuration system can be used to build a complete model structure (Figure 2). With a user account, once the flowmeter selection and sizing have been completed, the net prices can even be seen immediately, and various models or options can be compared. A group of suppliers have been working with standards committees to make ISA Specification Sheets, and NE100 (ProList) documents available with product attributes in .xml format to streamline the process of generating bid requests on major projects. This is not just online shopping; it is an integrated process for simplifying the entire purchasing cycle, eliminating errors, and taking advantage of multi-million dollar e-Procurement investments already made by many purchasing departments.

Cost implication. Time is money, and in this case, the money savings can be significant, considering the hours consumed in requesting quotes from vendors, gathering bids, accurately documenting the devices being considered, comparing various choices and conveying all of this to buyers in order to generate the purchase orders.

Calibration in accredited labs

Since a flowmeter is purchased simply to provide accurate measurement data, how good is that investment if the measurement accuracy is questionable? A device should have its calibration performed on a production flow rig that is accredited by a third-party agency (the American Association of Laboratory Accreditation) and certified to be NIST traceable.

New technology. The ISO 17025 standard allows manufacturers to received accreditation based on strict calibration procedures, using equipment of the highest performance. The results are factory capabilities that achieve repeatable calibrations with uncertainties that were not achievable even just a few years ago. These high-precision calibration rigs provide premium calibrations that exceed what was previously only available from national laboratories.

Cost implication. With these new levels of premium calibration now available from some flowmeter manufacturers, the precision of an instrument can be held to such tight ranges that the production processes can be further improved to even greater productivity. To the end user, this means tighter control, less waste and improved product quality, which all translate directly to the bottom line.

Proper installation and startup

Even if the first four steps discussed thus far are followed carefully, it is all for nothing if the instrument is installed poorly. With today's sophisticated electronic transmitters, this goes well beyond the mechanical mounting in the pipe. Several critical parameters in the device programming must be set up properly to achieve the greatest measurement results. Users demand more capabilities and greater performance from their flowmeters, and while this is achievable, it causes the instrument design to become more complex. Therefore, greater care must be taken in performing the initial

programming to achieve the desired performance.

New technology. New tools are now offered in addition to basic meters that maximize the performance of those meters. Dedicated applications for installation on personal digital assistants (PDAs) are powerful tools for getting the most out of devices. The most recent of these handhelds are ruggedized for industrial environments and are even approved for explosion hazard areas. They utilize WiFi interfaces so that instrument enclosures are not compromised. Software applications are developed specifically for the devices being programmed, where parameters are unique to the make and model so that all values entered enable peak performance. With immediate feedback on operational performance, the instrument can essentially be tuned to the process in which it is installed. These same handhelds can be used again later when troubleshooting any problems encountered over the life of the instrument.

Cost implication. Having a single handheld device to communicate with multiple instruments (including but not limited to flowmeters) is very cost efficient, as only one programmer needs to be bought, supported and learned by technicians. Many instrumentation companies have joined forces to standardize on the newest Field Device Tool (FDT) platform so that users can take advantage of this concept. Suppliers offer unique DTMs (Device Type Managers) for each model, which enables users to get the most out of the device. Since new applications can be installed in the future, it provides a great return on the investment.

Maintenance, repair & operations

The maintenance, repair and operations (MRO) phase naturally comes well after the purchase is made. Selecting a meter with some limited features will often also limit the ability to implement some of these great performance capabilities. It pays to understand from the beginning how well the product is designed to take advantage of these powerful tools.

New technology. There is a host of available tools that will increase staff productivity and extend the life of installed meters. Some can be installed locally, and others are online, but just to be in a position to use some of these can be determined well before the flowmeter is selected and ordered. A brief list is shown with the associated benefits in Table 1 to provide a sample of the great offerings that exist, many of which were not available even just a few years ago. Though few companies would use every single one of these tools, employing several is the norm.

TABLE 1. MAINTENANCE, REPAIR AND OPERATION TOOLS

Tool	Benefit
Web-enabled asset management portal	24/7 immediate access to important asset information
Computerized calibration management software	Tools to transfer on-board meter data to PC package
Parts lists and drawings database	Ready access for users to speed maintenance
Repair concepts	Quick swap-out of boards, modules, program data chips
Product status list	Quickly determines age, and parts and repair availability
Order code translator	Helps to quickly determine replacements for obsolete meters
Predictive maintenance	Avoid unexpected downtime
Condition monitoring	Realtime reporting on meter health to signal problems
Meter data Integration with existing CMMS packages (for example, Maximo, Datastream and so on)	Maximize investment already made with minimal effort
Ethernet & wireless communications	Transfer information into plant asset management system
Digital communications (for example, Foundation Fieldbus, HART and so on)	Protocols compatible with existing network
Web applications and data hosting for site monitoring and inventory control	Supply chain management benefits

Local service centers with A2LA accreditation provide quick turnaround and perform onsite flow calibrations with mobile, traceable rigs that meet ISO 17025 standards. This includes the required record keeping and certificates documented to meet the quality standards of a company's maintenance-management procedures. If a meter is selected that cannot work with any of these calibration rigs, the benefits can never be realized, so it is best to be aware of their compatibility ahead of time.

Cost implication. It cannot be overemphasized that a chosen flowmeter may or may not have the design features needed to enable the implementation of MRO tools. The operational phase can incur up to ten times or more the initial purchase cost of the meter. Therefore, it makes sense to consider any of these capabilities that would be important to the operation over the life of the instrument before deciding which unit to install. Otherwise, the full cost savings benefit that many of these new tools offer cannot be achieved. Employing one or several of these tools can have an impact on the operation of the process over the life of the flowmeter in terms of manpower, efficiency and overall productivity.

Training and technical support

All of the newest technology and product design improvements offer users unprecedented performance, but to take advantage of this technology, full understanding and the ability to implement it are required. Never before has training been more important, so selecting the right flowmeter also means selecting the organization that will help the user get the most from the purchase.

New technology. New methods of learning and education are now employed in the process control industry. Not only are traditional classroom courses still being conducted, and in more convenient locations with hands-on sessions, but online sessions in the form of live Webinars and eLearning portals with recorded training modules are also being offered. This allows users to easily receive necessary training without having to leave the office or take time away from normal work hours.

Beyond learning sessions, when emergencies arise and answers are much more time critical, a team of

factory-trained technicians, either onsite or by phone support, are extremely important. The latest phone systems and customer-support software enable vendors to offer higher quality support that exceeds what was previously possible. These support systems engage the user with tools that accelerate the problem-resolution process and help owners get the most from their instrumentation.

Cost implication. Learning at a flexible pace and schedule allows users to obtain training information easily. With no travel expenses or time away from work, employers can allow workers to improve their skills at minimal expense. Working with a supplier that makes use of efficient communication methods helps users get the immediate answers needed to help keep operational costs down.

In emergency situations, a quick response team is invaluable. By getting answers needed in a timely manner, downtime is minimized, production upsets are reduced and output (and thus revenue) is maximized. The result is that, ultimately, the flowmeter selected has provided its greatest possible value — a high return on its investment.

This multi-step process should be of interest not only to engineers, but also to purchasing groups, maintenance technicians, operators, quality departments, plant managers and even the associated financial group. Such groups may have influence on flowmeter selection that involve a number of nontraditional elements that buyers may overlook. With this in mind, it is recommended to use a team approach to ensure that the vendor selected will meet the expectations of the entire organization.

Economics and operational performance issues are hot topics today given the current business condition, leading users to look for ways to cut costs. The critical information discussed here, upon which to base flowmeter selection, is highly valuable. Considering all of these factors will, over time, prove that selection should not be based only on the initial price but on every related aspect of spending that stems from the operation of that flowmeter. By going beyond the first couple of steps normally taken and considering additional aspects of price versus performance, significant economic savings can be achieved in the long run. ■

Edited by Kate Torzewski

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Avoiding Static Sparks In Hazardous Atmospheres

Relatively simple steps can be taken to mitigate risks associated with static electricity in process plants

Graham Tyers, Newson Gale Inc.

FIGURE 1. Many self-testing grounding clamps also monitor cable condition back to the designed ground point, and will alert the operator if the cable has worked itself loose or is broken

We are all familiar with the effects of static electricity in everyday life — the sharp spark we experience as we approach a metal file cabinet or the crackle we feel as we remove a garment made of synthetic material. While these effects are largely harmless, in the chemical process industries (CPI), whenever flammable or combustible atmospheres are present, uncontrolled discharges of static electricity can be potentially disastrous.

The National Fire Protection Assn. (NFPA; Quincy, Mass.; www.nfpa.org) tracks the causes of all industrial fires and explosions reported to U.S. fire departments. Roughly 280 incidents/year in the U.S. are attributed to static electricity, and these result in significant damage to property, lost production, injuries and even fatalities. According to the U.K. Institute of Chemical Engineers, roughly 350 incidents per year are caused by static electricity. And this figure is probably conservative, as more such incidents likely occur but go unreported, or do not have an electrostatic cause substantiated during the investigation.

Case in point

One major industrial fire at a tote-filling operation at a chemical distribution facility in Des Moines, Iowa, was investigated in 2008 by the U.S. Chemical Safety Board (CSB; Washington, D.C.; csb.gov), and the cause was determined to be static electricity. (the full report is available at csb.gov). CSB concluded that a combination of technical and procedural factors led to an uncontrolled static discharge, which created a fire that spread rapidly to a wood-framed warehouse, igniting a large volume of flammable and combustible liquids. One employee and one firefighter were injured. The main warehouse structure was destroyed, the operator's business was significantly interrupted, and surrounding businesses were evacuated.

Best practices

Anyone responsible for, or working in, potentially explosive atmospheres (Class I, II or III) is aware of the fact that all potential sources of ignition, including naked flames, hot surfaces and electrical sparking must be eliminated. Today, a variety of safety codes and guidelines (discussed below) specify safe working practices in hazardous areas, and provide specific guidance on how to control static electricity.

The risk of static electricity is ever-present, as it is generated continuously, whenever surfaces come into contact and then separate. Examples include liquids flowing through pipelines or filling into drums and tanks, powder dropping down a chute, and even a person walking across an insulating floor.

The extent of charge generation in industrial processes is usually very low, typically no greater than 1×10^{-4} Amp. However, these generated charges become a problem in hazardous areas when allowed to accumulate on objects that are not at ground (earth) potential. Unfortunately, many of today's paints, coatings, gaskets, seals and other non-conductive materials are sufficiently insulating — so they actually prevent the proper dissipation of static charge.

Without proper engineering and worker training, charges can quickly build up to a very high potential, with voltages in excess of 30 kV not being uncommon. Depending on the capacitance of the object, this may result in significant levels of energy being available for discharge — well above the minimum ignition energy (MIE) of the surrounding flammable atmosphere. Typical MIE values (Table 1) vary according to whether the flammable atmosphere comprises vapor, dust or gas, but many commonly used solvents and other flammable chemicals have MIEs that are relatively low — on the order of 1 mJ or less. If the isolated conductor then comes into proximity with another object at a lower potential, much of this energy could be released in the form of an incendive spark.

Of course, in order for there to be static ignition of the flammable atmosphere, there would need to also be a suitable concentration of fuel (vapor, dust or gas) in air, but for the purposes of safe plant design, the very fact that there is an identified flammable atmosphere should suggest that this is possible or likely.

Despite these potential hazards, the danger associated with static electricity can be effectively mitigated by following national and industry codes of practice, technical standards, and working practices — such as NFPA 77 (Recommended Practice on Static Electricity), and NFPA 30 (Flammable and Combustible Liquids Code) — that specify proper grounding and bonding techniques. Such techniques work on the assumption that if a) conductive or static-dissipative plant, equipment and materials are used, and b) these materials are properly bonded and grounded, it will be impossible for

TABLE 1. TYPICAL MIE VALUES

Material (gas/vapor or powder/dust)	Minimum Ignition Energy (MIE), mJ
Carbon disulfide	0.009
Methanol	0.14
Xylene	0.20
Toluene	0.24
Propane	0.25
Ethyl acetate	0.46
Zirconium	5.00
Epoxy resin	9.00
Aluminum	10.00
Sugar	30.00
Wheat flour	50.00

Note 1: Minimum ignition energy (MIE) is defined as the minimum energy that can ignite a mixture of a specified flammable material with air or oxygen, measured by a standard procedure.

Note 2: MIE values are provided for guidance only — specific MIE data for any material should be verified. Source: NFPA, IchemE

FIGURE 2. FM/ATEX-approved grounding clamps, when properly bonded and grounded, can control static buildup

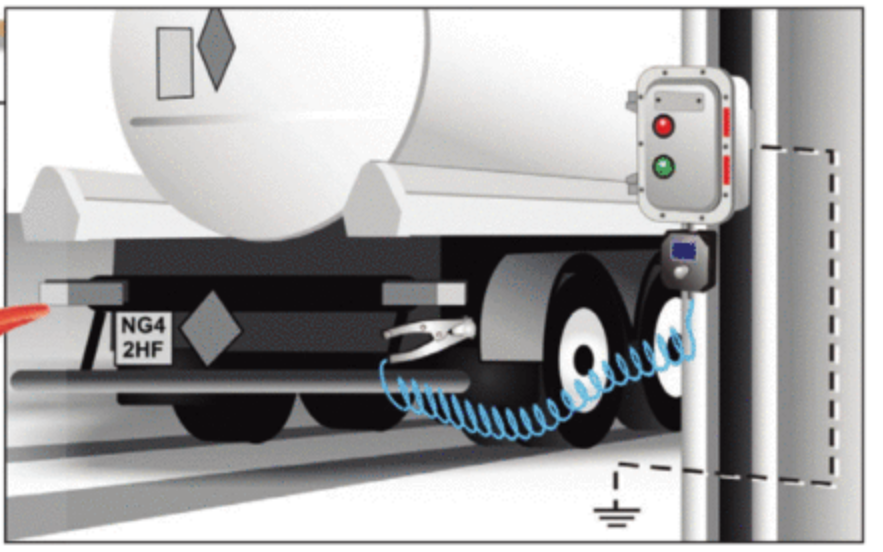

FIGURE 3. Static ground-verification and interlock systems are essential for certain critical applications — such as loading/unloading tanker trucks and rail cars, IBCs, fluid bed dryers, mixers, transfer equipment and other process equipment that have a high explosion potential, applications with a high likelihood of static charge accumulation in a very-low-MIE flammable atmosphere, and situations in which low-conductivity liquids or highly resistive powders are being handled

dangerous levels of static electricity to accumulate and result in an uncontrolled discharge.

NFPA 77 and NFPA 30 are extremely useful, in that they provide practical examples of common operations, and detail effective ways to eliminate, control or mitigate the problem. Where today's recommendations tend to converge is in the recommendation to always use conductive or static dissipative materials, and to ensure effective bonding and grounding. In this context, the term "conductive" would apply to metal materials, such as stainless or carbon steel, aluminum and others, and "static-dissipative" may indicate rubber or plastics that have been formulated with some added semi-conductive additives.

"Bonding" means linking these objects together by means of a suitably strong conductor (wire), and "grounding" refers to a true "ground/earth" connection that is applied to one or more of the bonded objects. When one or both of these techniques is applied, and while a low resistance connection between the objects and ground is maintained, operators are able to prevent dangerous levels of static charge from accumulating.

Hidden dangers

In any type of flammable atmosphere there may be hidden dangers lurking in the form of so-called isolated conductors. These are conductive objects that are either inherently or accidentally insulated from earth. The insulation effectively keeps any static electricity buildup from safely discharging, thereby resulting in accumulation of charge on the object.

Isolated conductors may arise from metal flanges, fittings or valves in pipework systems; portable drums, containers or vessels; tanker trucks, rail cars and intermediate bulk containers (IBCs); and even people. During day-to-day operations at industrial facilities, isolated conductors are probably the most likely source of static ignition incidents.

Fortunately, the problems associated with isolated conductors can be remedied by effective grounding and bonding. In the case of fixed installations such as pipe work, storage tanks and so forth, this is relatively simple to implement. However, these preventive measures are more difficult to implement with mobile/portable objects, such as drums, IBCs and tankers. In these instances, purpose-designed temporary grounding and bonding devices must be used, with strict procedures to ensure that they are always in place prior to starting the process.

For instance, specific types of clamps and devices for grounding and bonding portable or mobile plant equipment, drums and containers are recommended in NFPA 77, and such grounding clamps and devices generally should employ sharp contact points. These contact points should be made of a wear-resistant material, have positive spring pressure, and be universally adaptable to a wide range of plant objects.

In some cases, these grounding clamps and devices may have additional third-party notified-body testing such as Factory Mutual (FM) or the European ATEX Directive (Figure 2). If these units are properly specified and correctly used, in most cases the user can be reasonably sure of effective static control.

In all situations it is also important to periodically test the control measures used, to check the condition of the clamp, contact and cable, and to verify the all-important connection back to the grounding point (bus bar). Instruments like Ohm testers or multi-meters are useful for performing such verifications, but, of course, these will need to be approved as intrinsically safe instruments if you are working "live" in a hazardous area.

According to the recommendations in the latest edition of NFPA 77, the maximum resistance to ground in conductive (metal) bonding systems should be tested to 10 Ohms or less. With all-metal systems and tight connections, it should be easy to achieve this level of resistance to ground.

While higher resistance levels may be theoretically low enough for static charge removal from conductive objects, resistance levels higher than two-digit figures in all-metal systems usually indicate problems, such as corrosion, loose or broken connections or a buildup of coating or insulating materials somewhere in the system. Any such readings should be immediately investigated and rectified.

The presence of semi-conductive or so-called static-dissipative materials may also exhibit higher resistance levels, owing to their varying characteristics (which in some cases may be as high as 1×10^8 Ohms).

Additional considerations

Even when the appropriate static safety equipment has been specified, there are some further concerns that must be addressed by all those responsible for operations within hazardous areas. In operational terms, attaching

a grounding clamp to a plant object is always a "physical" action. Thus, there is always a risk that even if operators diligently carries out their duties per the company-recommended safety procedures, no one can ever be sure that the clamp has made good enough contact with the object. For instance, the clamp has to make a low enough resistance contact with the conductive object to enable any static that is generated to be safely dissipated to ground before it can accumulate to dangerous levels.

The fact remains that many conductive objects that are capable of accumulating high static charges also have insulating layers on their surfaces, which may prevent this low resistance contact. Examples include paints and coatings on drums, tank vehicles and other mobile plant equipment, or product buildup caused by normal working conditions (for instance where insulating liquids, powders and other materials are part of the operation or process). As a result, many grounding and bonding clamps show very high resistance readings when clamped to conductive objects with insulating surfaces. Worse still, if the company tries to cut costs by using standard welding clamps or lightweight alligator clips for static grounding (instead of purpose-designed clamps), these devices have an even higher failure rate with potentially grave consequences.

During an internal audit (using an approved Ohm meter) of ground connections in its flammable-liquids area, one major chemical company actually determined that only 85% of the devices had acceptable low resistance levels, or proper ground. Therefore, 15% of their ground connections failed to meet the proper levels, and as a result were at risk to the process area and operating personnel.

To solve this problem, NFPA 77 suggests that intrinsically safe, self-checking grounding and bonding clamps be used. From an operator's point of view, these devices are employed in exactly the same way as conventional grounding clamps. Where they differ is in the way that they reassure the operator that the clamp has not only been physically attached, but is also performing it's intended function of safely dissipating any static electricity that is generated.

These specialized clamps employ intrinsically safe electronic monitoring circuits that are powered from a low-energy battery. The circuit is only completed when the clamp achieves a low resistance contact onto the object to be grounded, and the operator receives visual confirmation of this via a light/indicator (usually a flashing LED). The self-testing grounding clamp also monitors cable condition back to the designed ground point, and will also fail to register a permissive signal if the cable has worked itself loose or is broken (Figure 1). In order to be safely used in hazardous locations, these clamps should be approved as intrinsically safe devices and carry the appropriate Hazardous Area Certification, for instance, from Factory Mutual (FM), Underwriters' Laboratories (UL), or the Canadian Standards Authority (CSA).

To move to an even higher level of security, static ground verification systems are available that not only give visual verification to the operator, but that provide interlock switching contacts that may be linked to process pumps, valves, alarm/shutdown/control systems, as well. This means that the process cannot be started until the conductive object has been safely grounded, and, if at any time during the operation the condition changes (due to a clamp falling off or wire breaking for instance), the system automatically switches to the "non-permissive" state and shuts down the process.

Systems employing interlocks can also prevent accidents that would otherwise result when operators approach plant objects that are already carrying accumulated static charges. In this case, the process cannot be initiated until proper grounding is established, thereby ensuring that any generated static electricity is safely dissipated to ground. These systems are generally fed from a "line feed" 110/120-V a.c. power supply, and employ approved intrinsically safe barriers to limit the monitoring circuit down to safe levels. They must also have proper hazardous location and safety certification.

Static ground-verification and interlock systems are typically used in critical/ultra-safety applications, such as loading/unloading tanker trucks and rail cars, IBCs, fluid bed dryers, mixers, transfer equipment and special process machines that have a high explosion potential. They are also useful wherever there is a high likelihood of static charge accumulation in very low MIE flammable atmospheres, or where low-conductivity liquids or highly resistive powders are being handled (Figure 3).

Static ground-verification clamps and interlock systems also tend to have an important beneficial effect on the operators using them. Since they build an additional check into the operation, their use helps to reinforce the static safety procedures of the company — in short, the operator is more likely to observe the correct procedures, as he or she is kept aware of the need to properly control static electricity on a daily basis.

One final element of the static safety audit is the "static accumulating characteristics" of people working in the hazardous area. If the human body is insulated from natural contact with the ground, either by non-conducting shoes, insulating floors or both, then static charge can start to accumulate as the person walks along the floor. After just a few steps, a fairly high po-

(Continues on p. 49)

RECOMMENDED RESOURCES

Useful guidance on minimizing fire and explosion hazards, and managing static electricity in process plants, can be found at these websites.

NFPA77, NFPA30	www.nfpa.org
Chemical Safety Board	www.csb.gov
IchemE	www.icheme.org
OSHA	www.osha.gov

FIGURE 4. If static-dissipative footwear is specified, it can also be tested for ongoing effectiveness using test stations that test the ground leakage from the individual, via the footwear, to ground. These devices help prevent incorrect shoes from being used in static-sensitive environments

Vibratory Feeders And Conveyors: Useful Selection Tips

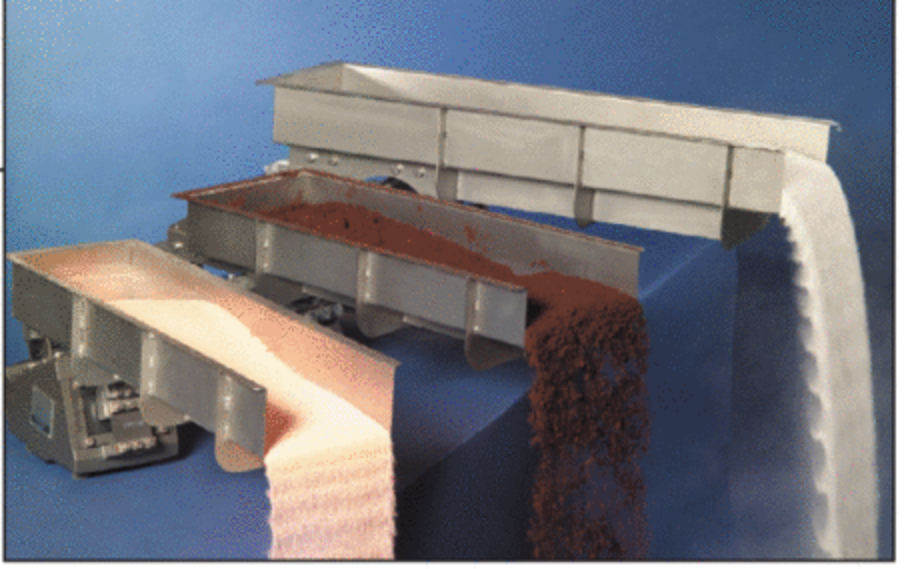

FIGURE 1. Vibratory feeders are particularly well-suited for fragile or friable materials, and hard-to-convey powders

Ongoing advances in technology have helped these systems overcome key shortcomings of earlier designs

Rob Yandrick, Eriez Vibratory Products

The need to move, convey and feed materials exists in virtually all segments of the chemical process industries (CPI). Vibratory feeding and conveying equipment (Figure 1) has been used in the CPI for several decades to efficiently move both fine and coarse materials that tend to pack, cake, smear, break apart or fluidize. For instance, in many CPI facilities, vibratory feeders are used to meter precise amounts of product from hoppers, and to gently deposit them on a conveyor or a packaging machine. Vibratory equipment is also used for many types of screening applications, including size separating, scalping or removing oversized product and conglomerates, and for dust or fines removal, as well.

Key components

In most process applications, materials must be conveyed repeatedly from their point of arrival throughout successive operations within the plant. Feeders, which are often turned on and off repeatedly as needed, are typically placed throughout a plant to maintain and control the flow of product, as it moves into the next stage of the process.

Vibratory feeders throw the material up and forward, so that it drops to the surface at a point further down the tray, at a pre-determined *displacement* or *amplitude*. The number of times per minute that this repeats is the unit's *frequency.* A third variable is the *angle of deflection*, meaning how high the product is thrown compared to its horizontal movement.

Each vibratory feeder or conveyor is designed with a different amplitude, frequency and angle of deflection to move different materials at specific desired rates. The design is based on many factors, including the nature of the material being processed, the flowrate of the process, the nature of the environment, the need to start and stop (cycle) the process, the cost to operate the equipment and the likelihood of repairs.

Most of today's feeding and conveying systems are built to accommodate one of the following four applications:

- ***Standard-design vibratory feeders***: Ideal for denser materials, such as those greater than 100 mesh in size and heavier than 10 lb/ft^3, or for applications where significant material load may be applied to the feeder
- ***High-speed feeders***: Excellent choice for applications where fast travel speeds and frequent on/off cycling are needed. These are ideally suited for packaging
- ***High-stroke, low-frequency feeders and conveyors***: These are ideal for handling loose or powdery materials
- ***High-stroke mechanical conveyors***: Well-suited for high capacity applications where longer lengths or intermediate discharge gates are required

Vibratory feeders and conveyors have undergone numerous design changes and upgrades that today enhance their role in process applications. For instance, the latest equipment offers increased energy savings, more precise control over material flow, easier maintenance, a variety of options, better technical support, and, in some cases, faster delivery of product for your plant.

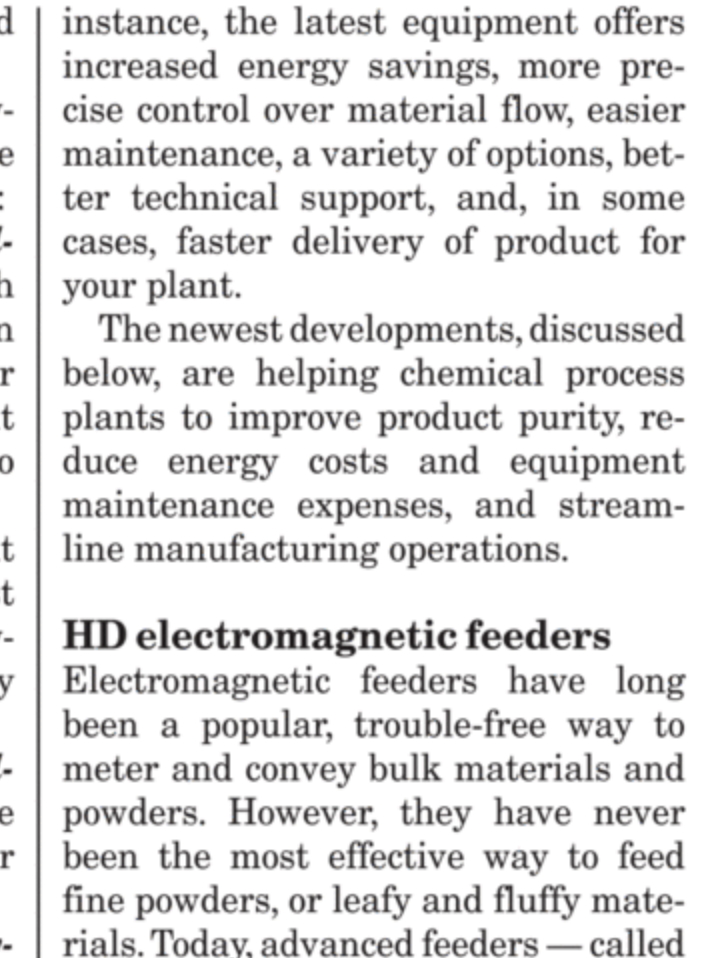

FIGURE 2. Today's advanced electromagnetic drives address many shortcomings of earlier designs

The newest developments, discussed below, are helping chemical process plants to improve product purity, reduce energy costs and equipment maintenance expenses, and streamline manufacturing operations.

HD electromagnetic feeders

Electromagnetic feeders have long been a popular, trouble-free way to meter and convey bulk materials and powders. However, they have never been the most effective way to feed fine powders, or leafy and fluffy materials. Today, advanced feeders — called high-deflection (HD) electromagnetic feeders — are helping to address this shortcoming (Figure 2).

Modern HD electromagnetic feeders offer feed rates of up to 80 ft/min (24 m/min).

Materials from –50 mesh to –400 mesh may tend to fluidize and flush

(which is to wash out of the feeder or conveyor tray) on traditional electromagnetic feeders. But after years of research, today's HD electromagnetic feeders offer relatively high deflection — up to 3/16-in. (4.8 mm) — with lower frequency (30 cycles per minute) to handle finer and loose products, such as long-stranded chopped fiberglass, talc or flour. Newer HD feeders also offer increased throughput for greater flexibility in packaging and other difficult applications.

Energy-saving drives

All vibratory equipment features a drive system with an a.c or d.c. power source, mounted either from above or below to produce a consistent vibratory force. Many newer feeder and conveyer systems use has an electromagnetic drive, which creates the same vibratory force with reduced power consumption.

Electromagnetic drives in both a.c. and d.c. mode use magnets to energize the vibratory motion. Each has its advantages, with a.c. units providing high precision with lower operating costs, and d.c. models typically being less expensive.

The a.c.-electromagnetic-drive systems typically consume up to 65% less energy compared to their d.c. counterparts. These units have no sliding or rotating parts to wear out, and require very little power to operate.

Conversely, d.c.-operated electromagnetic drives produce the same vibratory action as a.c. units, but are not as energy efficient. Today's d.c. drives use a less-efficient "attract and release" system where half of the sine wave is eliminated and the d.c.-pulsed power delivery is much less linear. The half-wave design feeders only energize the electromagnet drive with half the a.c. sine wave. Alternatively, an a.c.-operated drive using the full sine wave delivers power to the unit proportionately to the voltage increase.

Advanced mechanical drives

Mechanical drives (Figure 3) are still used in a variety of feeding and conveying applications. In some cases they create the vibratory motion of the tray using a direct mechanical linkage (push rod). In others they use out-of-balance weights to initiate motion in the tray and then amplify the resulting vibration through a set of springs.

Among the newer mechanical drive units for conveyors are those that use strictly horizontal vibrating motion. Such a drive uses a set of weights powered by a motor that is alternately "in phase" and "out of phase," to create a slow motion in one direction and a fast motion in the opposite direction.

This action causes the tray to slide beneath the material. Such a device is particularly useful for handling fragile materials that may be damaged from the normal vibratory motion.

Limitless tray designs

Today, a nearly limitless array of feeder trays is available, in terms of configuration, shape, length and width. Feeder trays can be flat, curved, v-channel, tubular or custom-designed, depending upon the process application and material being conveyed (Figure 4).

Trays are typically fabricated from mild steel or stainless steel. The latter is often used in food and pharmaceutical applications, while the former is for general-purpose process operations. Trays can also be lined with abrasion-resistant steel, stainless, urethane, rubber and other coatings.

Trays can be designed for fast removal and cleanout to avoid cross contamination and minimize downtime. Many have quick-release clamps that allow the tray and cover to be removed without tools, easing overall maintenance requirements.

Over-deflection monitoring

State-of-the-art vibratory feeders offer a variety of monitoring devices that allow operators to keep close tabs on equipment operation and prevent any potential equipment damage. The over-deflection monitor is one such device.

This monitor detects changes in tray deflection resulting from material accumulation on the tray surface. As material accumulates, it adds weight to the tray, affecting performance and possibly damaging the feeder. The monitor can alert the operator or provide automatic shutdown so the tray can be cleaned to improve performance and reduce costly downtime.

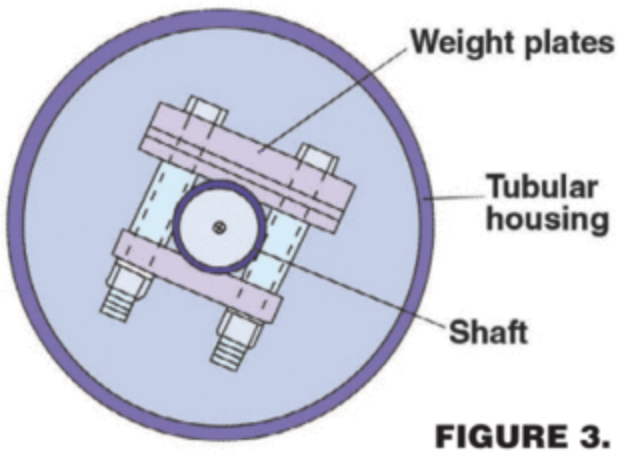

FIGURE 3. This mechanical drive mechanism generates the vibrating action of an electromechanical feeder or conveyor

The over-deflection monitor uses a vibration transducer mounted to the tray, and a comparator amplifier, which monitors changes in the tray deflection. The vibration transducer sends a constant signal to the comparator amplifier. If an upset occurs and the tray becomes overloaded, the amplifier trips a relay to shut down the feeder or set off an alarm.

Spring systems

Springs are an integral part of the feeding system process, because they amplify the vibration from the drive to the tray, causing the conveyed material to move. Just as today's trays come in a variety of configurations, the springs on today's vibratory feeders and conveyors also come in a variety of materials, sizes and configurations.

Fiberglass springs are the most popular for light- and medium-duty applications. For instance, small electromagnetic feeders, light- to medium-duty conveyors, and most high-precision vibratory equipment use fiberglass leaf springs as their primary spring action material.

Steel coil springs are commonly used on heavy-duty and high-temperature applications. These coils are effective in ambient temperatures up to 300°F.

Dense rubber springs are typically used on heavy-duty feeders and conveyors, to provide stability and motion control between the drive and tray. However, the use of rubber springs is limited to applications whose maximum temperature s 120°F.

Solid-state control units

The ability to adjust flowrates from tvibratory feeders continues to evolve, in parallel with other upgrades in feeders and conveyors. For instance, the latest solid-state control units operate feeders with improved preci-

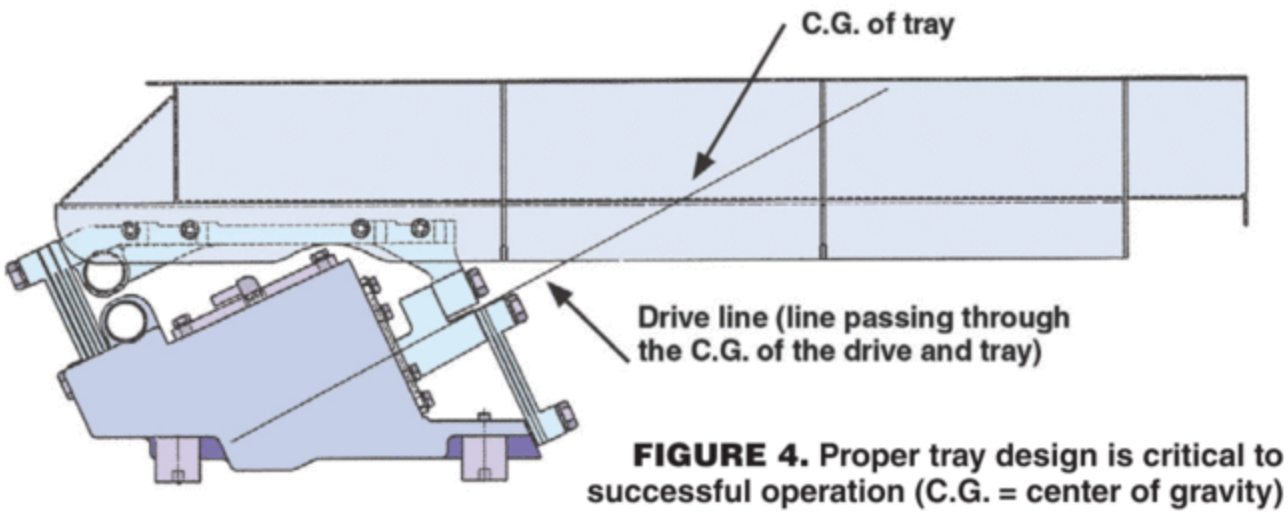

FIGURE 4. Proper tray design is critical to successful operation (C.G. = center of gravity)

sion, and can easily adjust the flow of material using a manually adjusted potentiometer, or automatically, through a user's analog signal from a programmable logic controller.

Feedrates can vary from 0 to 100%, thanks to the use of control potentiometers or digital keypads that allow users to precisely lock in control settings, and "smart" transducers mounted on the tray. These are wired to the controller, to provide constant feedback of the tray's amplitude.

The constant-feedrate system allows plant operators to set the feedrate at the beginning, and the control system automatically compensates for the changes in head load, material buildup on the tray or any voltage fluctuations during the production run.

Technical support

During system evaluation, material samples of various density and different equipment configurations should be tested with the original equipment manufacturer (OEM), to identify the optimum piece of vibratory and conveying equipment. Such pre-testing virtually eliminates the potential for installing an under- or oversized piece of equipment for the job at hand.

Vibratory solutions have long been a preferred means to meter and convey materials. Thanks to the ongoing advances in technology discussed here — coupled with the sanitary construction, ease of cleaning and ow maintenance — these systems are more reliable than ever for CPI operators, especially those handling fragile or hard-to-convey materials. ■

Edited by Suzanne Shelley

Author

Rob Yandrick is the product manager-Vibratory/Screening for Eriez (2200 Asbury Rd., Erie, PA 16506; Phone: 814 835-6000; Email: ryandrick@eriez.com). In that capacity, he oversees the Eriez Vibratory Product Line, provides technical support, develops OEM sales strategies, and pursues new product opportunities. Yandrick holds a B.S. in economics from the University of Pittsburgh, and an Associate's Degree in welding engineering from Westmoreland County Community College.

AVOIDING STATIC SPARKS IN HAZARDOUS ATMOSPHERES

(*Continued from p. 46*)

tential may develop (especially in dry, low-humidity atmospheres).

If the person now approaches a conductive material at either ground or a lower electrical potential, a spark may be promoted. It is generally thought that sparks from people can reach energies as high as 30 mJ — sufficient to ignite almost all flammable vapors and gases, and many sensitive combustible powder (dust) atmospheres.

In order to control this, it is necessary to "ground" the employees working in sensitive hazardous areas. This can take the form of ground wrist-straps for sedentary workers, or specialized static-dissipative (SD) safety shoes for personnel who need to move around to carry out their tasks. In the case of the latter, it is also necessary for the floor materials to be sufficiently conducting to allow a "ground leakage" path to safely dissipate any static charge as each foot contacts the ground.

In the U.S., SD footwear is manufactured according to ASTM F2413-05, which specifies maximum and minimum levels for ground leakage via the shoe. According to ASTM, it should be sufficiently low to allow static charges to be safely dissipated to ground, but sufficiently high to afford some protection against electric shock. If SD footwear is specified, it can be tested for ongoing effectiveness using test stations that test the ground leakage from the individual, via the footwear, to ground. These devices help prevent incorrect shoes from being used in static-sensitive environments (Figure 4).

In general, proper mitigation of static electricity risk in hazardous areas demands a holistic approach to plant, process and personnel safety. Any multi-part control program is only as good as the weakest link in the chain. As the speed and scale of modern manufacturing and distribution techniques increase, and the range of materials used and processed grows, this basic approach to safety will become even more important.

More detailed information on this subject may be found in industry safety guidelines, such as NFPA 77, and OSHA Regulations, Section 1910, which provide safety managers with practical guidance for specific situations. It is also important to remember that proper grounding and bonding may not be enough on their own to ensure completely safe operations. Depending on the materials involved it may sometimes be necessary to also employ other protection measures like static charge neutralization, inert gas blanketing (to remove the flammable atmosphere), and to look at process related ways to minimize charge generation and maximize charge dissipation rates.

Controlling static electricity in hazardous areas may be simple in theory, but in practice requires a thorough knowledge of processes and operations, sound engineering controls, properly specified safety equipment and properly trained operational staff. ■

Edited by Suzanne Shelley

Author

Graham Tyers is president of Newson Gale Inc. (www.newson-gale.com), a manufacturer of static control equipment for hazardous areas (460 Faraday Ave., Unit B, Suite 1, Jackson, NJ 08527). He has worked in the specialist field of electrostatic control and hazardous atmospheres for nearly 20 years. His industry background is in monitoring and control systems, and general electrical equipment for potentially explosive atmospheres. Tyers is a member of the NFPA, ESDA, and ISA. He regularly conducts training and presents to industry and safety groups on the subject of static electricity and hazardous areas. In addition to his technical subject background, he holds a Diploma in Business Management (Open University, United Kingdom). As part of the management team of Newson Gale in the U.K., Graham was awarded the Queens Award for Enterprise in 2005. He now heads up Newson Gale's North American Operations, based in New Jersey.

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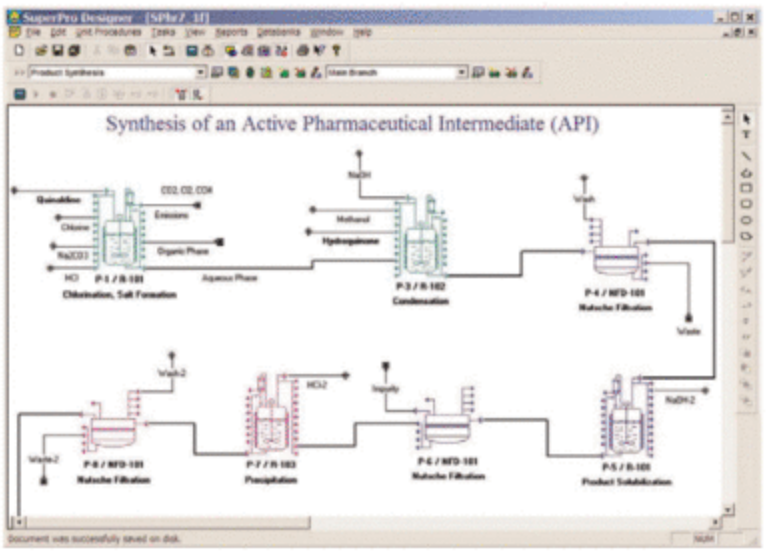

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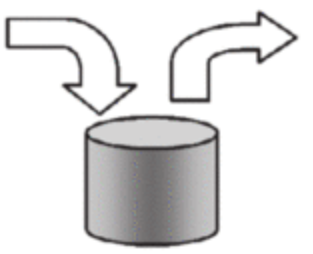

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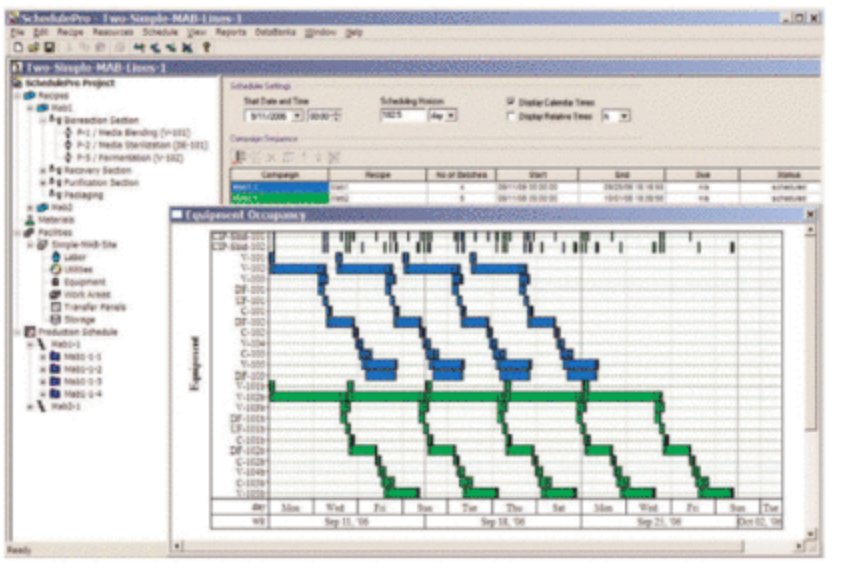

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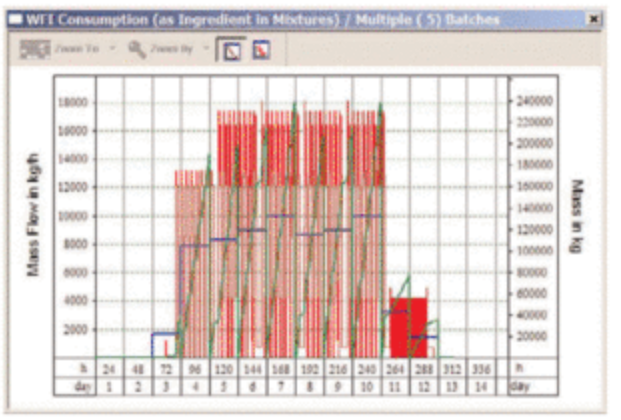

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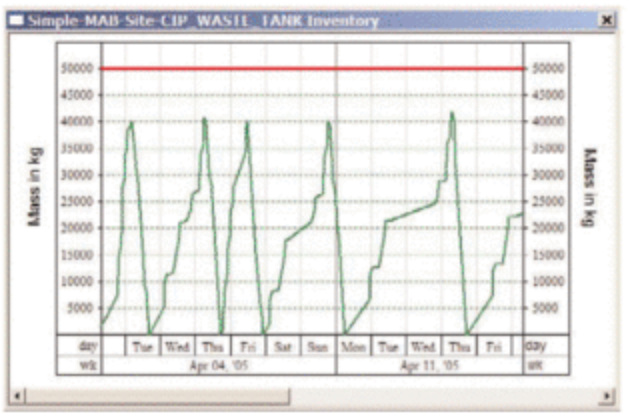

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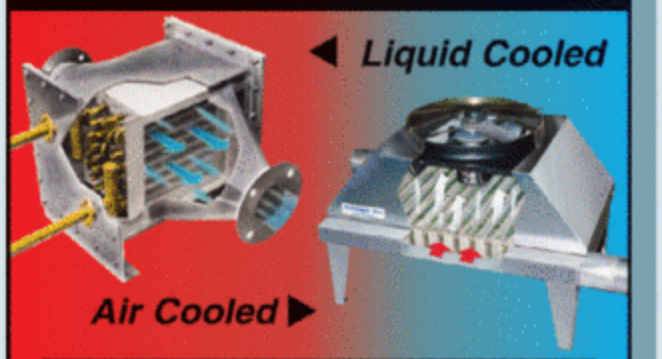

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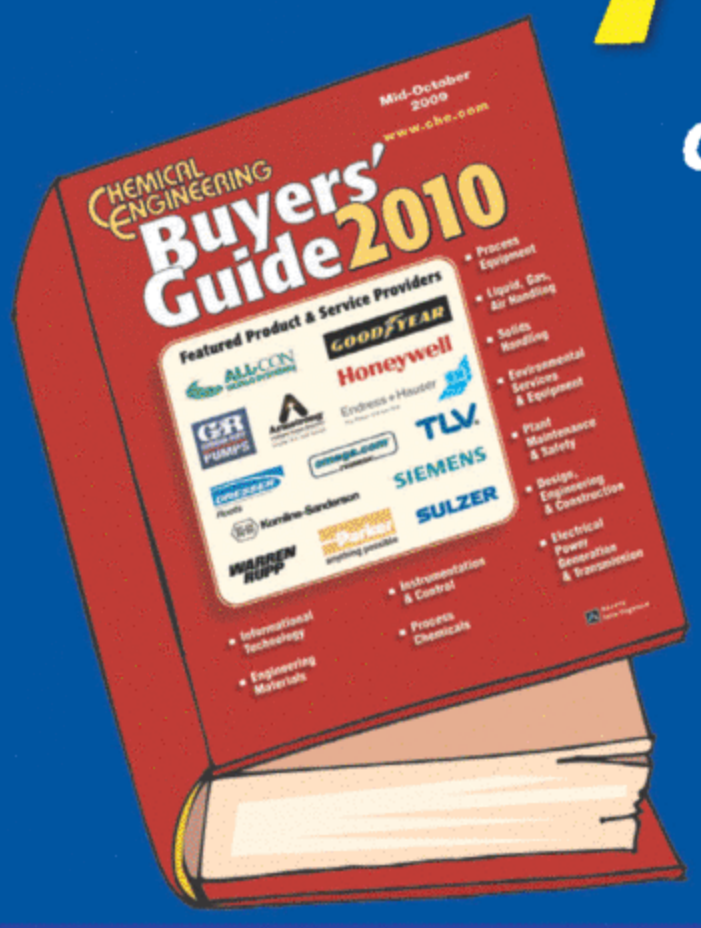

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Equipnet *781-821-3482* *adlinks.che.com/23015-249*	53
e-simulators *480-380-4738* *adlinks.che.com/23015-242*	52
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CHEMICAL ENGINEERING **New Product Information** June 2009

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(please answer all the questions)

YOUR INDUSTRY
01 Food & Beverages
02 Wood, Pulp & Paper
03 Inorganic Chemicals
04 Plastics, Synthetic Resins
05 Drugs & Cosmetics
06 Soaps & Detergents
07 Paints & Allied Products
08 Organic Chemicals
09 Agricultural Chemicals
10 Petroleum Refining, Coal Products
11 Rubber & Misc. Plastics
12 Stone, Clay, Glass, Ceramics
13 Metallurgical & Metal Products
14 Engineering, Design & Construction Firms
15 Engineering/Environmental Services
16 Equipment Manufacturer
17 Energy incl. Co-generation
18 Other_____

JOB FUNCTION
20 Corporate Management
21 Plant Operations incl. Maintenance
22 Engineering
23 Research & Development
24 Safety & Environmental
26 Other_____

EMPLOYEE SIZE
28 Less than 10 Employees
29 10 to 49 Employees
30 50 to 99 Employees
31 100 to 249 Employees
32 250 to 499 Employees
33 500 to 999 Employees
34 1,000 or more Employees

YOU RECOMMEND, SPECIFY, PURCHASE
(please circle all that apply)
40 Drying Equipment
41 Filtration/Separation Equipment
42 Heat Transfer/Energy Conservation Equipment
43 Instrumentation & Control Systems
44 Mixing, Blending Equipment
45 Motors, Motor Controls
46 Piping, Tubing, Fittings
47 Pollution Control Equipment & Systems
48 Pumps
49 Safety Equipment & Services
50 Size Reduction & Agglomeration Equipment
51 Solids Handling Equipment
52 Tanks, Vessels, Reactors
53 Valves
54 Engineering Computers/Software/Peripherals
55 Water Treatment Chemicals & Equipment
56 Hazardous Waste Management Systems
57 Chemicals & Raw Materials
58 Materials of Construction
59 Compressors

1	16	31	46	61	76	91	106	121	136	151	166	181	196	211	226	241	256	271	286	301	316	331	346	361	376	391	406	421	436	451	466	481	496	511	526	541	556	571	586
2	17	32	47	62	77	92	107	122	137	152	167	182	197	212	227	242	257	272	287	302	317	332	347	362	377	392	407	422	437	452	467	482	497	512	527	542	557	572	587
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213	228	243	258	273	288	303	318	333	348	363	378	393	408	423	438	453	468	483	498	513	528	543	558	573	588
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214	229	244	259	274	289	304	319	334	349	364	379	394	409	424	439	454	469	484	499	514	529	544	559	574	589
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215	230	245	260	275	290	305	320	335	350	365	380	395	410	425	440	455	470	485	500	515	530	545	560	575	590
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216	231	246	261	276	291	306	321	336	351	366	381	396	411	426	441	456	471	486	501	516	531	546	561	576	591
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217	232	247	262	277	292	307	322	337	352	367	382	397	412	427	442	457	472	487	502	517	532	547	562	577	592
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218	233	248	263	278	293	308	323	338	353	368	383	398	413	428	443	458	473	488	503	518	533	548	563	578	593
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219	234	249	264	279	294	309	324	339	354	369	384	399	414	429	444	459	474	489	504	519	534	549	564	579	594
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220	235	250	265	280	295	310	325	340	355	370	385	400	415	430	445	460	475	490	505	520	535	550	565	580	595
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221	236	251	266	281	296	311	326	341	356	371	386	401	416	431	446	461	476	491	506	521	536	551	566	581	596
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222	237	252	267	282	297	312	327	342	357	372	387	402	417	432	447	462	477	492	507	522	537	552	567	582	597
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223	238	253	268	283	298	313	328	343	358	373	388	403	418	433	448	463	478	493	508	523	538	553	568	583	598
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224	239	254	269	284	299	314	329	344	359	374	389	404	419	434	449	464	479	494	509	524	539	554	569	584	599
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345	360	375	390	405	420	435	450	465	480	495	510	525	540	555	570	585	600

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Economic Indicators

2009 2008

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CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957-59 = 100)	Mar.'09 Prelim.	Feb.'09 Final	Mar.'08 Final
***CE* Index**	522.6	532.3	549.2
Equipment	616.6	631.9	659.5
Heat exchangers & tanks	563.2	587.0	631.5
Process machinery	597.2	615.2	616.4
Pipe, valves & fittings	761.0	770.6	795.7
Process instruments	385.2	384.6	431.0
Pumps & compressors	898.0	897.0	857.6
Electrical equipment	459.6	458.7	452.2
Structural supports & misc	636.1	660.9	694.7
Construction labor	325.7	323.7	317.1
Buildings	494.8	495.5	486.8
Engineering & supervision	349.0	349.8	354.9

Annual Index:

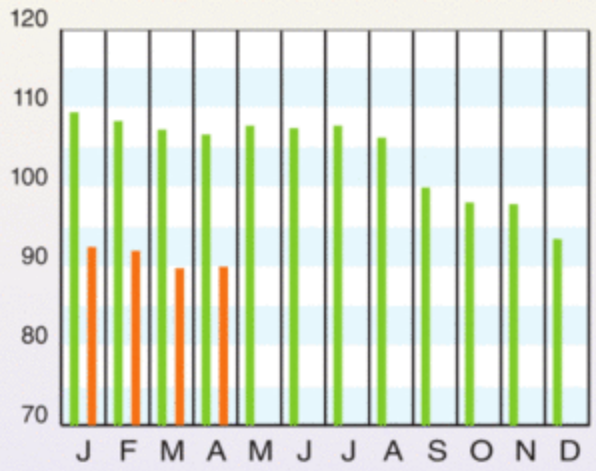
2001 = 394.3
2002 = 395.6
2003 = 402.0
2004 = 444.2
2005 = 468.2
2006 = 499.6
2007 = 525.4
2008 = 575.4

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

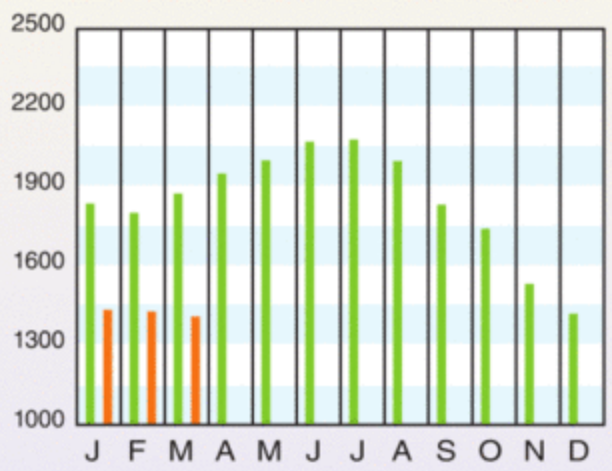
CURRENT BUSINESS INDICATORS

	LATEST		PREVIOUS		YEAR AGO	
CPI output index (2000 = 100)	Apr.'09 =	90.0	Mar.'09 =	89.8	Feb.'09 =	92.0	Apr.'08 =	106.7
CPI value of output, $ billions	Mar.'09 =	1,411.5	Feb.'09 =	1,430.2	Jan.'09 =	1,436.7	Mar.'08 =	1,877.6
CPI operating rate, %	Apr.'09 =	65.6	Mar.'09 =	65.4	Feb.'09 =	67.0	Apr.'08 =	78.3
Producer prices, industrial chemicals (1982 = 100)	Apr.'09 =	218.3	Mar.'09 =	224.0	Feb.'09 =	224.1	Apr.'08 =	270.7
Industrial Production in Manufacturing (2002=100)*	Apr.'09 =	95.5	Mar.'09 =	95.8	Feb.'09 =	97.9	Apr.'08 =	111.7
Hourly earnings index, chemical & allied products (1992 = 100)	Apr.'09 =	145.5	Mar.'09 =	145.5	Feb.'09 =	145.7	Apr.'08 =	141.2
Productivity index, chemicals & allied products (1992 = 100)	Apr.'09 =	129.7	Mar.'09 =	128.5	Feb.'09 =	128.2	Apr.'08 =	133.9

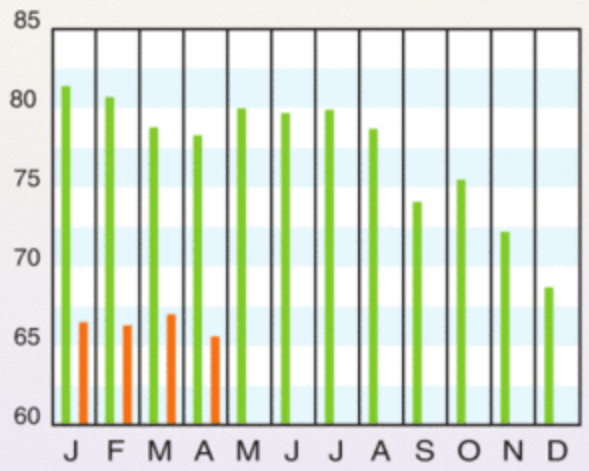
CPI OUTPUT INDEX (2000 = 100)



CPI OUTPUT VALUE ($ BILLIONS)



CPI OPERATING RATE (%)



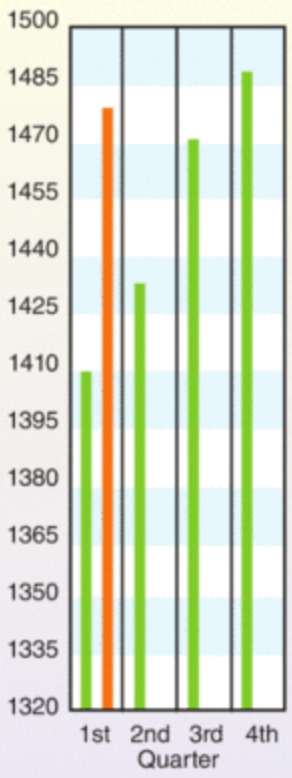
*Due to discontinuance, the Index of Industrial Activity has been replaced by the Industrial Production in Manufacturing index from the U.S. Federal Reserve Board.
Current business indicators provided by Global insight, Inc., Lexington, Mass.

MARSHALL & SWIFT EQUIPMENT COST INDEX

(1926 = 100)	1st Q 2009	4th Q 2008	3rd Q 2008	2nd Q 2008	1st Q 2008
M & S INDEX	1,477.7	1,487.2	1,469.5	1,431.7	1,408.6
Process industries, average	1,553.2	1,561.2	1,538.2	1,491.7	1,463.2
Cement	1,551.1	1,553.4	1,522.2	1,473.5	1,448.1
Chemicals	1,523.8	1,533.7	1,511.5	1,464.8	1,438.5
Clay products	1,526.4	1,524.4	1,495.6	1,453.5	1,429.1
Glass	1,439.8	1,448.1	1,432.4	1,385.1	1,359.7
Paint	1,554.1	1,564.2	1,543.9	1,494.8	1,467.6
Paper	1,453.3	1,462.9	1,443.1	1,400.0	1,377.7
Petroleum products	1,663.6	1,668.9	1,644.4	1,594.4	1,555.8
Rubber	1,600.3	1,604.6	1,575.6	1,537.5	1,512.3
Related industries					
Electrical power	1,425.0	1,454.2	1,454.4	1,412.8	1,380.4
Mining, milling	1,573.0	1,567.5	1,546.2	1,498.9	1,473.3
Refrigeration	1,807.3	1,818.1	1,793.1	1,741.4	1,711.9
Steam power	1,509.3	1,521.9	1,499.3	1,453.2	1,426.8

Annual Index:

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



CURRENT TRENDS

Although previous trends suggested that the month-over-month decline in equipment prices might be waning, preliminary estimates for the April CEPCI show that slightly sharper declines in equipment prices returned. Meanwhile, as expected, the operating rate edged up slightly in April — an indication that the U.S. has reached the bottom of widespread overcapacity.

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