CHEMICAL ENGINEERING

March
2009

www.che.com

SOLAR'S SECOND COMING

PAGE 18

Wireless News

Web 2.0 Tools

Industrial Gases

Milling & Grinding

Pressure Relief

Achema Show Preview

Facts at Your Fingertips: Membranes

Access Intelligence

CHEMICAL ENGINEERING

www.che.com

COVER STORY

NEWS

ENGINEERING

EQUIPMENT & SERVICES

COMMENTARY

DEPARTMENTS

ADVERTISERS

COMING IN APRIL

Look for: **Feature Reports** on Pumps; and Capital Cost Estimates; A **Solids Processing article** on Bends in Pneumatic Conveying Systems; An **Engineering Practice article** on Understanding and Using *CE's* Plant Cost Index; An **Environmetal Manager article** on Controlling Electrostatic Charges; A **Focus** on Temperature Measurement & Control; **News articles** on Project Management & Handover; and Recycling in the CPI; **Facts at Your Fingertips** on Energy Efficiency & Thermodynamics; An Achema **Show Preview II**; and more

This month's cover shows workers building Europe's first parabolic-trough CSP plant, Andasol 1, in Granada, Spain. The 50-MW facility started operation towards the end of last year Photo: Gollmer/Solar Millennium

Editor's Page

Thank you, from our Publisher

It is with great pride and honor that I announce to our loyal readers and advertisers that I have been promoted to publisher of *Chemical Engineering*. As I write this letter a week after the historic inauguration of President Obama, our nation has just enacted a change in leadership as well. Now, I am not comparing the role of the publisher of *Chemical Engineering* to that of the new president by any stretch. President Obama has many more problems on his plate trying to stabilize the economy, the housing industry, the job market and more.

Still, I am taking responsibility of a brand with tremendous history. *Chemical Engineering* has enjoyed a loyal readership for over 106 years. I would like to thank you, our readers, for consistently turning to us for the "how to" information that keeps your chemical processing plants running. That would not be possible without our dedicated team of editors led by Rebekkah Marshall our Editor in Chief. Following longstanding traditions of editorial quality and integrity, the content these editors provide keeps you coming back.

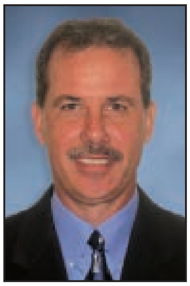
This year will be an important year for the chemical process industries (CPI) with two major trade shows impacting the market. Achema '09, is right around the corner in May, and we kick off our coverage of the event in this issue with the first of our two preview sections. We will follow that up with our April Achema issue as well as the Official *Achema Daily*, which we publish in a joint venture with Vogel Publishing. Later in the year is the Chem Show in New York City. Chemical Engineering will be deeply involved in the Chem Show as well, producing show previews, show issues and the *Chem Show Daily*.

As you may have noticed, *Chemical Engineering* continues to evolve into much more than a monthly print publication. We have developed a top notch Website, www.che.com, which includes an extensive archive of our award winning editorial as well as news and information about what is happening in and affecting the CPI. We have also developed a bimonthly eNewsletter and an informative series of Webinars. Our Webinars feature timely information regarding a variety of topics, such as the Plant of the Future Webinar we hosted in March of 2008. All of our Webinars are archived on our Website for viewing at your convenience, so please take a look.

Meanwhile, one of our newer products is our job board called ChemPloy. If you are looking for a job or looking for help filling a position, check out the ChemPloy section on our Website. You can post a resume, view positions and also post job openings. Check back regularly because the job board is updated on a daily basis.

Another popular feature on our Website is the Online *CE* Plant Cost Index subscription, which provides electronic access to our renowned capital-cost-estimation tool. Look for us to grow our eMedia offerings as we continue to serve the needs of our readers wherever you may be located. If you do not have access to these electronic products and would like to, please take a moment to register on our Website at www.che.com.

As we move forward, let us know if you like what you are seeing from *Chemical Engineering*. Also please do not hesitate to let us know if don't like something or if you simply have suggestions for topics you'd like to see more often. We are here to serve our loyal readers. Please contact me at morourke@che.com if I can be of any assistance. Here's to a successful 2009! ■



Best Regards,
Mike O'Rourke
Publisher

Hydrogen Pinch Analysis

I recently read Hydrogen-Pinch Analysis Made Easy *Chem. Eng.*, June 2008, pp. 56–61. The paper presents an automated spreadsheet program to target the minimum fresh hydrogen resource for a hydrogen network. While the effort of the authors is appreciated, I do not agree with some claims in the paper, including the following:

1. The authors do not acknowledge an earlier work by El-Halwagi (2003), which is the most important graphical tool for resource conservation networks, including setting targets for a hydrogen network (see Example 4 of the paper).
2. The authors claim that the gas cascade analysis (GCA) targeting technique by Foo and Manan (Authors' Ref. [*6*]) has several limitations, which I do not agree with as detailed below (a spreadsheet that illustrates these points is attached to the online discussion of this article, which may be found by searching for the article title at www.che.com):
   a. The authors claim that GCA by Foo and Manan [*6*] does not allow the labeling of individual hydrogen sources and sinks (pp. 56 and 59). This is a misleading claim, as users can easily add a comment on the cells to label the hydrogen sinks and sources in Microsoft Excel
   b. Similar comments were also applied to the claim found in p. 59 (paragraph just before Multiple Pinch Network), where the authors say that in order to change the flowrate of an individual source, one would have to change the combined source. Note that in MS Excel, one can easily link the cells that contain the limiting data of the sinks and sources with the table where the GCA calculation is performed.
   c. The authors claim that in order to identify the pinch using GCA, one will have to first assume a fresh hydrogen flowrate, and then go through two iterations. This is a seriously faulty claim. The principle of carrying out a GCA is the same as other algebraic targeting techniques (Linnhoff, others, 1982; Smith, 1995, 2005; El-Halwagi, 1997, 2006). The maximum deficit of fresh hydrogen is first identified, which is always located at the pinch. If one were to identify the fresh hydrogen feed, a second cascade would be needed, with the minimum fresh hydrogen being the absolute of the deficit value identified earlier. These are two sequential steps, not "iterations" as claimed by the authors.

Dr. Dominic C.Y. Foo, associate professor
University of Nottingham Malaysia.

Authors' reply

1. On p. 57 of our article, we state that our spreadsheet method extends our work on water-system optimization [*9*], which was accepted by this magazine in mid-2002, well before the graphical technique

by El-Halwagi et al. (*Ind. Eng. Chem. Res.*, 42, p. 4319, 2003) was submitted to its journal in April 2003. A thoughtful reader can easily recognize the close similarity between Tables 2A and 2B in [9] for water-pinch analysis and the spreadsheet in Figure 3 in our article for hydrogen-pinch analysis. We do not use a less accurate graphical technique and find no reason to cite the paper by El-Halwagi.

2a. We state on pp. 56–57 that "it is important to label each stream with a name, which the GCA technique does not do"; we did not say that "the GCA technique cannot do". It's a fact that Dr. Foo did not label each stream with a name in his article. We have made no comment of stream labeling on p. 59 of our article, as falsely claimed by Dr. Foo.

2b. In developing our method, we have recognized several limitations of the previous methods based on published information. Dr. Foo could write a letter to the editor to inform the reader that he has extended his published work and then post the extensions on a public Website for the interested readers. Significantly, we have already efficiently handled all of Dr. Foo's latest extensions in our automated spreadsheet; but Dr. Foo has nothing to say about a key limitation of his method in having no effective means to quickly handle the complications of the shift in flow interval ordering when changing the flowrates of hydrogen utilities, as discussed on p. 60 of our article.

2c. If Dr. Foo insists on calling it "two sequential steps", instead of "two iterations", we have no quarrel with him. Note that he did mention the need for a second cascade in his letter.

Contrary to the false claims by Dr. Foo, we have made our automated spreadsheet both user-friendly and practical for the engineers to apply our spreadsheet by: (1) not having to do any coding, and (2) simply following the examples and clicking on a few buttons such as "Initialize" and "Analyze". To find the hydrogen pinch, the engineers only need to use the "goal seek" function within Excel, which have been taught routinely to senior high school students for years. Since the publication of our article, over 800 readers have accessed our Website and downloaded our spreadsheet.

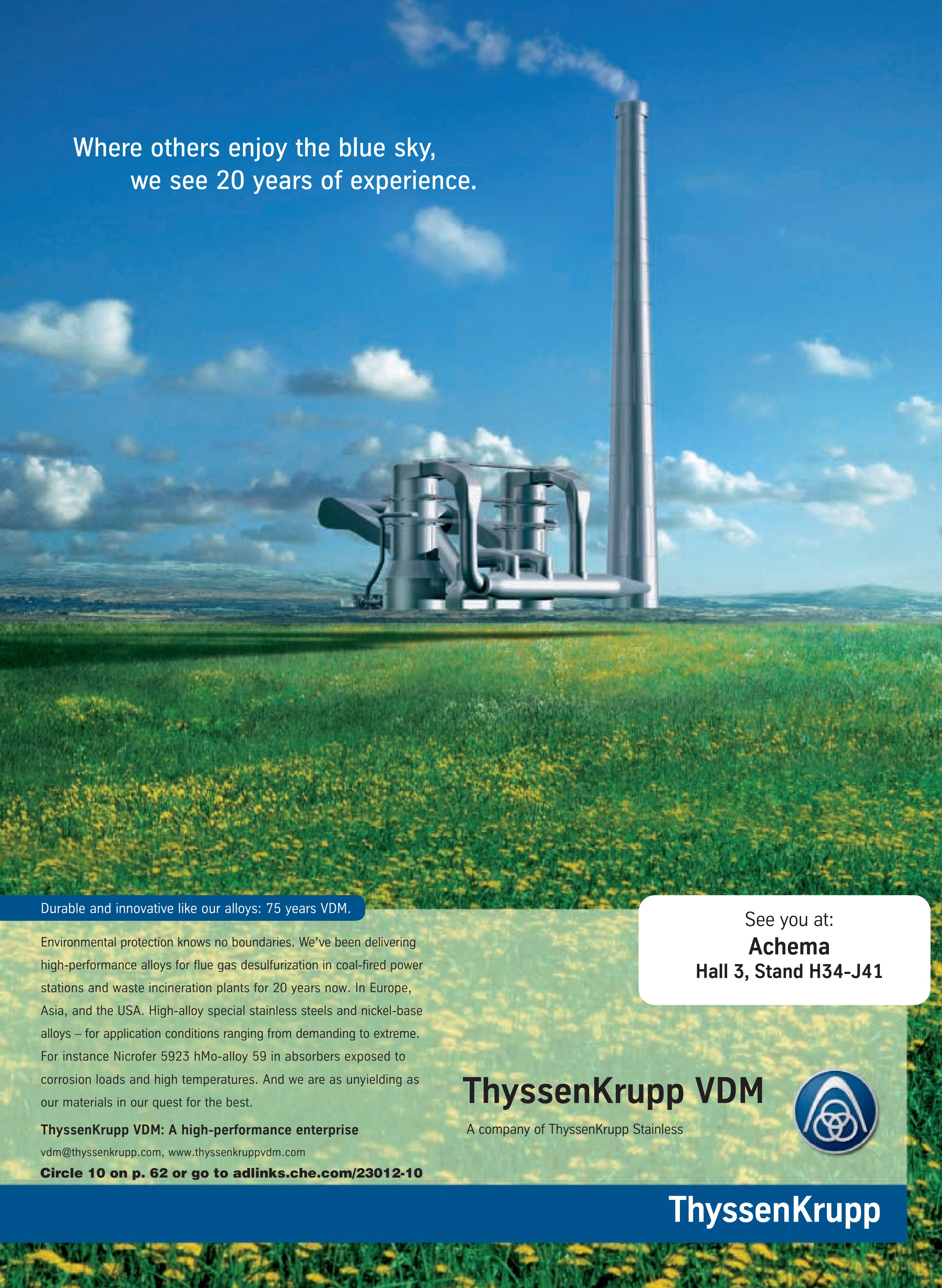
Y. A. Liu, Frank C. Vilbrandt Endowed Professor and April Nelson
Virginia Polytechnic Institute and State University

Postscripts, corrections

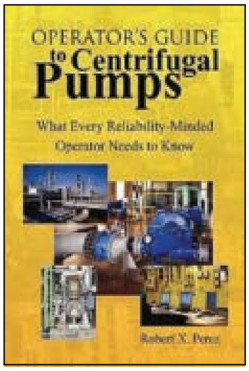
January, Cover Story, CSTRs: Bound for Maximum Conversion, pp. 30–34: Equation (2b) has an error. $C_{Df} = C_{B0}(1–X_f)$ should read as follows:

$$C_{Df} = C_{B0}(M–X_f) \quad \textbf{(2b)}$$

A corrected version of the article can be found by searching for the article title at www.che.com.


Where others enjoy the blue sky,
we see 20 years of experience.
Durable and innovative like our alloys: 75 years VDM.
Environmental protection knows no boundaries. We've been delivering high-performance alloys for flue gas desulfurization in coal-fired power stations and waste incineration plants for 20 years now. In Europe, Asia, and the USA. High-alloy special stainless steels and nickel-base alloys – for application conditions ranging from demanding to extreme. For instance Nicrofer 5923 hMo-alloy 59 in absorbers exposed to corrosion loads and high temperatures. And we are as unyielding as our materials in our quest for the best.
ThyssenKrupp VDM: A high-performance enterprise
vdm@thyssenkrupp.com, www.thyssenkruppvdm.com
Circle 10 on p. 62 or go to adlinks.che.com/23012-10
See you at:
Achema
Hall 3, Stand H34-J41
ThyssenKrupp VDM
A company of ThyssenKrupp Stainless
ThyssenKrupp

Bookshelf



Operator's Guide to Centrifugal Pumps. By Robert X. Perez. Xlibris Corp. 436 Walnut St., Philadelphia, PA 19101. Web: xlibris.com. 2008. 196 pages. $50.99.

Reviewed by Heinz P. Bloch, Process Machinery Consulting, West Des Moines, Iowa

It is important for reliability professionals to have easy access to a rather extensive library of technical books. There are certainly more than a dozen different pump books sitting on my shelves, and they all cater to different but overlapping audiences. If, until very recently, I might have had doubts about needing any additional ones, it turns out I would have been wrong.

With his Operator's Guide to Centrifugal Pumps, Robert X. Perez fills a very significant gap. Subtitled "What Every Reliability-Minded Operator Needs To Know," this book was specifically written for process operators who regularly deal with centrifugal pumps. It optimally addresses the various variables and factors under the operators' control and keeps design theory and mathematics to a minimum.

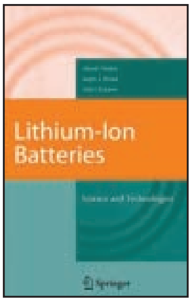
I was impressed by the relevance of the topics covered by Robert Perez, an experienced engineer who devoted the better part of his career to interfacing with process operators. His text deals with:

- The importance of equipment reliability and what role operators play in this mission
- Centrifugal pump operating characteristics
- Mechanical seals and their related seal flush plans
- What operators should know about electric motors
- Lubrication basics
- Troubleshooting basics
- How to start a pump reliability program

By the time the reader reaches the end of this 194-page hard-bound text, he or she will have acquired a clear understanding of how to operate and monitor process pumps. Three handy appendices are also contained in the book; they will answer questions that arise in the field. These appendices include: an Operator's Guide to API Flush Plans; Illustrated Glossary of Centrifugal Pump Terms; Glossary of Electric Motor Terms; and Useful Centrifugal Pump Formulas.

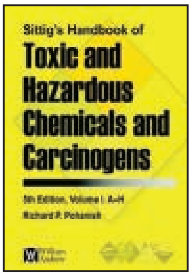
This multi-faceted book can be used as a self-paced, self-taught short course or as a companion to a "live" prepared short course for both inexperienced and seasoned operators. It can also serve as a handy field guide after completion of the course.

The author set out on a mission to add value. He wanted this book to provide the latest generation of operators with a body of knowledge that is relevant, complete and practical in any industrial setting. Perez also wanted the text to be useful for years to come — I firmly believe he has accomplished this goal. Your facility will benefit from this clear, extremely well-written narrative, the many illustrations, and the various experience-based checklists.



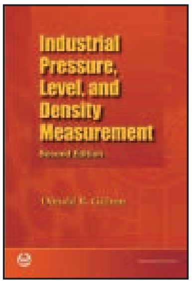
Lithium-Ion Batteries: Science and Technologies. By Masaki Yoshio, Ralph J. Brodd, and Akiya Kozawa. Springer, 233 Spring Street, New York, NY 10013. Web: springer.com. 2009. 279 pages. $99.00

Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens. Fifth edition. By Richard Phanish. William Andrew Inc., 13 Eaton Ave., Norwich, N.Y. 13815. Web: williamandrew.com. 2008. 4,266 pages. $595.00.

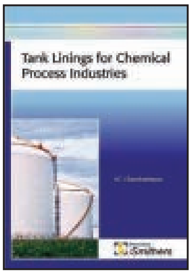


Molecular Modelling for Beginners. Second edition. By Sandor Fliszar. John Wiley & Sons, Inc. 111 River St., MS 8-01, Hoboken, NJ 07030-5774. Web: wiley.com. 2008. 428 pages. $70.00.

Industrial Pressure, Level, and Density Measurement. Second edition. By Donald R. Gillum. ISA, 67 Alexander Drive, Research Triangle Park, N.C. 27709. Web: isa.org. 2008. 624 pages. $99.00.

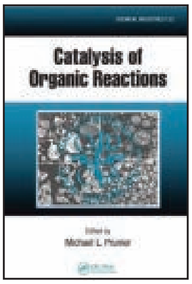


The Performance Paradox: Understanding the Real Drivers that Critically Affect Outcomes. By Jerry L. Harbour. Productivity Press, 444 Park Ave., South, New York, NY 10016. Web: productivitypress.com. 2008. 192 pages. $35.



Tank Linings for Chemical Process Industries. By V. C. Chandrasekaran. Rapra Publishing, Shawbury, Shrewsbury, Shropshire SY4 4NR U.K. Web: ismithers.net. 2008. 172 pages. $225.

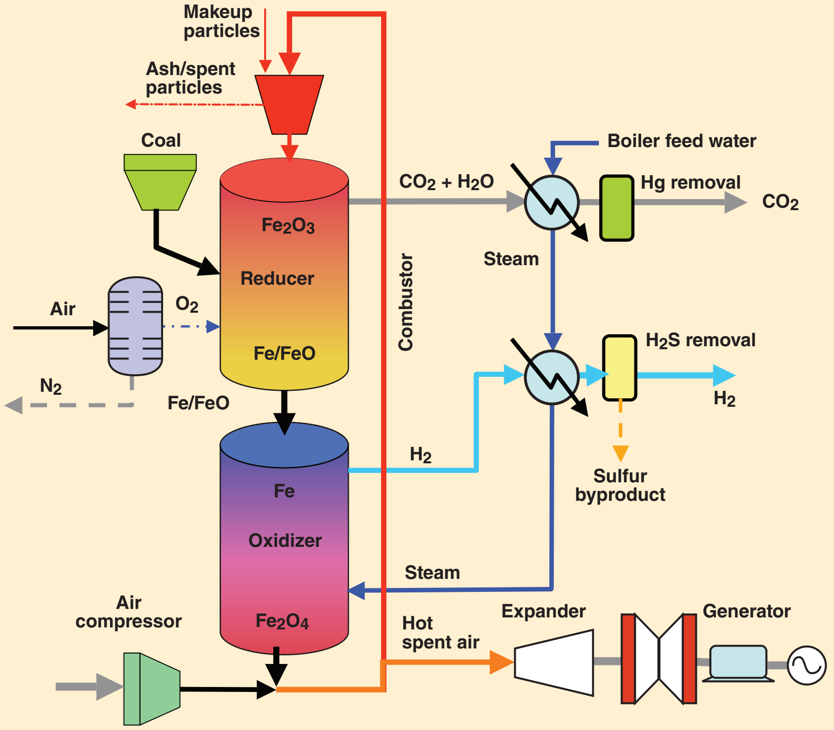
Catalysis of Organic Reactions. Twenty-second edition. By Eli Lilly & Company. CRC Press, 6000 Broken Sound Parkway, NW, Suite 300, Boca Raton, FL 33487. Web: crcpress.com. 2008. 568 pages. $169.95.



Process Systems Analysis and Control. By Donald R. Coughanowr and Steven LeBlanc. McGraw Hill. 1221 Ave. of the Americas, New York, N.Y. 10020-1095. Web: mhprofessional.com. 2008. 624 pages. $174.59. ■

Kate Torzewski

A more efficient way to extract energy from coal



A process that produces hydrogen from coal with close to 80% energy conversion efficiency, plus coproduction of a carbon-dioxide-rich stream for sequestration, is being developed at Ohio State University (Columbus, Ohio; www.osu.edu). This compares with around 60% conversion efficiency for traditional coal gasification processes, says Fanxing Li, a research associate and co-inventor of the process along with chemical engineering professor Liang-Shih Fan.

In the two-step process (flowsheet), called chemical looping conversion, pulverized coal, iron oxide pellets (a patented composite of iron and such materials as alumina and silica) and oxygen are fed into a moving-bed reactor (a reduction reactor). The carbon in the coal reacts with the iron oxide at about 850°C and 450 psi to produce iron and CO_2. The Fe passes to the second (oxidation) reactor, where it reacts with steam at around 800°C and 450 psi to yield H_2. The Fe is reoxidized and recycled to the first reactor.

The advantage of the process is that it produces H_2 without the traditional water-gas shift reaction and without the energy intensive step of separating the CO_2 from the resultant gas mixture, says Li. The oxygen requirement is only about 40% that of conventional coal gasification. Alternatively, the use of O_2 can be avoided by burning part of the iron oxide feed and using the sensible heat from those particles to drive the first reaction.

So far, the gasification process is being tested at a scale of 25 kW_{th}, or about 10 lb/h of coal. Li adds that a variation of the process can be used for "indirect" coal combustion, with CO_2 sequestration. In this configuration, the Fe is burned with air in the oxidation reactor and the hot gases are used to drive a steam turbine.

Takeshi Kamiya

1935 – 2009

With great sadness, we report that Takeshi Kamiya, former contributing editor of *Chemical Engineering*, passed away on January 2, 2009 at the age of 76 after his struggle with cancer. Readers of this department appreciate Takeshi's contributions, having provided 2–6 stories per month on Japanese technology since March 1996, in addition to news and special reports from Japan.

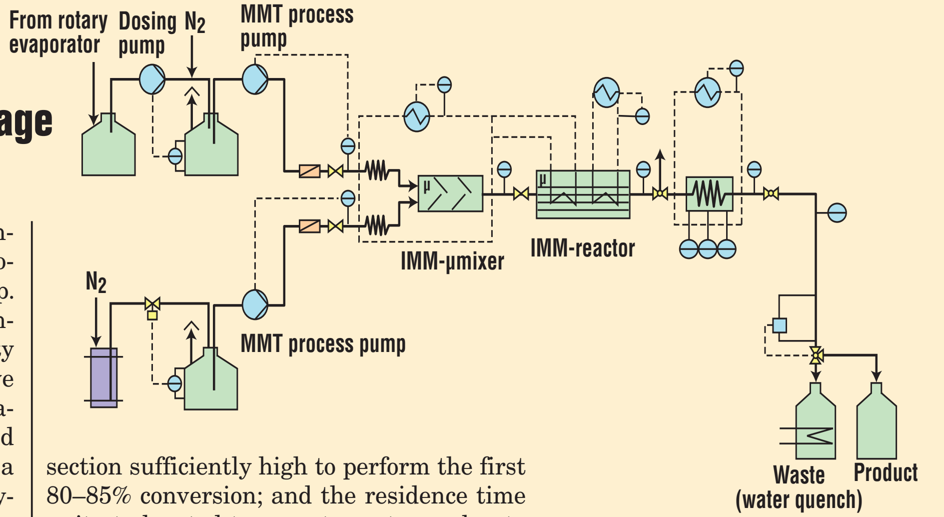
According to Takeshi's wishes, the funeral service was performed on January 5th, 2009 with his surviving wife, Midori and limited family members.

After majoring in applied chemistry at the University of Tokyo, Takeshi joined Furukawa Electric in 1955 where he worked as a chemical engineer at the Chemical Division of Furukawa Electric Group and later at the New Nippon Oil Group. Kamiya played a very important role in the world's first challenge of completely replacing the catalyst system of the commercial process for high-density polyethylene (HDPE) production, which was originally developed by Amoco and introduced to Furukawa Chemical Industry's PE business, with a new catalyst system developed by Nippon Oil Co. As a plastics engineer, Kamiya succeeded in fine tuning polymer characteristics, including polymer processing methods, to meet customer requirements. At the New Business Division of Nippon Petrochemicals, Kamiya proposed the company's entry into the high performance engineering plastics business and succeeded in importing Amoco's XYDAR technology against competition from 46 Japanese companies. Now, XYDAR has grown to become a promising business in the Chemical Division of Nippon Oil Group. During Kamiya's years at the department, those with whom he worked, and especially those lucky enough to be in his command, found him a tough but fair leader, capable of earning their deep respect.

Takeshi retired from the New Business Dept. of Nippon Petrochemicals in 1993 and established a consulting company, InterChem Ltd., where he worked for Kline & Co., Chandler Chemicals, Inc., *Chemical Engineering* and the Japanese Office of the German Industry Association. ❑

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

Multiscale reactors come of age for making fine chemicals



In the framework of the Impulse project (Integrated Multiscale Process Units with Locally Structured Elements; *CE*, April 2005, p. 19), researchers from the Industrial Chemistry Group at RWTH Aachen University (Germany; www.itmc.rwth-aachen.de) have developed a continuous production plant capable of producing 20 kg/d of an ionic liquid (IL). Normally, this IL is manufactured by a semi-batch process via the solvent-free alkylation of an aromatic amine — a highly exothermic reaction requiring careful control of temperature and residence time. The demonstration plant combines the advantage of high heat-and-mass transfer of micro-structured components with a macro-structured residence-time unit — newly developed at RWTH Aachen — into a completely integrated minifactory, which requires only one power line, one cooling-water circuit and one inert-gas line, says Clemens Minnich, a doctoral student at RWTH.

The reactive section of the plant (flowsheet) consists of a static mixer from IMM, a two-temperature-zone microreactor (a micro-structured heat exchanger from IMM) and the residence-time unit. The temperatures in these three core units are maintained at three different levels, explains Minnich: the mixing zone cooled to below reaction temperature; the heat-exchanger section sufficiently high to perform the first 80–85% conversion; and the residence time unit at elevated temperatures to accelerate the reaction at low residual substrate concentration. The third unit, based on 1–4-mm annular slits, is designed for long residence times (up to several hours), says Minnich.

In close collaboration with its partners — IMM GmbH (Mainz), Solvent Innovation GmbH (Cologne; now part of Merck KGaA, Darmstadt) and Siemens AG (Frankfurt) — the RWTH Aachen group has demonstrated the concept, having completed the first 14-d period of 24/7 operation at 20 kg/d. The next step will be a test-run of the minifactory, with modified reactor equipment from IMM, for 100 kg/d production and another 25-d campaign at 20 kg/d. The goal is to demonstrate the industrial feasibility for producing 1 ton of this IL. Minnich says other fine chemicals have been identified for this type of plant, and the group plans to extend its concept to multiphase systems.

A process to make butadiene from under-utilized cracker C_4 fractions

Mitsubishi Chemical Corp. (MCC; Tokyo, Japan; www.m-kagaku.co.jp) has developed a new technology for producing 1,3-butadiene (butadiene) from waste butenes using a self-developed, proprietary catalyst. The process has been pilot tested (200-ton/yr capacity) at MCC's Mizushima site in Japan, and the firm plans to complete process design this year with the aim to commercialize the technology by 2010.

Butadiene — a monomer used for the production of styrene-butadiene rubber (SBR) and other polymers — is normally made by dehydrogenation of *n*-butane, but recently, methods have been developed for extracting the C_4 fractions from naphtha catalytic cracking units, which account for about 11% of the cracker products. The butadiene content in this C_4 fraction is almost 40%, and after butadiene extraction, about 30% of the remaining C_4 fraction is butanes. Up to now, these butenes — about 0.5–1-million ton/yr in Asia alone — have been mainly used as fuel.

MCC has developed a highly active catalyst to selectively convert the waste butenes into butadiene by oxidative dehydrogenation. The company expects the new process can produce 40,000 ton/yr of butadiene from 50,000 ton/yr of *n*-butene, while creating 900,000 ton/yr of butadiene from the waste butenes in Asia. The technology may also be used to make butadiene from butenes from fluid-catalytic cracker (FCC) units at petroleum refineries, including next-generation FCC facilities yielding higher olefins.

Bioethanol

Ethanol from plant and forestry waste and dedicated energy crops could replace approximately one-third of U.S. gasoline requirements by 2030 on a sustainable basis, according to a study by Sandia National Laboratories (Livermore, Calif.; www.sandia.gov) and General Motors Corp. (Detroit, Mich.; www.gm.com). The researchers found that 90 billion gal of ethanol could be produced annually by 2030, enough to replace roughly 60 billion of the estimated 180 billion gal/yr of gasoline expected to be used by 2030. For reference, the U.S. Dept. of Energy (Washington, D.C.; doe.gov) has set an ethanol production goal of 60 billion gal of ethanol by 2030.

The study assumes that 15 billion gal would come from corn-based ethanol and 75 billion gal from nonfood cellulosic feedstocks. The latter include agricultural and forest residues, dedicated energy crops (such as switchgrass), and short-rotation woody crops, such as willow and poplar trees. The study asserts that cellulosic biofuels could compete without incentives, with oil priced at $90/bbl, assuming a reduction in total costs as advanced biofuels technologies mature.

A new feedstock for carbon and graphite electrodes: coal

A less-expensive way of making the raw materials for carbon anodes (for aluminum smelting) and graphite electrodes (used to make steel in electric arc furnaces) has been developed by West Virginia University (UWV; Morgantown, W.Va.; www.wvu.edu). The conventional starting materials for making electrodes are needle-grade coke (from petroleum) and binder pitch, which comes from petroleum distillation residue or coal tar (a co-product of metallurgical coke production). UWV's process substitutes a binder pitch made from coal for part of the conventional feed.

Coal sells for the oil equivalent of only about $10/bbl, says Elliot Kennel of UWV's chemical engineering dept., noting that the U.S. imports the equivalent of more than 10 million bbl/yr of petroleum for anode-grade coke alone. The technology has been licensed to Quantex Energy (Toronto, Ont.; www.quantexenergy.com), which plans to build a demonstration plant with a capacity of 4,000 metric tons per year (m.t./yr) of coal.

The process uses coal liquefaction to obtain a synthetic binder pitch (Synpitch). Coal is dissolved in a hydrogenated coal tar solvent at about 400°C and less than 500 psi, versus about 2,000 psi for other liquefaction methods. "We can use a lower pressure because we aren't trying to make light crude," says Kennel. The slurry is centrifuged to remove solid residue, then the light ends are distilled to recover the Synpitch.

In a commercial-scale test, the university made an 8,000 lb blend of about 20% Synpitch with coal tar binder pitch. The blend was solidified, then crushed and shipped to an electrode manufacturing plant, where the material was extruded and baked to form electrodes. These were tested in a commercial electric arc furnace, and their performance showed no detectable difference from that of conventional electrodes, says Kennel. Electrodes made from 100% Synpitch have been tested in the laboratory and didn't work as well as conventional electrodes, he says, "but we are confident we can improve on that."

Toxic plant yields a potential skin protector

Milkweed, a plant that is toxic to farm animals and other creatures, may be a future source of a base material for sunscreen and other skin care products. Milkweed is harvested for floss, used as a hypoallergenic filler for pillows and comforters, and a byproduct of that work is an unsaturated oil. A process that converts triglycerides in that oil to ultraviolet- (UV) light-absorbing compounds has been patented by the U.S. Dept. of Agriculture's National Center for Agricultural Utilization Research (Peoria, Ill.; ars.usda.gov).

The oil is extracted from the plant by pressing or solvent extraction, then is converted to cinamic acid derivatives by reaction with cinamic acid. The reaction takes place at below 110°C, using a zinc catalyst, says Rogers Harry-O'kuru, a research chemist.

The liquid compound absorbs harmful UV rays in the range of 200–360 nm at concentrations of only 1–3%, which is well below the 5% required by the U.S. Food and Drug Admin. (FDA; Washington, D.C.) for the active ingredients in commercial sunscreens, he says. Also, it contains natural antioxidants such as tocopherols. Harry-O'kuru says the liquid compound could be incorporated into creams and gels for topical application. Natural Fibers Corp. (Ogallala, Neb.), which supplied the oil, is planning to commercialize such products.

Using the sun to keep Australians cool

CSIRO Energy Technology (Newcastle, New South Wales, Australia; www.csiro.au) is developing a solar-powered air conditioning unit for residential use, using a desiccant-evaporative process to provide cool and dehumidified air. Thermally driven ab- or adsorption chillers are commonly used to provide cooling using heat, but these entail disadvantages: they are expensive, bulky, they produce chilled water instead of air, and they are not ideal for providing dehumidification under Australian summer ambient conditions.

Stephen White, a member of the CSIRO team, says that using solar heating for cooling is a new and important research area for Australia. "It addresses a national challenge since air conditioning and space heating are responsible for around 18% of the annual

(*Continues on p. 16*)

Straw power

A biogas plant that generates 30% more biogas than its predecessors has been developed by researchers from the Fraunhofer Institute for Ceramic Technologies and Systems (IKTS; Dresden, Germany; www.ikts.fraunhofer.de). The pilot plant operates entirely on agricultural waste, such as corn stalks, without requiring any edible grains.

The waste is pretreated and the silage decomposed (fermented) into biogas. IKTS' pretreatment process is said to reduce the time needed for the gas buildup by 50–70% over conventional processes, to just 30 days.

Biogas is then diverted to a high-temperature (850°C) fuel cell that has an electrical efficiency of 40–55%, and a power output of 1.5 kW — enough to supply a family home. Heat produced in the fuel cell can be used directly for heating, or fed into a district heating network. The concept will be presented next month at the Hannover Fair (Germany; April 20–24).

Bioremediation

Scientists at CSIRO Entomology (Canberra, Australia; www.csiro.au/org/entomology) have identified an enzyme that breaks down the herbicide atrazine [2-chloro-4-(ethylamine)-6-(isopropylamine)-s-triazine] into non-toxic compounds. Banned in the EU, the herbicide is still used in other countries, where it can end up in runoff from farms.

In field trials, the enzyme was shown to remove 90% of the atrazine contaminating the runoff from the Burdekin sugar-growing region near Ayr, Queensland, after four hours. The results indicate that the enzyme shows promise for reducing the contamination in runoff that reaches the Great Barrier Reef, says CSIRO. The enzyme has also been shown to be effective against other triazine-based herbicides, and CSIRO is looking for commercial partners to improve production and application of the enzyme.

Photocatalysts for decomposing VOCs

A photocatalyst that is more active for decomposing volatile organic compounds (VOCs) with visible light than existing catalysts has been developed by researchers from the New Energy and Industrial Technology Development Organization (NEDO; Kawasaki City, Japan) in a project lead by professor Kazuhito Hashimoto at the University of Tokyo. The catalyst — a copper ion supported tungsten oxide — has been shown to decompose isopropyl alcohol vapor into CO_2 and water 15.8 times more effectively than traditional nitrogen-doped titanium dioxide, when exposed to visible light. Similar to another photocatalyst being developed by a Hashimoto-led project (*CE*, November 2008, p. 18), this new tungsten oxide catalyst promises to help alleviate sick house and building syndrome and reduce malodorous substances in rooms, hospitals and cars.

Showa Titanium Corp., a subsidiary of the Showa Denko Group (Tokyo), has developed a mass-production process for the tungsten-oxide catalyst, based on its TiO_2 product, and expects production costs to be comparable for both. The company has constructed a pilot plant at its Toyama site, and has already produced several kilograms of the new catalyst for evaluation by the project's participating companies. Panasonic Electric Works Co. has built a demonstration house at the university's Komaba Research Campus, where the performance of the catalyst is being verified. By next month, other industrial participants in the project will have incorporated the new catalyst into housing components for testing. The next step is to reduce the cost of the catalyst, and improve its resistance to alkaline detergents, says NEDO.

SOLAR-POWERED AIR CONDITIONING

(*Continued from p. 15*)

residential greenhouse gas emissions in Australia. Replacing 10% of the existing air conditioners in Australia with a low-energy consumption, solar-powered system could result in CO_2 emission reductions of up to 1 million ton/yr of CO_2."

The CSIRO team has tested the dehumidification performance of a desiccant wheel (300 mm dia.) made of an iron-alumino-phosphate zeolite with an AFI structure and traded under the name of FAM Z-01. Moisture removal capacity of the material is 8 g of water per kilogram of dry air with regeneration air at 80°C and 8.25% relative humidity, and an inlet air stream of 30°C and 93% relative humidity. The difference in moisture removal between 50°C and 80°C regeneration temperature was found to be less than 1-g water/kg dry air, for supply inlet temperatures between 10°C and 30°C and supply inlet relative humidity between 20 and 50%. Compared with silica gel, the performance of the FAM-Z01 material was best at the low regeneration temperatures expected in solar applications.

Eni orders world's largest reactors

Last month, GE Oil & Gas (Florence, Italy; www.ge.com/oilandgas) received a contract to supply Eni S.p.A. (Rome; www.eni.it) with the largest refinery reactors of their type ever to be manufactured. GE Oil & Gas' components-production facility in Massa, Italy, will manufacture the heavy-wall, slurry reactors — each weighing about 2,000 tons — and then transport them to Eni's Sannazzaro refinery. Delivery of the two reactors is scheduled for 2011, with commercial operation expected in 2012.

The reactors are the centerpiece of a a new hydrocracking process, called Eni Slurry Technology (EST), which is said to achieve the total conversion of heavy oils, bitumens and asphaltenes into light products, such as naphtha, kerosene and high-quality diesel. EST is based on a proprietary slurry-phase, catalytic hydroconversion, and eliminates the production of both liquid and solid refinery residue (coke or fuel oil), says Eni. The process has been tested in a 1,200-bbl/d, commercial-demonstration plant, which has been operating since November 2005 at Eni's Taranto refinery. The Sannazzaro refinery will host the first full-scale EST plant, with a capacity of 20,000 bbl/d.

Eni says the EST process offers a solution for the conversion of "bottom of the barrel" resources, as well as for the utilization of non-conventional resources, such as ultraheavy crude and tar sands. Such unconventional oil resources are estimated to be about 4.6 trillion barrels — nearly four times the proven oil reserves of about 1.2 trillion barrels. ■

Biomass-to-ethanol

The two-step production of ethanol and methanol from biomass via gasification, followed by catalytic conversion of the resultant syngas, typically produces a lot of unwanted methane along with the alcohols. Now, a process that minimizes methane generation has been developed at Ames Laboratory (Ames, Iowa; www.ameslab.gov).

As in the case of the conventional route, the conversion step starts with a hydrogen, carbon monoxide mixture in a 2:1 ratio. However, while the conventional process typically uses a copper or rhodium catalyst on an alumina or silica support, the Ames method employs a transition metal catalyst on a porous carbon material. A key feature is that the supported catalyst is in the form of nanoparticles, of 150–500 nm, which are mixed with the syngas in a tubular slurry reactor, says Victor Lin, director of the laboratory's chemical and biological sciences program. The nanoparticles provide a large surface area and allow the syngas to interact with the support, which promotes the conversion to alcohols.

The reaction takes place at 240–260°C and about 450 psi, compared with about 280–300°C and 450 psi for a conventional process, says Lin. The product consists of about 60% ethanol, 30% methanol and about 10% butanol, he says, with "very little methane," whereas the conventional route yields 40–60% methane. So far the process has been tested only in the laboratory, but Lin says several companies have expressed interest in testing the catalyst at the pilot scale. ❑

Cover Story

SOLAR'S SECOND COMING

Abengoa Solar

FIGURE 1. Constructed by Abengoa Solar, the Solúcar Platform in Sanlúcar la Mayor, Seville, is the largest solar platform in Europe. When completed in 2013, the site will generate 300 MW of electric power using both parabolic trough and power-tower technologies

Construction of CSP plants is on the rise, bringing jobs and business to equipment suppliers and chemical producers alike

Nearly 30 years ago (May 6, 1979), U.S. President Jimmy Carter made the following prophetic statement at the inauguration of a solar-thermal water heater installed on the White House roof: "In the year 2000, the solar heater behind me will still be here, supplying cheap, efficient energy. A generation from now, this solar heater can either be a curiosity, a museum piece, an example of a road not taken; or it can be just a small part of the greatest and most exciting adventure ever undertaken by the American people."

Carter's words are prophetic in two respects: First, the solar heater was removed in 1986 during the Reagan Administration.* More importantly, the solar industry really was born then (as the result of two oil embargos in the 1970s). Between 1985 and 1991, a total of nine solar power plants were installed, all in California's Mojave Desert, with a total capacity of 354 MW. Since then, due to a number of factors — plentiful, cheap oil, for one — the construction of large solar plants came to a halt.

Today, a second surge is taking place in the solar industry, not only in photovoltaics (PV; *CE*, February 2008, pp. 17–20), but in large-scale power plants that make electricity with conventional steam turbines. As their name implies, these so-called CSP (concentrating solar power) plants concentrate sunlight in large fields of collectors, and the radiation is absorbed by a heat-transfer medium that subsequently transfers the thermal energy to make steam.

Although CSP plants made their commercial debut nearly 20 years ago — and some continue to operate with 98% availability — it wasn't until recently that a new CSP plant was built in the world. Early last year, Acciona Energía (Sarriguren, Spain; www.acciona-energia.com) officially inaugurated Nevada Solar One — a 64-MW CSP facility located near Boulder City in the Nevada Desert. The facility not only became the largest CSP plant to be built in the last 18 years, but made Acciona the first Spanish company to have a solar-thermal plant in operation using parabolic reflectors. Since then, there has been a big surge in the number of CSP plants being planned or starting up (Table 1), and Spain is set to overtake the U.S. in CSP capacity.

CSP types

There are basically four main technologies for CSP plants: parabolic trough (which uses parabolic mirrors [see cover] to concentrate radiation onto a receiver tube through which flows the heat-transfer fluid); tower (which uses mirrors to focus radiation to a receiver at the top of a tower [Figure 1]); Fresnel lens (which concentrates light using planar, Fresnel lenses); and dish/Stirling engines (which uses dish mirrors to focus radiation onto a receiver and the thermal energy operates an integrated Stirling engine).

CSP's advance

Although there's a need for all four technologies, parabolic trough designs are the real winner so far, accounting for about 90% of the installed or planned capacity, says Werner Koldehoff, a consultant at Management Consulting (Görisried, Germany) and board member of the BSW German Solar Industry Assn. (Berlin; www.bsw-solar.de). Such plants have an efficiency of 19% at peak load compared to 10–14% for large PV plants (c-Si and CdTe modules, which are used today), says Koldehoff. However, in January 2008, Stirling Engine Systems (SES; Phoenix, Ariz.; www.stirlingenergy.com) and Sandia National Laboratories (Albuquerque, N.M.; www.sandia.gov) set a new solar-to-grid conversion efficiency record by achieving a 31.25% net efficiency with SES's Series No. 3 solar dish Stirling system at Sandia's National Solar Thermal Test Facility, breaking the old record of 29.4% set in 1984 (Figure 2).

Last June, SES filed an application

*Since 1992, this solar heater has been operating at Unity College in Maine. In a symbolic gesture, one of the modules was on display at Google's Washington, D.C. building for the January 20 inauguration of Barack Obama.

TABLE 1. A SELECTION OF RECENT CSP ANNOUNCEMENTS					
Location	**MW**	**CPS type**	**Project Name**	**Company**	**Startup date**
Ivanpah, Calif.	100	Luz Power Tower		BrightSource Energy	2011
Boulder City, Nev.	64	Parabolic trough	Nevada Solar One	Acciona Solar Power	2007
Aldeire, Granada	50	Parabolic trough	Andasol 1	Solar Millennium	2008
Aldeire, Granada	50	Parabolic trough	Andasol 2	Solar Millennium	2009
Aldeire, Granada	50	Parabolic trough	Andasol 3	Solar Millennium	2011
Sanlucar la Mayor, Sevilla	50	Parabolic trough	Solnova 1*	Abengoa Solar	*
Sanlucar la Mayor, Sevilla	11	Tower	PS10	Abengoa Solar	2007
Gila Bend, Ariz.	280	Parabolic trough		Abengoa Solar	2011
Mojave Desert, Calif.	553	Parabolic trough	Mojave Solar Park 1	Solel	
Bakersfield, Calif	5	Compact Linear Fresnel Reflector (CLFR)	Kimberlina	Ausra	2008
Carrizo Plains, Calif	177	CLFR		Ausra	NA
Mojave Desert, Calif.	500 (850)**	Solar dish/ Stirling engine	Solar One	Stirling Engine Systems	2011
Imperial Valley, Calif.	300 (900)**	Solar dish/ Stirling engine	Solar Two	Stirling Engine Systems	NA
Fuentes de Andalucia, Spain	17	Tower with molten salt storage	Gemasolar	Torresol Energy	2011
Gotarrendura, Spain	10	Fresnel technology		Solar Power Group/Laer	NA
Indiantown, Fla.	75	Hybrid parabolic trough/combined-cycle natural gas	Martin Next Generation Solar Energy Center	FPL	2010
Extrmadura, Spain	100	Parabolic trough	Extrasol	Sener/Cobra	

* The Solnova 1 is just a part of the Solúcar Platform, the largest solar platform in Europe, which will reach 300 MW of power output capacity by 2013
** Second number is potential expansion plans; NA = not announced

to build the world's largest solar-energy-generating system in Southern California. The 750-MW facility, called SES Solar Two, will utilize SES solar dish engine technology, called the SunCatcher system. The project site is located in the Imperial Valley, Calif.

In the first phase of the project, 12,000 SunCatcher dishes generating 300 MW will be constructed, followed by an additional 18,000 solar dishes generating 450 MW. Each SunCatcher is 38 ft tall, 40 ft wide and generates 25 kW of power.

Pros and cons of CSP

By the end of 2008, approximately 1.3 GW of cumulative capacity from CSP systems was in service, and this is forecast to reach 5.5 GW by 2012, says Koldehoff. While many could argue that this is a very small fraction of the world's demand for electrical power, most would agree that the experience gained from these masive, expensive investments will advance the technology in order to reduce the costs for future plants.

Investment for a large CSP plant is about €3,500–6,000/kW, compared to 1,500/kW for a gas-fired power plant. But the capital cost is expected to come down to €2,500–4,000/kW in the next 5 years — compable to a new nuclear power plant, Koldehoff says. And the cost of producing electricity is roughly €0.23–0.24/kWh for CSP versus €0.26–0.30/kWh for PV, he adds.

On the down side, water consumption for a 50-MW CSP system (mainly for cooling purposes) is about 600,000 to 700,000 m^3/yr, roughly the same needed to grow crops over the same surface area, says Koldehoff. Cutting costs and water consumption are the key areas to address before the technology can compete with traditional power plants. One way is with thermal storage, which enables the CSP plant to continue power generation during cloudy days and at night, without additional firing by gas or other fuels.

R&D continues

Last Fall, the U.S. Dept. of Energy (DOE; Washington, D.C.) announced funding for 15 new projects to develop solar power storage and heat transfer. The 15 projects, for up to $67.6 million, will facilitate the development of lower-cost energy storage for CSP technology. The projects are said to support former President Bush's Solar America Initiative, which aimed to make solar energy cost competitive with conventional forms of electricity by 2015.

DOE's goal is reducing the cost of CSP electricity from 13–16¢/kWh today with no storage (DOE estimates), to 8–11¢/kWh with 6-h of storage by 2015, and to less than 7¢/kWh with 12–17-h storage by 2020. Among the 15 projects are the following:

- Symyx (Sunnyvale, Calif.), to use a high-throughput combinatorial approach to identify advanced heat-transfer fluids, with the objective to find eutectic salts that can operate within a temperature range of 80–500°C with a significantly increased heat capacity
- City University of New York (New York) will develop a new storage method that utilizes CO_2 as the heat transfer fluid and solid ceramic for storage. The concept promises operation at higher temperatures, thus lowering costs
- Infinia Corp. (Kennewick, Wash.) will demonstrate the practicality of integrating a thermal energy storage module with a dish/Stirling engine, enabling the system to operate during cloud transients and to provide dispatchable power for 4–6 h after sunset. Infinia will demonstrate the concept on 40–50 dish-engine systems at Sandia National Laboratories
- Abengoa (Lakewood, Colo.) will analyze cost reduction opportunities for several new concepts using an indirect two-tank molten salt design as a baseline for comparison. The goal is to find a concept that will achieve a 20–25% cost reduction from baseline
- Acciona (Henderson, Nev.) will design and validate at the prototype level, then demonstrate an 800-MW, 4-h thermal-energy storage system using phase-change material. The project will be integrated into Acciona's 64-MW trough plant in Boulder City, Nev.

Meanwhile, the EU is already demonstrating thermal storage. Solar Millennium's Andasol 1 (see Table 1) is a parabolic trough with an electricity capacity of 50 MW. It uses a thermal storage system consisting of 28,000 tons of molten salt (60% $NaNO_3$ and 40% KNO_3), sufficient for 7.5 h at 50 MW power output. It started operating in the fall of 2008 and was developed by Solar Millennium AG (Erlangen, Germany; www.solarmillennium.de) with the cooperation of ACS/Cobra

Group (Madrid; www.grupocobra.com), Spain's largest contruction and plant engineering company. Flagsol GmbH, the technology subsidiary of Solar Millennium, provided the engineering for the solar field.

Another project to use molten salt technology with thermal storage in a solar-tower design (*CE*, February, p. 11) is under development by Sener Ingenieria y Sistmas (Madrid; www.sener.es). The 17-MW facility is due onstream by 2011.

New business

The rapid growth for CSP plants in Spain and the U.S. is not only creating jobs for those working on the projects, but is opening new markets for both equipment manufacturers and chemical producers. The tons of heat-transfer fluids required, for example, has caught the attention of companies, such as Dow Chemical Co. (*CE*, August 2008, p. 29).

Sandia National Laboratories

FIGURE 2. The solar-dish/Stirling-engine unit shown here holds the world's record in light-to-grid conversion efficiency. Each unit generated 25 kW with 31.25% efficiency. Thousands of these units will be combined to supply up to 900 MW of power to Southern Calif. in the near future

Last September, Solel Solar Systems Ltd. (Bet Shemesh, Israel) opened a $9-million facility in Akaa, Finland, for the production of parabolic solar reflectors, in cooperation with Glaston Corp. (Tampere, Finland; www.kyro.fi). The new facility produces 240,000 parabolic solar reflectors per year, enough for a 50-MW power plant.

Last June, Schott Solar AG (Alzenau, Germany; www.schott.com) inaugurated a new plant for manufacturing solar receivers in Aznalcóllar, Spain. These absorber tubes are key components of CSP parabolic trough plants. Production began at the new plant in March 2008, and the annual production corresponds to a power capacity of 200 MW, thereby doubling the firm's receiver production capacity. The company only began operating its first industrial manufacturing plant for solar receivers in Mitterteich, Bavaria, in 2006. A third receiver plant in Albuquerque, N.M., is under construction with startup slated for May, and the Spanish facility is already planning to double its capacity.

Besides glass and heat exchange fluids, CSP plants also require lots of pumps, heat exchangers, turbines and control systems. For example, last July, Friatec AG (Wiesbaden, Germany; www.friatec.de) received orders for six vertical pumps, each with 130–160-m^3/h capacity, for pumping molten salt at 550°C. The pumps will be used in the Archimede Project, a 5-MW demonstration plant in Sicily, which is being developed by a consortium consisting of the Italian Energy Corp. (ENEL) and the Italian National R&D Institute for New Technologies, Energy and Environment (both Rome).

For this relatively small project, 8-m tall GVSO pumps will be used, says sales engineer Jürgen Weinerth. Friatec is also bidding on the Gemasolar tower project, which would require 16-ft tall pumps with a 260-m head and handle 40-bars pressure, he says.

Both Alfa Laval AB (Lund, Sweden, www.alfalaval.com) and GEA Group (Bochum, Germany; www.geagroup.com) have supplied equipment to some of the new CSP projects. Alfa Laval has, for example, recently closed three orders for plate heat exchangers for the Solnova 1, 3 and 4 plants, says Efrén Fernández, sales manager at Alfa Laval Iberia S.A. (Madrid).

In January, GEA Ibérica acquired Caldemón Ibérica S.A., a leading manufacturer of shell-and-tube exchangers and surface condensers that are commonly used in CSP plants. The company has already supplied surface condensers to the PS10 and PS20 projects, as well as to Andasol 1 & 2, Extresol 1 & 2 and Ibersol–Puertollano. GEA not only anticipates market growth in Mediterranean countries such as Italy, Greece, and Croatia, but also a huge potential in the U.S. as well as North Africa and the Middle East.

Last December, BrightSource Energy, Inc. (Oakland, Calif.; www.brightsourceenergy.com) ordered the world's largest solar-powered steam turbine from Siemens Energy (Erlangen, Germany; www.siemens.com/energy). The 123-MW steam turbine will be used in the Ivanapah Solar Complex in the Mojave Desert. The turbine is to be delivered in 2011, and the 100-MW plant will generate electricity in 4Q 2011.

Siemens has already secured orders for 45 specially adapted steam turbines for solar thermal plants ranging in size from 1.5 to 123 MW. In October, CEO Markus Tacke said that solar power is one of the fastest growing power plant markets, and solar accounted for company revenues totaling €17 billion in 2007.

ABB is also taking part in the CSP surge, receiving contracts to supply the distributed control system for Andasol 1 & 2 plants and more recently, to automate the Extresol 1 & 2 CSP plants in southern Spain. For Extresol, the firm's AC500 PLCs are equipped with an advanced solar positioning algorithm that was developed by ABB, which enables the collectors to track the sun to within 0.03 deg. of error, therby absorbing the maximum amount of energy at all times, says ABB. ■

Gerald Ondrey

IF THEY BUILD IT, WILL YOU COME?

Despite emerging wireless standards and heaps of benefits, the CPI are approaching wireless technology with caution

Endress+Hauser

Endress+Hauser strives to develop wireless technology that easily integrates with the supply chain and other plant environments

Despite various studies and process automation supplier suggestions that wireless sensing technologies cost less and provide tighter control than their wired counterparts, chemical processors are still proceeding with caution when it comes to implementing wireless instrumentation. Wireless supporters hope the introduction of WirelessHART and the eventual publication of ISA 100 will help break down the barriers as previously sketchy wireless characteristics such as security and reliability will be improved thanks to the standards.

Wireless benefits

Notwithstanding the slow start, wireless does provide a plethora of benefits. Some can even be seen in black and white. For example, Emerson Process Management (Austin, Texas) has unveiled quantified results of an independent real-world greenfield project that recommends wireless infrastructure be a key component of all new projects. JDI Contracts, Inc. (Cohasset, Minn.) applied Emerson's Smart Wireless technology to applications in a new process plant for a major U.S. chemical manufacturer, where economics, efficiency and other advantages made the case for wireless.

JDI worked with a major EPC and end user to study the project impact of wireless. It compared engineering, construction, startup and overhead costs for approaches using wired HART, wired bus technologies, WirelessHART and combinations of each. Wireless was used for non-safety, low-speed control and monitoring, amounting to about 25% of the total points.

With each paradigm shift — wireless being the latest — plants realized savings and became smarter through simpler engineering and construction, flexible startup, faster deployment and project completion, and changing automation needs. For the use of Smart Wireless on 25% of points, overall plant engineering, construction and startup savings were about 10% of considered costs as compared with wired HART; for the bus installation, wireless savings were on par with wired busing. Although not quantified, other considerations of flexibility and schedule impact were deemed very important in each approach.

"With wireless technology, we can deliver a better plant," says Roger Hoyum, principal engineer with JDI Contracts. He adds that wireless is an important new tool in capital projects. "It delivers savings, flexibility and speed of implementation."

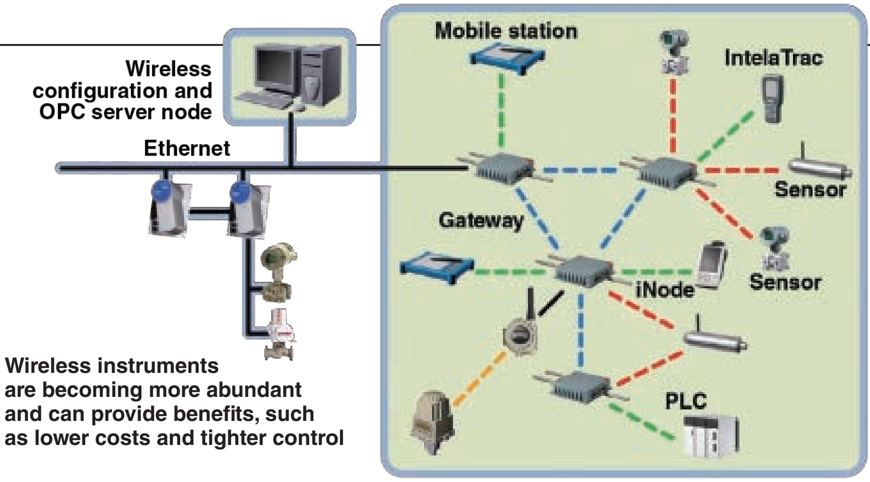
And, wireless perks extend beyond greenfield projects. For new or existing projects, one of the biggest benefits is the hard dollar savings of installing wireless instrumentation versus running wires. The reduction in wiring allows chemical processors to place transmitters and sensors in places where it was previously prohibitive to do so because of the cost of wiring or the remote location of an asset, says Cliff Whitehead, manager of business development for Rockwell Automation (Milwaukee, Wis.).

But, saving money on installation in such applications is not the only benefit to be had. Previously, if there were wired devices in the field that weren't intelligent, operators had to do rounds and collect the data from these devices, explains Gareth Johnston, wireless product manager with ABB Instrumentation (Norwalk, Conn.). "Wireless versions of these instruments could be installed at a low cost, and the addition of these instruments would replace operator rounds, which could provide further savings via reduced labor costs," he says. Meanwhile, in the current economic climate, where a number of plants have already been forced to cut personnel, these tools can help ease the burden on the remaining staff.

Beyond cost savings, there are also production efficiencies to be had via wireless technologies. "Right now chemical processors are in a situation where they have to become more efficient, and the only way to do that is to look more deeply at the process," says Bob Karschnia, vice president of wireless for Emerson Process Management. He says the ability to very cost effectively obtain more measurements allows processors to see and understand what's going on at a deeper level, which allows processes to be controlled to tighter specifications. "More efficiency, less waste, better products and tighter tolerances will result, and these are all things chemical processors can use to differentiate themselves in the marketplace," explains Karschnia.

Standards: the cherry on top

While these benefits exist under any proprietary wireless infrastructure, having standards that provide an in-



Honeywell

Wireless instruments are becoming more abundant and can provide benefits, such as lower costs and tighter control

teroperable platform ups the ante. Prior to standardization, end users were faced with proprietary wireless networks that worked, but were limited in terms of expanding the system in the future and guaranteeing ongoing support, says Jeff Becker, director of global wireless business for Honeywell Process Solutions (Phoenix, Ariz.). Under both WirelessHART and ISA 100, end users will be able to select products from vendors that support the network they've chosen and know that the instruments will work together.

"Standards give users the ability to know whatever product they are installing — no matter the vendor — will talk to their system," says Billy Jenkins, product marketing manager with the Process Instrumentation and Analytics business unit of Siemens Energy & Automation (Alpharetta, Ga.). "There's no special programming and no special software or updates to get the instrument into the network."

Aside from this, end users can relax about security, which was one of the biggest turn offs associated with wireless. "Security is the first thing on people's mind when it comes to wireless networks," says Hesh Kagan, director of wireless programs for Invensys Process Systems (London, England). "Right now there's a lot of proprietary systems floating around and the way they implement security is variable from one vendor to another. But with standards, and strong organizations behind those standards, it will verify that security measures of the networks and instruments will be excellent, provided the end user correctly implements them."

Though ISA 100 and WirelessHART standards developers took great pains to ensure encryption and authentication methods to enhance security of the devices and end users can feel safe that there are no lax points, experts say it is still up to the end users to maintain the security of the systems.

"There is a dark side to wireless," notes Kagan. "The level of effort associated with keeping wireless networks secure and maintaining them so they remain robust is greater than with a wired network."

STANDARDS: THE BIG TWO

While several standards concerning wireless instrumentation exist in the world of process control, WirlessHART and ISA 100.11a seem to be garnering the most support from equipment manufacturers and end users. Though the two share a similar objective — to create an interoperable communication platform for wireless process instrumentation — the standards and specifications remain separate entities. However some hope persists that the two will eventually unite.

WirelessHART basics

The wireless version of the HART Communication Protocol, WirelessHART, uses a wireless mesh networking multipath topology and is designed specifically for process automation applications. Each WirelessHART network includes three main elements:

- Wireless field devices (or wired field devices with wireless adapters) connected to process or plant equipment
- Gateways/Access Points that enable communication between wireless field devices and host applications connected via a high-speed backbone or other existing plant communications network
- A Network Manager responsible for configuring the network, scheduling communications, managing message routes and monitoring network health

WirelessHART devices use IEEE 802.15.4 compatible radios operating in the 2.4 GHz Industrial, Scientific, and Medical radio band. The radios employ direct-sequence spread spectrum technology and channel hopping for communication security and reliability, as well as Time Division Multiple Access for synchronized low latency communications between devices on the network.

It should be noted that WirelessHART is already a published specification.

ISA 100 Basics

Similarly, ISA 100.11a is a multi-protocol capability that also will allow users to deploy a single, integrated wireless infrastructure platform in a plant. The standard network will have the ability to simultane-

Enhanced features

Perhaps one of the most overlooked benefits of wireless standards is reduced costs for the instrument suppliers, which can lead to increased innovation, resulting in enhanced product offerings.

"When dealing with proprietary systems, each manufacturer had to spend a lot of money to develop and maintain the platform, but when building to a standard, R&D can be focused on the elements of the system that will enhance or differentiate it from other systems," explains Becker. "Now instead of having to spend 50% of my money to make a proprietary system, I can spend 10% of my money to buy the standard and then spend the rest on adding improvements to make the product extra special with more benefits to the customer."

For instance, Honeywell's OneWireless solution, which is ISA 100 ready,

Circle 18 on p. 62 or go to adlinks.che.com/23012-18

ously communicate with many existing application protocols wirelessly throughout a plant, including HART, Foundation Fieldbus, Modbus, Profibus, Common Industrial Protocol and more. The ISA 100 network will be optimized to send all these protocols wirelessly, preserving existing protocol investments and protecting future protocol needs.

The ISA family of standards is being designed with coexistence in mind. The standards will feature technology to ensure the best performance possible in the presence of other wireless networks. Coexistence with other wireless devices anticipated in the industrial workspace is a major goal of this standard, as is interoperability with all other ISA 100-based devices.

ISA 100 has yet to be published.

Working it out?

Recently, the ISA 100 standards committee on wireless systems for automation created a subcommittee to address options for convergence of the ISA 100.11a and WirelessHART standards. The subcommittee will compare the technologies of the two standards with the ultimate goal of merging the best of both standards into a single, subsequent release of the ISA standard.

Many instrumentation manufacturers are hoping this occurs because having two separate standards puts ends users into a difficult position. "End users are reluctant to choose between the two because they worry that they aren't selecting the right technology," says Jeff Becker, director of global wireless business for Honeywell Process Solutions.

He says it is in the best interest of everyone involved if the two can find common ground "This would allow end users to comfortably buy a system today if they know there's a roadmap that will bring them to a single unified system in the future."

Others aren't as optimistic about finding common ground. "ABB has long believed that a single fieldbus standard would provide significant benefits to both users and vendors. However, it is a business reality that multiple standards are here to stay," says Josef Guth, head of ABB Instrumentation's Global Instrumentation Business Unit.

And, with many other vendors feeling the same, WirelessHART seems to be the more-widely embraced standard, simply because it is the first out of the gate. WirelessHART specifications were published about one year ago, while ISA 100.11a is still under review. And, for many vendors, timing is everything.

"One year ago the specification of HART V7 was released, and from our point of view, WirelessHART is the most important part as it is currently the only open industrial standard for wireless communication at field level in the process industry available worldwide," says Has-Georg Kumpfmuller, division president for Sensors and Communication with Siemens Energy & Process. "We believe that WirelessHART will be successful as many customers and big automation suppliers brought their experience in wireless technology into the specification. In 2009, we plan to have WirelessHART products to enable our customers to build complete solutions."

Other process automation suppliers are following suit. ABB, Emerson Process Management, Endress+Hauser and Siemens are among the vendors already offering or soon to launch WirelessHART-capable products. ❑

provides a single, plant-wide infrastructure that can support multiple applications, including field instrumentation, equipment health monitoring devices and mobility solutions that are focused on improving safety, reliability and efficiency at the customer's plant.

Emerson Process Management is striving to make its' WirelessHART-enabled product line, Smart Wireless, very broad and easy to use. "Our strategy as a company is that every product we make will have a wireless option and those products will all be easy to use," says Karschnia.

Meanwhile, Endress+Hauser is concentrating its efforts on superior integration into the processing environment. "We want our wireless technology to have the best integration into a supply chain environment, asset management environment, energy management and process monitoring environment to make sure the information becomes practically available in the existing system," says Craig McIntyre, industry manager for chemicals with Endress+Hauser (Greenwood, Mass.). "We are about adaptation into the environment."

WIRELESS INSTRUMENTATION & NETWORK SERVICE PROVIDERS

ABB Instrumentation	www.abb.us
Emerson Process Management	www.emersonprocess.com
Endress+Hauser	www.us.endress.com
Honeywell	www.honeywell.com
Invensys Process Systems	www.invensys.com
Rockwell Automation	www.rockwellautomation.com
Siemens Energy & Automation	www.siemens.com
Yokogawa	www.yokogawa.com

Honeywell

Proceeding with caution

Now that many vendors have developed wireless instruments with such enhancements, the real question remains, will the chemical processors be willing to use them? In short, the answer is yes, but with caution.

The general consensus is that because chemical processors tend to be a conservative bunch regarding new technologies, they will start applying wireless technologies in non-critical environments to measure points that aren't currently being measured.

"Once they get confident and gain some experience, they will slowly start to use the technology in more demanding applications," notes Frank Hils, corporate director of projects and solutions with Endress+Hauser.

One way chemical processors will gain such experience, suggests Kagan, is by taking small steps by using something like Invensys' Mobile Operator, which allows "untethered" operators to roam the facility with handheld wireless devices. "That type of technology allows them to get their feet wet and explore wireless technology without a huge commitment. With Mobile Operator, and others like it, they are on the cusp of joining in on wireless activity. Maybe they are doing so with a raised eyebrow and with caution, but none-the-less, they are jumping on the wireless bandwagon." ■

Joy LePree

Circle 20 on p. 62 or go to adlinks.che.com/23012-20

Department Editor: Kate Torzewski

Membrane Configurations

Membrane polymers are packaged into a configuration, commonly called a device or an element. The most-common element configurations (figure) are tubular, capillary fiber, spiral wound, and plate and frame.

TUBULAR

Made from ceramic, carbon, stainless steel or a number of thermoplastics, tubular elements have inside diameters from 1/4 in. up to about 1 in. Typically, the membrane is coated on the inside of the tube, and the feed solution flows through the interior (lumen) from one end to the other, with the permeate passing through the wall and collected on the outside of the tube.

CAPILLARY (HOLLOW FIBER)

These elements are similar to the tubular element in design. They are, however, smaller in diameter and usually consist of unsupported membrane polymers, which require rigid support on each end. This support is provided by an epoxy "potting" of a bundle of the fibers inside a cylinder. The feed flow is either down the interior of the fiber or around its outside.

SPIRAL WOUND

This type of element is made from an envelope of sheet membrane, wound around a permeate tube that is perforated to allow collection of the permeate. Feed water becomes purified by passing through one layer of the membrane and flowing into the permeate tube. This is by far the most common configuration in water-purification applications.

PLATE AND FRAME

This kind of element employs sheet membrane, stretched over a frame to separate the layers and facilitate collection of the permeate, which goes to a center tube.

CHOOSING A CONFIGURATION

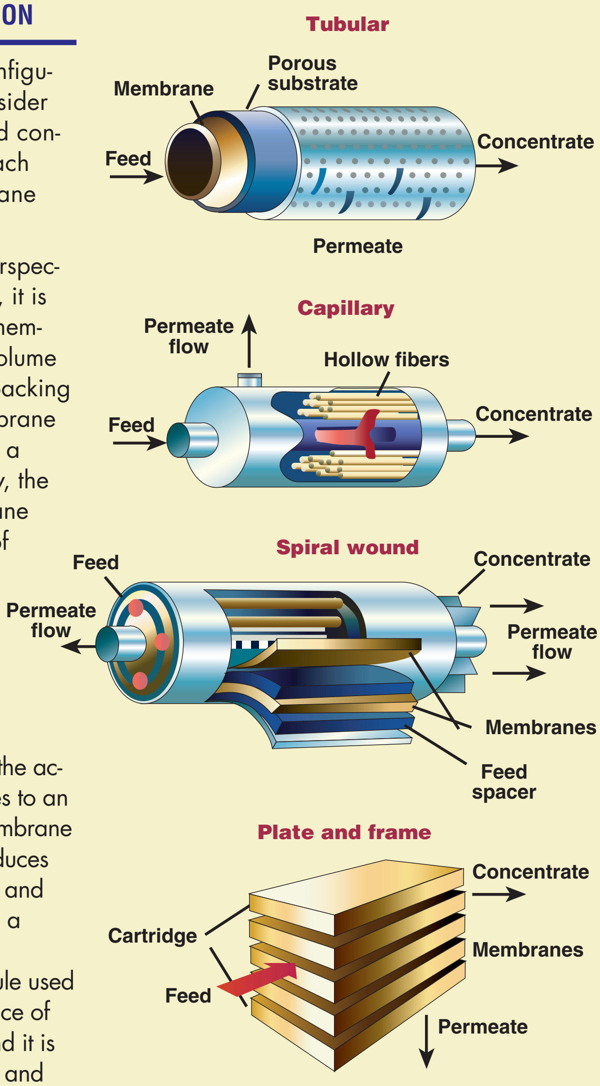
In selecting a membrane configuration, it is important to consider how the packing density and concentration polarization of each configuration affects membrane fouling resistance.

Packing density. From the perspective of cost and convenience, it is beneficial to pack as much membrane area into as small a volume as possible. The higher the packing density, the greater the membrane area enclosed in a device of a given volume, and, generally, the lower the cost of the membrane element. The disadvantage of membrane elements having high packing density is their greater propensity for fouling, as outlined in the table.

Concentration polarization. Concentration polarization is the accumulation of rejected particles to an extent that transport to the membrane surface becomes limited. It reduces the permeability of the solvent and can lead to a limiting flux and a higher fouling tendency.

The type of membrane module used in a process affects the influence of concentration polarization; and it is difficult to balance high fluxes and low fouling with low investment and operating costs. Tubular modules can accommodate high cross flow and large particles, but their capital costs and ratio of relative price to membrane area are considerably higher than those for spiral-wound modules. Spiral-wound modules, on the other hand, enjoy the advantages of lower installed costs and easier changeout. Channel height can be varied by the use of distance keepers, also known as spacers.

Capillary membrane modules can be backwashed inline during filtration to remove particles from the membrane or to add chemicals from the permeate side. Like tubular modules, they have high investment costs, but their ability to backwash at regular intervals reduces the potential for fouling.



COMPARISON OF MEMBRANE ELEMENT CONFIGURATIONS

Element configuration	Packing density*	Fouling resistance**
Capillary filter	medium	high
Plate and frame	low	high
Spiral wound	medium	moderate
Tubular	low	high

* Membrane area per unit volume of element
** Tolerance to suspended solids

References

1. Cartwright, P., Membranes for Process Water Reuse, *Chem. Eng.*, June 2004, pp. 38–42.
2. Baird, A., Making High-Purity Water, *Chem. Eng.*, May 2005, pp. 36–43.
3. Buecker, B., Microfiltration for CPI Wastewater, *Chem. Eng.*, May 2007, pp. 63–65.
4. Lipnizki, J., Strategies for Controlling Membrane Fouling, *Chem. Eng.*, September 2007, pp. 62–64.

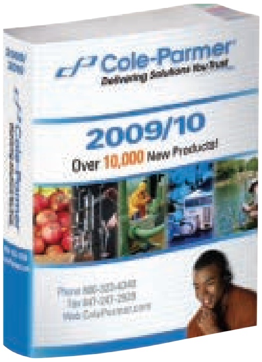
CHEMICAL ENGINEERING'S
CHE.COM
MARCH 2009

Literature Review

Featuring Brochures and Catalogs of Products and Services for the CPI

Visit CE Lit Online at che.com

2009/10 Cole-Parmer® General Catalog



This 2,600-page book features a vast selection of chemical industry products including test, measurement, and process control instrumentation, flowmeters, fittings, valves, and much more. Find products from industry-leading brands—including over 10,000 new products—all backed by our **FREE** applications assistance. To request your **FREE** catalog, call ***800-323-4340*** or visit ***ColeParmer.com/4075***

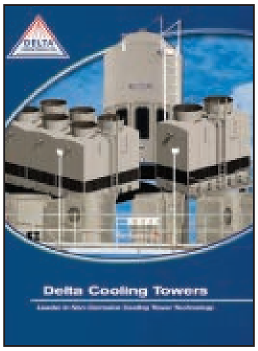
Circle 295 on p. 62 or go to adlinks.che.com/23012-295

These railcar movers are best for small to mid-size applications

The CUB® Railcar Mover is designed to move one railcar or a group of railcars safely. It moves along a steel runway utilizing a carriage assembly without dangerous wire ropes. Two pivoting arms securely capture the railcar truck frame. A variable speed motor drive powers a chain and sprocket arrangement that allows the CUB to travel in a swift bi-directional manner. Safe, easy to install and operate, the CUB is ideal for small to mid-sized railcar loading, unloading and repositioning. H&P offers a complete line of railcar movers from 1 railcar to a complete train. Visit us at ***www.heylpatterson.com***
P 412-788-9810 F412-788-9822 E info@heylpatterson.com

Circle 296 on p. 62 or go to adlinks.che.com/23012-296

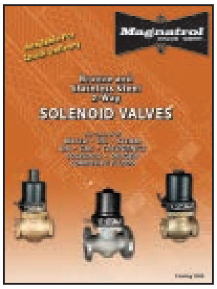
Delta Cooling Towers, Inc.



Delta Cooling Towers manufactures a complete line of corrosion-proof engineered plastic cooling towers. The towers incorporate a high efficiency counter-flow design and carry a 15-year warranty on the casing, which is molded into a unitary leak-proof structure of engineered plastic. All models are factory assembled, simple to install and nearly maintenance free.
1-800-289-3358 www.deltacooling.com
sales@deltacooling.com

Circle 297 on p. 62 or go to adlinks.che.com/23012-297

New Catalog - Magnatrol Solenoid Valves

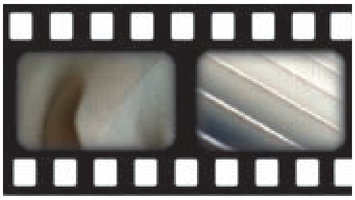


NEW catalog details 2-way bronze & stainless steel solenoid valves 1/4" - 3" to control flow of Water, Ammonias, Fuel Oil, Gas, Steam, Brine, Solvents, Cryogenics and Oxygen. Available NC/NO, packless construction, continuous-duty coils for all voltages, no differential pressure required to open and 2-way straight thru design. For literature or same day quotation contact:
MAGNATROL VALVE CORPORATION
67 Fifth Avenue • P.O. Box 17 • Hawthorne, New Jersey • 07507 • U.S.A.
PHONE: 973-427-4341 - FAX: 973-427-7611
E-MAIL: info@magnatrol.com WEB SITE: www.magnatrol.com

Circle 298 on p. 62 or go to adlinks.che.com/23012-298

EPA Certified Filter Medias!

Midwesco® utilizes all available filter medias that are certified by the EPA to meet U.S. emissions standards of P.M. 2.5 for both conventional and pleated filter fabrication.



Membrane Media **Spunbond Media**

Benefits for you:
- Energy Savings
- Energy Tax Credits
- Emission Reduction Credits
- Longer Filter Life
- Increases Throughput

*More information @ **www.midwescofilter.com***
*or call us **800.336.7300** or **+1.540.667.8500***

Interphex Booth # 1458

Circle 299 on p. 62 or go to adlinks.che.com/23012-299

ALL 316SS Solenoid Valve up to 6" Pipe Size

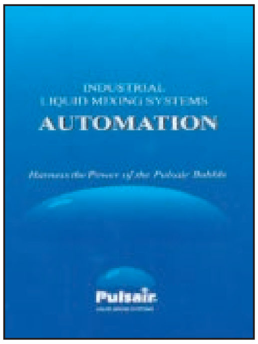
All wetted components are made from 316SS. This rotary shaft type solenoid valve completely isolates the fluid from all magnetic solenoid components. Easily handles corrosive or viscous fluids. Available in ½" to 6" pipe sizes. For literature or same day quotation contact:

CLARK-COOPER DIVISION
Magnatrol Valve Corporation
855 Industrial Hwy - Unit # 4
Cinnaminson, NJ 08077-1933
Phone: 856-829-4580 - Fax: 856-829-7303
E-Mail: techsupport@clarkcooper.com
Website: www.clarkcooper.com

Circle 300 on p. 62 or go to adlinks.che.com/23012-300

Mixing Solutions by Pulsair

Equipment



This brochure describes Pulsair's mixing systems that release sequential pulses of air or gas to mix tank contents. Systems are adaptable from a single 55-gallon drum to multiple 1,000,000 gallon tanks and can be managed from a central control unit. Pulsair mixers are currently in use worldwide in the petroleum, lubricant, wastewater, food and wine industries. ***Pulsair Systems, Inc.***, *Bellevue, WA; Tel: 800-582-7797; www.pulsair.com sales@pulsair.com*

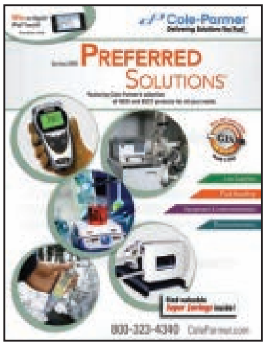
Circle 301 on p. 62 or go to adlinks.che.com/23012-301

Measure Transmitted Color of Liquids & Solids

The ***ColorQuest XT*** is a self-contained transmission spectrophotometer that measures the transmitted color of transparent materials such as resins, solvents, acids and oils. It includes widely used color scales and indices such as APHA/PtCo/Hazen. Gardner, Saybolt and ASTM Color. Data is displayed on an integral LCD. The ***ColorQuest XT*** eliminates the subjectivity of visual comparison methods and increases precision.
www.hunterlab.com/Industry/Chemical
See us at PITTCON Booth # 1748

Circle 302 on p. 62 or go to adlinks.che.com/23012-302

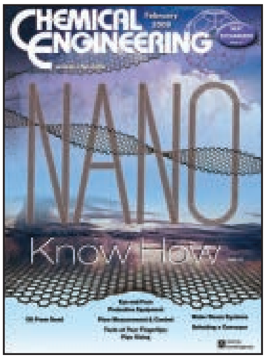
NEW Spring 2009 Cole-Parmer® Preferred Solutions® Catalog



This 96-page book features new and best-selling products, including fluid handling products, electrochemistry items, equipment and instrumentation, and lab supplies. Save time and money with exciting Super Savings promotions, additional quantity discounts, products guaranteed in stock, and no minimum order charges.
To request your **FREE** catalog, call ***800-323-4340*** or visit ***ColeParmer.com/4074***

Circle 303 on p. 62 or go to adlinks.che.com/23012-303

Place Your Ad Here!

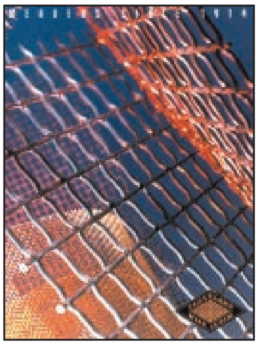


Advertise in Chemical Engineering Literature Review, a special bound-in-the-magazine supplement that can showcase your latest catalogs, brochures, and spec sheets. Reach over 266,700 engineering professionals who turn to *Chemical Engineering* every month for just this kind of production information.
Contact: ***Helene Hicks***
Inside Sales Manager
Phone: 212 621-4958 Fax: 212 621-4976
hhicks@che.com

www.che.com

Cleveland Wire Cloth

Wire Cloth



Specializes in high temperature, corrosion resistant, and specialty metals and alloys for process functions, as well as OEM components. Wire cloth is woven to precise, customer requirements. Catalog includes application data, design guidelines, technical specifications, ordering information, and a new, interactive CD with a wire cloth specifications calculator. *Tel: 800-321-3234 (U.S. & Canada) or 216-341-1832; Fax: 216-341-1876; cleveland@wirecloth.com; www.wirecloth.com*

Circle 304 on p. 62 or go to adlinks.che.com/23012-304

Boiler Tech Support

Topog-E Gasket Co. since 1956 formulates and mixes its own rubber, manufactures superior molded rubber handhole manhole gaskets for steam, hot water boilers, water heaters, softeners, deaerators, makeup tanks, & other selected pressure vessels. Topog-E Gaskets seal quickly, completely, preventing seepage, corrosion & pitting. ***Topog-E Gasket Co.*** offers a ***FREE*** Technical Specification & usage Guide and a ***FREE*** pocket slide rule to chart temp. vs. pressure. For more information contact: ***Topog-E Gasket Co.*** *1224 N. Utica, Tulsa, OK 74110, Tel: 800-587-7123, Fax: 918-587-6961, www.topog-e.com <http://www.topog-e.com>, info@topog-e.com.*

Circle 305 on p. 62 or go to adlinks.che.com/23012-305

Answers

The New
CHEMSHOW
Processing Solutions
for a Changing Marketplace

November 17-19, 2009
Javits Convention Center • New York City

Connecting Processor Needs To Supplier Solutions

- Increased focus on industry and global imperatives for **"Sustainable and Green Process Operations"**
- More solutions for core processing issues including **Optimizing Process Efficiency • Process Controls & Automation Solutions • Efficient Powder Processing • Water/Wastewater Treatment • Emerging Technologies**
- An **Online Matching Service to connect the right buyers with the right sellers** before, during and after the Show
- More practical educational opportunities to help processors succeed in this difficult economic environment including **AIChE-led Workshops, *Chemical Engineering Magazine*-sponsored Seminars, Nanotechnology Symposium, practical solutions-based Exhibitor Workshops,** and more

Join Our Growing Family of Exhibitors
Visit our Website for more information: www.chemshow.com
Or contact us at: Tel: 203-221-9232 • E-mail: info@chemshow.com

Produced and managed by:
INTERNATIONAL EXPOSITION CO.

Circle 21 on p. 62 or go to adlinks.che.com/23012-21

Using Web 2.0 Tools to Increase Your Productivity

Web 2.0 developments can improve an engineer's productivity at work, as well as his or her professional development

Adnan Siddiqui
Engineered Product Services, LLC

Since it was opened to commercial content in the early 1990s, the internet has become a ubiquitous repository of knowledge. Its open architecture allows for an almost unlimited number of diverse applications, such as sending and receiving email, sharing video clips, publishing blogs, performing commercial transactions, buying from mail-order stores and so on. While a plethora of internet services are valued for personal use, many can improve your productivity and performance as an engineer.

A major recent development in internet content is Web 2.0, which is an umbrella term used to describe the next generation of user interfaces and technologies that make it easier to use The Web. While the internet initially required some technical know-how to fully exploit its potential, Web 2.0 enhancements have refined internet use, and have reduced if not eliminated the need for this technical knowledge.

Web 2.0 technologies include blogs, Really Simple Syndication (RSS), social networks, online communities and other related technologies that make it easier for people to communicate and find information on the internet. For practicing engineers, Web 2.0 has created new productivity tools that can not only make work easier, but can also enhance professional and career development.

In this article, we will discuss how the following four important Web 2.0 services can help a practicing engineer improve productivity:

- Enhanced search engines with alert services
- Blogs and new article subscription services
- Social networks
- Industry and trade sites with technical news and discussion forums

Each of these services can provide engineers with an edge. Social networks can expand an engineer's peer network and contacts for both technical knowledge and career development. Enhanced search engines with alerts can help in finding information about a particular topic, as well as keeping users up to date on new content posted about the topic. Blogs reveal the latest ideas and thinking about engineering challenges. Finally, industry sites provide technical news, reference information and easy-to-use discussion forums to find technical answers.

Alert services for search engines

Search engines have been part of the internet since the early 1990s. The first search engines were directories of sites organized by category, similarly to telephone yellow pages. In the late 1990s, search engines allowed for keyword-based search for internet information. Today, search engines have become the primary entry point for people looking for new information on the internet. Google, Yahoo, and MSN are among the most well-known search engines today.

One recent Web 2.0 enhancement to search engines has been the development of automated, periodic-alert services, which are powerful tools for keeping up with new developments on a particular topic. Users can sign up for a daily alert via email related to any new content added to the internet about a specific keyword. For example, an engineer could subscribe to a daily email about new internet content on "distillation." The daily alert email will include the first few lines of the new Web page, as well as a link to it.

The alert tool is also useful for gathering competitive intelligence. Setting an alert with the name of a competitor's or competing product or company makes it easy to keep up with the latest information about it.

Since alerts are a recent technology, keep in mind that most alert services do not identify all new content. They are a powerful supplementary tool but should not be viewed as 100% comprehensive in their coverage. Also, it may take a few tries to find the optimum keywords to avoid receiving too many or too few links. Using more keywords will often result in focused, high-value alerts that are easier for users to scan and digest.

Blogs

Another recent Web 2.0 development is the refinement of weblogs, which are commonly referred to as blogs. While the origin of blogs can be traced to personal home pages created by early internet adopters, the development of Really Simple Syndication (RSS) has allowed for better distribution of blog content. RSS can be viewed as a newswire services for blogs. Using either a browser, a dedicated news reader such as Google Reader or even an email client like Outlook, RSS allows subscription to the content feed of a particular blog. The feed subscription will provide automatic alerts when new content is posted.

Currently, the number of technical and engineering blogs available on the internet is limited, but more are created daily. Most search engines allow users to search for blogs by keywords, while search engine alert services also cover popular blogs and will notify users if a keyword is mentioned in a new blog article.

Blogs can be used to keep up with developments in the industry, but more importantly, the lack of engineering blogs provides a low-cost opportunity for an engineer to build a reputation. A blog can be used to share solutions to a challenging problem or improvements to an existing design. New bloggers should not be discouraged if they initially have few readers; blogs tend to have a viral marketing growth cycle, and after the first few subscriptions are established, the readership usually jumps exponentially.

Social networks

Of the various new Web 2.0 developments, social networking has generated the most buzz. Covered extensively in media, social networks like MySpace and Facebook now claim several million members. Social networks have both professional and personal uses for engineers in developing contacts and building relationships in the industry.

Professional networks. One of the original social networks, LinkedIn, was started in 2003. LinkedIn is a professional social network for business and career development. Members can post their professional profiles and add colleagues and friends to their network. LinkedIn has professional and alumni networks to connect people with common backgrounds and interests, while allowing users to search for other members based on company, profession, school and so on. This network also allows for introductions between members that do not know each other.

An engineer can use LinkedIn to get in touch with colleagues and classmates. Furthermore, it can be used to stay in touch with professional colleagues after leaving a job without having to add them to a personal social network.

Another benefit of LinkedIn is the newly added Question and Answer feature, which allows users to post questions that can be answered by the network community. Most questions are related to information technology and business, but general engineering questions are often posted as well.

Personal networks. Facebook and MySpace are leading examples of personal social networks. Compared to LinkedIn, members profiles tend to focus more on personal information, such as hobbies, activities and personal photos. While Facebook and MySpace can be more effective than LinkedIn for finding classmates and coworkers due to their larger member populations, the informal and personal nature of these social networks limits their use as professional networking mediums. However, they can be used to find friends who can be added to professional networks.

Industry and trade sites

Although not actually a Web 2.0 technology, another source of professional knowledge is specialized industry websites with online forums. Such sites, which are sponsored by trade magazines and industry associations, provide venues for practicing engineers to share problems and solutions, resulting in a great wealth of technical knowledge about engineering products and design practices. Most of these sites host easy-to-use forums that allow technical questions to be posted for other engineers. If you encounter a novel problem or are searching for a product referral, these forums are a good starting point for obtaining industry knowledge. In addition to the trade magazines and associations, most engineering software vendors also have a forum where users can exchange tips.

A recent addition to technical websites has been online specification and book libraries, such as Knovel, ICIS Online and GlobalSpec. These websites allow for online retrieval and keyword searching of popular references and specifications. Such resources normally require subscription-based access, but many large corporations have a corporate subscription that permits their employees to use these sites. ■

Edited by Kate Torzewski

Author

Adnan Siddiqui is the founder and president of Engineered Project Services LLC (EPS; 5700 Northwest Central Dr., Ste. 301, Houston, TX 77092; Phone: 832-228-0327; Email: aasiddiqui@engineeredprojects.com), a provider of software and project advisory services to the process industries. After 11 years of capital project leadership experience with The Dow Chemical Co., Siddiqui founded EPS in 2008. EPS licenses ConcepSys, which enables rapid conceptual design of plant facilities for feasibility studies and cost estimates. He holds B.S. and M.S. degrees in civil engineering, as well as an MBA from the University of Texas at Austin. Siddiqui's project management blog can be found on the EPS website (www.engineeredproducts.com).

LIST

DRY PROCESSING – INTELLIGENT PROCESSING

Technical Bulletin

LISTrusted

March 2009

For over 40 years LIST has been known for high viscosity technology which is "clean" and conserving resources

Klaus R. List, President and CEO of the LIST Group

Heinz List, founder of the LIST Company in 1966, had already envisioned the possibilities of running solvent-light or even solvent-free chemical processes. He was convinced that operating processes in the liquid phase was both inefficient and uneconomical. But at this time processing in the concentrated phase was thought to be impractical and challenging as no technology was available to run processes others than in the liquid phase.

Following the founder's vision LIST has succeeded on developing and further improving a technology being able to treat pasty, crust forming and sticky products. The LIST KneaderReactor Technology was used mainly in drying and mixing processes with viscous phases. This changed in the early 90s when the LIST KneaderReactor Technology was more often applied to continuous and multiphase processes in the "concentrated" or "dry" phase especially in the field of fibers, polymers and elastomers.

Still focussing on this revolutionary technology it is the goal of LIST and its "brain trust", a large group of highly educated and experienced staff, to be and stay at the forefront of further developing and implementing this innovative "Dry Processing" technology.

More than ever before, LIST KneaderReactor Technology helps our customers running processes efficiently and economically in ways otherwise inconceivable using conventional technology. As reliable partners we support our customers with all the services required, starting at the feasibility of an application through project execution, implementation and help through the life cycle of an installation.

LISTrusted replaces the earlier LISToday. LISTrusted will focus and will report innovative technology developments, advanced process solutions, and the results of LIST's proprietary R&D.

Yours sincerely

Klaus R. List

i Contents

Polymer Industries | Chemical Industries | Fiber Industries | Food Industries | Environmental Industries | Life Cycle Management

Conventional versus New Technologies

For many years the processing industries have made use of conventional technologies for reaction (synthesis) and finishing (drying, crystallization, steam stripping, etc.) steps for the production of polymers and chemicals.

These technologies are considered to be technically mature, well engineered and perfected for application in processes utilizing solvents or diluents as the carrier phase and also for processes in which the product does not go through phase changes. Recent thinking challenges that convention, especially when there are phase changes occurring during the process. In addition, today's modern manufacturers demand processes that offer:

- Cost effectiveness
- Higher operating efficiency
- Optimum use of raw materials
- Elimination of toxic materials
- Cleaner production environment
- Energy conservation
- Minimum emissions and wastes
- Compact and flexible installations
- Minimum solvent requirements

To meet these demands the processing industries are researching new technological opportunities including:

- New processes, such as the synthesis in the concentrated phase and process intensification
- Innovations perfecting overall process control
- New chemical developments allowing new processes and products

Processing in the Concentrated Phase

In the chemical process industries a large number of products are processed in stirred tank reactors. Assuming the reactants are liquids or a mixture of solids and liquids, whereby the solids are soluble in the liquids, and while the reaction takes place the reaction mass does not undergo a physical phase change, then the reaction can be realized in a stirred tank.

If however phase changes occur during processing the conventional technology requires the use of diluents. For the most part, diluents decrease the viscosity of the reaction mass enabling better mixing, enhancing the control of the reaction temperature through contact heat transfer and through evaporative cooling with reflux condensation. Well-known examples are production of Xanthates, Hexamethylol Melamine (HMM), Superabsorbent Polymers (SAP), Synthetic Rubbers (SBR, ESBR, EPDM), and other Elastomers and Plastomers. More recently, manufacturers have been looking for technological solutions that allow synthesis in the concentrated phase and intensification of the process itself. While this thinking is just starting to become popular in the processing industry, it always was, is and will be LIST's core competence.

It was Heinz List, a pioneer of modern industrial processing technology, who in 1966 first said: "Processes in the concentrated phase are considerably more efficient than processes in the diluted phase and therefore also significantly more economical". He recognized that processing in the concentrated phase,

"Processes in the concentrated phase are considerably more efficient than processes in the diluted phase and therefore also significantly more economical."

Heinz List (1912 - 1988), founder of LIST AG, in 1966

Twin Shaft Continuous LIST KneaderReactor

meaning solvent-lean or even solvent-free, can maximize process yield per unit volume. In order to process in the concentrated phase, in itself a very complex and challenging task, new technology was required that subsequently allowed handling of high viscous, pasty and crust-forming products. He began the development of reliable process technology capable of handling phase changes during processing in the concentrated phase.

> !
>
> **Processing in the "Concentrated Phase" maximizes process yield per unit volume**

The new and revolutionary LIST KneaderReactor Technology, the core business focus of our company ever since, was introduced with the following competitive technological characteristics:

- Excellent mixing and kneading performance during wet, pasty and viscous phases
- Large working volume reactors efficiently handling large product volumes
- Large heat-exchange surface areas yielding highest possible surface-to-volume ratio
- Maximum self-cleaning
- Narrow residence-time distribution
- Adaptive for a wide range of residence times
- Closed design for cleaner production environment
- Robust design for high viscosity processing
- Compact design maximizing process yield per performance volume and minimizing space requirement

Today, LIST KneaderReactor Technology comprises the well-known twin shaft AP (1969) and single shaft DISCOTHERM B (1974), the versatile twin shaft ORP (1990), CRP (1990), CKR (2000), the unique single shaft LCD (**L**ist **C**ontinuous **D**issolver, 1992) the new generation single shaft CBP (**C**ontinuous **B**ulk **P**olymerizer, 2003), single shaft CME (**C**ontinuous **M**ain **E**vaporator, 2002) and TSF (**T**win **S**haft **F**inisher, 2002). The LIST KneaderReactor has long practiced what today is known as "Process Intensification", where multiple processing steps are performed in the same unit. Such units are characterized by high yield per performance volume and also have the flexibility to produce different grades and/or products.

Process Intensification
in practice using LIST Technology

Production of Hexamethylol Melamine

Hexamethylol melamine (HMM) is produced from melamine $[C_3N_3(NH_2)_3]$ and Formaldehyde $[CH_2O]$. The conventional process requires an excess of 7 – 10 mol formaldehyde per mol of melamine. The reaction product HMM is a paste containing 40 – 70 % water by weight and unreacted formaldehyde.

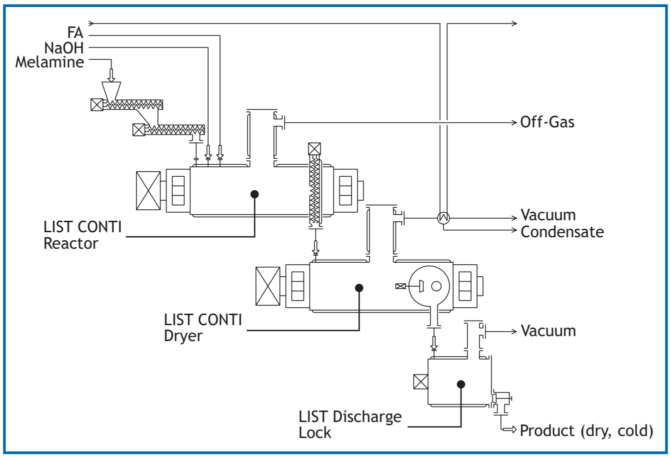


Fig. 1: Process flow diagram for the new HMM production process

The disadvantages of the conventional process are summarized as:

- The pasty HMM tends to harden
- Poor rheological properties (HMM sticks to surfaces) for mixing and further processing
- Poor ecological and safety characteristics because of the presence of free formaldehyde
- Because convective dryers are used, drying of HMM is difficult and un-economical. Low temperature drying is very expensive (HMM is temperature sensitive, polymerizing and degrading simultaneously at 133 °C) by a diffusion controlled mechanism
- Furthermore, convective drying has adverse ecological impact due to the release of formaldehyde

> **!**
>
> **LIST KneaderReactors have long practiced "Process Intensification"**

In cooperation with a European customer, LIST developed a new nearly stoichiometric process, whereby the KneaderReactor Technology is applied for the synthesis and the drying process stage (Fig. 1, Fig. 2 top right and Fig. 3).

> **i** Unique competitive characteristics
>
> - Continuous process starting with a solution of melamine and formaldehyde
> - Continuous reaction followed by continuous vacuum drying
> - Nearly stochiometric reaction
> - Final product at discharge of drying stage:
>   - White crystalline
>   - Powder or fine granular
>   - Low formaldehyde and water content
>   - Easy to handle

Bulk Polymerization of MMA to PMMA

The conventional bulk free radical polymerization of methyl methacrylate (MMA) to polymethyl methacrylate (PMMA) is realized in continuous stirred tank reactors (CSTR) whereby the conversion lies in the 50 – 60 % range and the unconverted MMA acts as solvent. Limitations are attributed to the viscosity increase, to the gel effect and to the inefficient management of the released energy of reaction (exothermic). The application of LIST CBP KneaderReactor Technology (Fig. 2 top left) for the bulk free radical (co-) polymerization of MMA without solvent overcomes the difficulty of temperature control, with a high conversion up to 95 % despite the increase of the viscosity and the strong Trommsdorff's effect (gel effect) exhibited from this reaction system.

The LIST CBP KneaderReactor is well suited to carry out the exothermic bulk free radical polymerization of MMA because the heat exchange surfaces provided in the casing jacket, shaft, and shaft kneading elements can remove the exothermic heat of reaction and mechanical heat input in order to maintain the proper reaction temperature. Evaporative cooling is also utilized to remove this heat by evaporating, condensing and refluxing MMA.

Fig. 2: Top left, Single Shaft LIST CBP KneaderReactor; Top right: Twin Shaft LIST CONTI KneaderReactor for HMM Synthesis

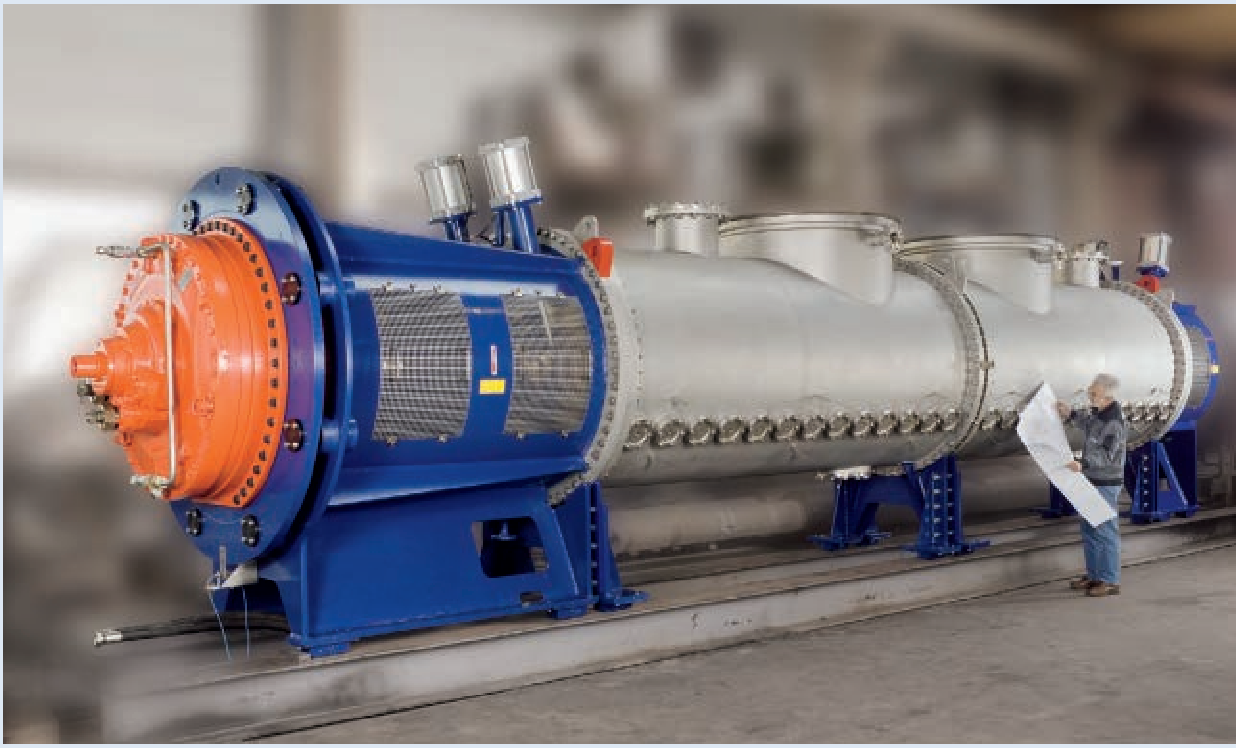


Fig. 3: Single Shaft LIST CONTI KneaderReactor for HMM Drying

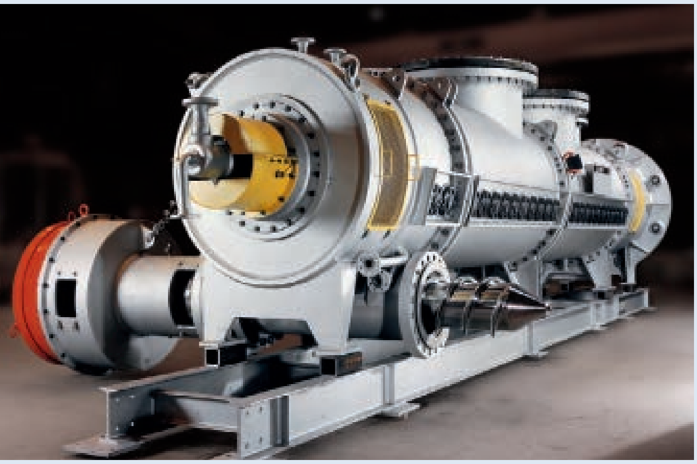
Additionally, the kneading/cleaning elements of the LIST CBP KneaderReactor provide constant surface renewal, which further improves heat transfer by reducing stagnant zones of polymer that may insulate against heat transfer. These elements also reduce or eliminate the diffusion and mass transfer limitations of the reaction by keeping the polymer mass well mixed radially and axially. Minimizing the mass transfer limitation leads to significant reduction of the reaction time, thereby maximizing the production capacity per unit time and volume.

Concluding, the bulk free radical (co-) polymerization of MMA to PMMA reflects processing in the concentrated phase and process intensification thus demonstrating outstanding economic advantages as compared to the CSTR processing technology.

Dry Processing of Elastomers

Typical processes to make synthetic elastomers include emulsion, suspension, or solution polymerizations. For example, styrene-butadiene rubber (SBR) is made by solution polymerization of styrene and butadiene in a solvent (hexane, cyclohexane, toluene, etc.).

The concentration of SBR in the solvent is kept low (10 – 25 %). Once the reaction is complete, the resulting cement solution of crude product is coagulated and stripped with steam in hot water in order to remove the solvent from the rubber. This is the "Wet Process", where the so-called "rubber slurry" is subjected to a series of mechanical dewatering steps to remove the majority of the water. Convective dryers are then typically used to remove the final residual amount of water from the rubber.



Single Shaft LIST CONTI KneaderReactor for Drying Processing-Devolatilization

Single Shaft BATCH LIST KneaderReactor for heterogeneous reactions

The principle benefit of the wet process is that the technology has been used for over 50 years, consequently, the equipment and process are well known and understood. There are however significant disadvantages. A large amount of steam is used for coagulation and stripping. The recovered solvent must be refined, as it contains significant amounts of water. As the targeted final residual solvent content decreases, the amount of steam required increases dramatically. Polymers that stick to the jacket of the stripping vessel or strongly foam cannot be steam stripped. Since the hot air exiting the rubber dryers contains solvent, the exhaust must be treated in an incinerator for environmental reasons. Many pieces of equipment are required for this process, thus requiring more maintenance, a larger plant footprint, and difficult cleaning procedures. When polymers are produced using metallocene catalysts, water coagulation and steam stripping is prohibited. If water coagulation and steam stripping is applied for the separation of the solvent from polymers produced using anionic catalytic systems, the recovery of a pure, water free solvent requires a high recovery effort.

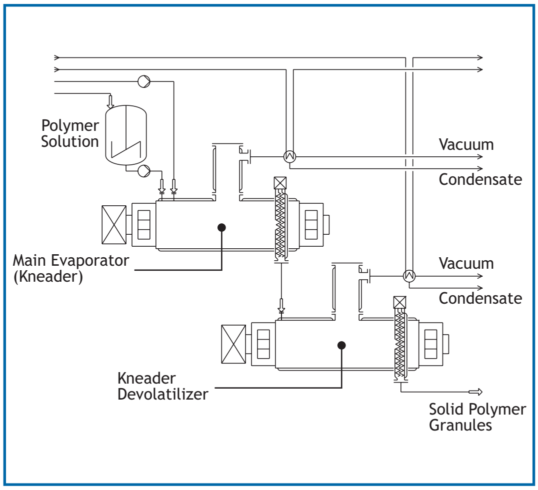


Fig. 4: Process Flow Diagram "Dry Process"

In order to resolve these drawbacks, a new continuous two-step process for the direct devolatilization of elastomers was developed. This so-called "Dry Process" addresses the disadvantages of wet Processing, which are: high water and steam consumption, high energy consumption, environmental problems due to high level of emissions, solvent purification, and high maintenance and cleaning costs due to amount of equipment required. At the core of this new process is the new generation single shaft LIST CME and twin shaft finisher LIST TSF KneaderReactor. Fig. 4 shows the process flow diagram of the "Dry Process" technology.

> **!**
>
> **Dry Processing reduces energy and solvent consumption**

The first step, the primary evaporator concentrates cement solution and the recovery of the solvent for direct recycling back to the reactor. The main evaporation takes place either at atmospheric pressure or under vacuum. The type of solvent present and the temperature sensitivity of the rubber determine the selection of the operating pressure. The continuous operation takes place entirely in the viscous phase so that a large portion of the required energy is provided by mechanical means. The concentrated cement, roughly 90 – 95 % rubber concentration, is continuously discharged from the LIST CME main evaporator and fed to the LIST TSF twin shaft finisher. The LIST TSF twin-shaft finisher typically operates under vacuum. The function of the finisher is to reduce the residual solvent concentration down to the required volatile level, normally between 200 - 2000 ppm. Depending on the temperature sensitivity of the rubber the state of the rubber mass under which operations take place is selected.

It is estimated that the Dry Process reduces energy consumption by up to 76 % when compared to the conventional Wet Process. Further more, it is also estimated that the consumption of water is decreased by up to 66 %.

Summarizing, the Dry Process shows remarkable advantages compared to the conventional Wet Process and drying process. By not using steam/ water for the separation of solvent and rubber, energy can be saved, emissions reduced, and purification of the solvent can be eliminated. Trace amounts of water in the recycled solvent will also be eliminated, which may also permit the application of new catalytic systems (anionic polymerization; metallocene catalysts) or the development of polymers that were previously not possible due to water sensitivity or due to temperature sensitivity (<100 °C).

All-In-One Processing

The conventional way to operate processes involving multiple phase changes is to handle those changes in separate distinct process steps.

> **!**
>
> **LIST's "All-in-One" Processors minimize operating costs**

Accordingly, the associated space requirements, investment and operating costs are substantial. In contrast, LIST KneaderReactors with large working volumes can combine several unit operations and multi-phase processing in a single unit. This solution helps manufacturers realize a faster return on their investment, minimize their operating costs and gives them a competitive edge.

> **i** Examples of "All-In-One Processing"
>
> The following are examples of "All-In-One Processing" from the various industrial sectors demonstrating the capacities and potentials of the solutions provided from the specialized LIST KneaderReactor Technology:
>
> - The continuous crystallization of sugar alcohols by flash evaporation with subsequent vacuum drying
> - The realization of heterogeneous reactions in the absence of solvents or in the presence of low solvent concentration such as, Xanthates, CMC, food Phosphates, etc.
> - The evaporative concentration with subsequent dissolving of cellulose, or of poly-phenylene terephthalamide (PPTA) to a homogeneous spinning solution
> - The evaporative separation of Toluene Diisocyanate (TDI) from distillation residue with subsequent drying and total recovery of TDI
>
> The above processes are characterized by multiple phase changes, they are heat transfer controlled, but also diffusion limited unit operations. The success of the LIST KneaderReactor Technology has far exceeded anybody's expectations.

LIST

DRY PROCESSING – INTELLIGENT PROCESSING

Polymer
Industries

Chemical
Industries

Fiber
Industries

Food
Industries

Environmental
Industries

Life Cycle
Management

Try dry, forget wet

LIST informs and demonstrates the advantages and benefits of DRY PROCESSING.

Visit us at ACHEMA 2009,
May 11 – 15 in Frankfurt/DE
Hall 4.1 Booth F8 – G9

NPE 2009

Visit us at NPE 2009/ANTEC 2009
June 22 – 26 in Chicago, IL
Booth 58072

ANTEC 2009

LIST AG
Berstelstrasse 24
CH-4422 Arisdorf
Switzerland
Phone +41 61 815 30 00
Fax +41 61 815 30 01
www.list.ch
info@list.ch

LIST USA INC.
1629 Cross Beam Drive
Charlotte, NC 28217
USA
Phone +1 704 423 54 78
Fax +1 704 423 02 10
www.list.us
info@list.us

LIST AG (SINGAPORE BRANCH)
9 Temasek Boulevard
#18-01A, Suntec City Tower Two
SGP-038989 Singapore
Phone +65 63 38 78 76
Fax +65 63 38 37 71
www.list.sg
info@list.sg

IMPRINT
No reproduction of publication without approval of LIST AG

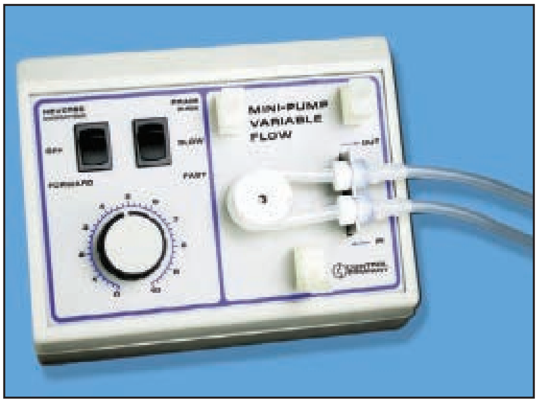
Issue: March 2009
Print run: 68.000

Show Preview

Veolia Water Solutions & Technologies

ACHEMA 2009

GEKO-Pumpen



Control Company

UWT

GEA

Achema 2009 (Frankfurt am Main, Germany; May 11–15), the World's largest assembly of chemical process industry professionals is approaching. With over 200,000 visitors and more than 3,500 exhibitors from 50 countries filling the exhibition grounds of Messe Frankfurt GmbH, this exhibition and congress on chemical engineering, environmental protection and biotechnology continues to be the flagship trade fair for the chemical process industries (CPI).

Dechema e.V. (www.dechema.de), the show organizer, reports that the Achema Congress is now larger than ever, with 925 lectures. The estimated 27,000 congress attendees will have the opportunity to take part in podium discussions, expert talks and plenary lectures that will reflect the diverse areas of process engineering. In addition to the Congress, the Industrial Biotechnology Partnering Conference will focus specifically on the growing significance of industrial biotechnology in the chemical, pharmaceutical, cosmetics, food and textile industries.

Below is a cross-section of the products and services that will be on display at the show. For more details on the event and developing news about the planned technology announcements and the congress, please visit www.che.com/achema, which we will be updating often. When you arrive at the exhibition grounds, stay on top of breaking show news with the Achema Daily, which will be produced by the staffs of *Chemical Engineering* and Vogel Business Media GmbH. And, as you make your way through the exhibition halls, be sure to stop by the Chemical Engineering stand (Hall 9.0, Stand G30; Hall 5.1/6.1, Stand A1) to say hello.

Use this non-contaminating pump for clean applications

These new compact, variable-flow, bi-directional, self-priming, peristaltic pumps (photo) offer precise flow deliveries. They are ideal for use with conductivity flow-thru cells, liquid chromatography, collecting fractions, pH/circulating fluids or buffers in baths, and moving corrosive materials. They provide outstanding flow control and flexibility for transferring and dosing liquids. The fluid contacts only the tubing for contamination-free pumping. Flowrates are from 0.005–600 mL/min. Variable-speed flow control and five different tubing sizes provide fine resolution with a wide flow range. Tubing may be used with fluid temperatures from –80 to 500°F. The unit pumps liquids and gases and will not he harmed by dry pumping. Hall 5.1, Stand B21–22 — *Control Co., Friendswood, Tex.*
www.control3.com

Tank-bottom valves now available in larger widths

Vesta Tank Bottom Valves (photo) are used to shut off liquid media at vessels or tanks. Preferably installed at the lowest point of the tank bottom, their characteristic feature is shut-off at tank bottom level without any sump. The pocket-free design enables complete draining of the vessel and optimal clean-in-place (CIP) and steam-in-place (SIP). Due to the compact design, these valves are also ideal for confined spaces. The new extended range includes the following sizes: DN 32, 40, 50, 65 (DIN pipe standard); ISO 42.4, 48.3 and 60.3 (ISO pipe standard); and OD 1.5, 2, 2.5 and 3 in. (OD pipe standard). The ex-

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

tended range of valves is available for manual operation with NC/NO pneumatic actuators made from synthetic material or stainless steel. Hall 4.1, Stand D13–G22 — *GEA Tuchenhagen GmbH, Büchen, Germany*
www.tuchenhagen.com

Operate under harsh conditions with ceramic membranes
The CeraMem proprietary technology platform (photo, p. 40D-1) provides ceramic membrane performance at comparable lifecycle costs to polymeric membranes. The design, which is a combination of unique materials of construction and novel membrane chemistry, allows the utilization of large-diameter ceramic monolith microfiltration membranes and ultrafiltration that reduce the overall footprint of installed equipment. These features allow operation in harsh environments, including processing high temperature feed, resistance to chemical and abrasive attacks, and membrane elements inert to all solvents. Hall 4.1, Stand J8–J10 — *Veolia Water Solutions & Technologies, Saint Maurice, France*
www.veoliawaterst.com


GEA Ecoflex

This heat exchanger holds up to a thousand plates
The new NT 500 plate heat exchanger (photo) sets new performance standards with a volume flow of up to 4,500 m^3/h. The steel frame can hold up to a thousand plates, and the largest version is 4.7-m high and 1.6-m wide. Maximum operating pressure is 16 bars, and the firm's OptiWave technology guarantees the best flow behavior across the full plate width, says the manufacturer. The NT 500 is fitted with glue-less EcoLoc gaskets, which can be replaced quickly and easily. Thanks to the PosLoc system, the plate heat exchanger has a self-centering plate pack, which guarantees a perfect fit of the plates to ensure safe process reliability. Hall 4.0, Stand A13–G22 — *GEA Ecoflex GmbH, Sarstedt, Germany*
www.gea-ecoflex.de

Pump hazardous liquids without the risk of corrosion or leaks
Designed for pumping hazardous and chemically aggressive liquids, this sealless PTFE/PFA-lined chemical pump (photo, p. 40D-1) complies with DIN

AM Technology

Christ Water Technology

EN 22858 and Atex. The pump provides virtually leak-free operation and unrestricted corrosion resistance, even at temperatures of 160°C and higher. The pump features PTFE impellers with shovels, PTFE-lined, carbon-fiber isolation shells, and delivers maximum flowrates of up to 180 m^3/h. Modular design permits the use of either a bear-shaft or block-type design, both of which are interchangeable. Pumps with mechanical seals are also available. Hall 8, Stand J45–J48 — *GEKO-Pumpen GmbH, Eltville, Germany*
www.geko-pumpen.de

This EDI module also has a membrane stage
Septron Bio-Safe (photo) is said to be the world's first electro-deionization (EDI) module with an integrated membrane stage. It is based on proven and patented spiral-wound technology and has an additional membrane stage for removal of particles and bacteria. The EDI module is available in a cold-water version and a version that can be sanitized with hot (>80°C) water. Both versions are available in various sizes with outputs of 500 to 3,000 L/h. The combination of this module with a preceding reverse-osmosis stage makes it possible — without additional ultrafiltration — to produce highly purified water with bacterial counts of less than 10 calorie forming units per 1,200 mL. Hall 4.1, Stand F3–G7 — *Christ Water Technology Group, Aesch, Switzerland*
www.christwater.com

Measure distances up to 40m with this level measurement device
Nivobob (photo, p. 40D-1) is a re-engineered model of this firm's popular plumb-bob range of level measurement technology. Among the enhancements offered are: increased durability via a brushless motor; a new rope system that extends the time between servicing; and a larger measurement distance of up to 40 m (with the tape version). An additional remote box is available for controlling up to 10 instruments. In addition to the 4–20-mA output, both Modbus and Profibus DP communication is offered for integrating measured data into existing control systems. Hall 9.2, Stand K35–L36 — *UWT GmbH, Betzigau, Germany*
www.uwt.de

Handle difficult liquids on a small scale with this flow reactor
The Coflore ACR (photo) is a new type of flow reactor for use in laboratories

and pilot plants. The use of multiple reaction cells and dynamic mixing gives the reactor much greater flexibility and ability to handle problem fluids. Free-floating agitator elements eliminate the need for mechanical seals and rotating shafts. The reactor has a flexible throughput (10–5,000 mL/h) and has a very low pressure drop. It is able to handle problem fluids (slurries, high viscosity fluids, slow reactions). All wetted surfaces can be assessed for cleaning, and dismantling and assembly takes less than 10 minutes. The ACR is intended for small-scale production, process development and scale up studies. Hall 6.2, Stand F21 — *AM Technology, Runcorn, U.K.*
www.amtechuk.com

Separate droplets as small as 1 micrometer in diameter

Coalescers of type Phase Separator PT 800 and PT 500 were developed for an application to separate micro droplets of hydrochloric acid from silicone oil, and vice versa. The pressure vessels are made of carbon steel with an inner, 3-mm-thick PVDF lining. Unlike pressure vessels of pure PVDF or of glass-reinforced PVDF, the lined-carbon-steel type of vessel can be fabricated according to any user-defined design code, design pressure and vessel size. The coalescer elements and other internals are also constructed of PVDF with coalescing media of a special, acid-resistant micro-glass fiber with an optional PTFE microfiber. Droplets as small as 1 μm in diameter can be separated with this custom-designed coalescer. Hall 5.0, Stand H10–H13 — *Franken Filtertechnik KG, Huerth, Germany*
www.frankenfilter.com

These dryers collect powder down to the micrometer range


Ohkawara Kakohki

Spray Bag Dryers (BDP; photo) feature a heat-resistant, cloth-made drying chamber, which allows for a fast heat up of the machine, as well as a low risk of impurities. BDPs are especially suitable for ceramics of all kinds. The drying air and evaporated water penetrate the filter bag and are drawn off by an exhaust system, while product powders, as small as micrometer range, are held back and collected at the base point. There is a single powder collection point and no aero-cyclone or filters are necessary, resulting in a homogeneous powder mixture and a very compact design. Water evaporation capacities range from 5 to 80 kg/h. Hall 4.0 Stand D3 — *Ohkawara Kakohki Co., Ltd., Yokohama, Japan*
www.oc-sd.co.jp ■

Kate Torzewski

Circle 30 on p. 62 or go to adlinks.che.com/23012-30

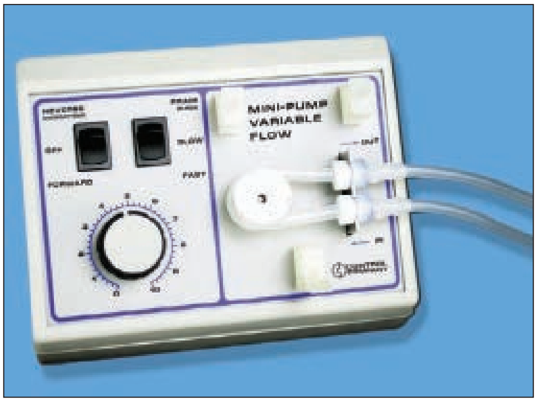
Circle 31 on p. 62 or go to adlinks.che.com/23012-31

Veolia Water Solutions & Technologies

UWT

ACHEMA 2009

GEKO-Pumpen



Control Company

GEA

Achema 2009 (Frankfurt am Main, Germany; May 11–15), the World's largest assembly of chemical process industry professionals is approaching. With over 200,000 visitors and more than 3,500 exhibitors from 50 countries filling the exhibition grounds of Messe Frankfurt GmbH, this exhibition and congress on chemical engineering, environmental protection and biotechnology continues to be the flagship trade fair for the chemical process industries (CPI).

Dechema e.V. (www.dechema.de), the show organizer, reports that the Achema Congress is now larger than ever, with 925 lectures. The estimated 27,000 congress attendees will have the opportunity to take part in podium discussions, expert talks and plenary lectures that will reflect the diverse areas of process engineering. In addition to the Congress, the Industrial Biotechnology Partnering Conference will focus specifically on the growing significance of industrial biotechnology in the chemical, pharmaceutical, cosmetics, food and textile industries.

Below is a cross-section of the products and services that will be on display at the show. For more details on the event and developing news about the planned technology announcements and the congress, please visit www.che.com/achema, which we will be updating often. When you arrive at the exhibition grounds, stay on top of breaking show news with the Achema Daily, which will be produced by the staffs of *Chemical Engineering* and Vogel Business Media GmbH. And, as you make your way through the exhibition halls, be sure to stop by the Chemical Engineering stand (Hall 9.0, Stand G30; Hall 5.1/6.1, Stand A1) to say hello.

Use this non-contaminating pump for clean applications

These new compact, variable-flow, bidirectional, self-priming, peristaltic pumps (photo) offer precise flow deliveries. They are ideal for use with conductivity flow-thru cells, liquid chromatography, collecting fractions, pH/circulating fluids or buffers in baths, and moving corrosive materials. They provide outstanding flow control and flexibility for transferring and dosing liquids. The fluid contacts only the tubing for contamination-free pumping. Flowrates are from 0.005–600 mL/min. Variable-speed flow control and five different tubing sizes provide fine resolution with a wide flow range. Tubing may be used with fluid temperatures from –80 to 500°F. The unit pumps liquids and gases and will not he harmed by dry pumping. Hall 5.1, Stand B21–22 — *Control Co., Friendswood, Tex.*
www.control3.com

Tank-bottom valves now available in larger widths

Vesta Tank Bottom Valves (photo) are used to shut off liquid media at vessels or tanks. Preferably installed at the lowest point of the tank bottom, their characteristic feature is shut-off at tank bottom level without any sump. The pocket-free design enables complete draining of the vessel and optimal clean-in-place (CIP) and steam-in-place (SIP). Due to the compact design, these valves are also ideal for confined spaces. The new extended range includes the following sizes: DN 32, 40, 50, 65 (DIN pipe standard); ISO 42.4, 48.3 and 60.3 (ISO pipe standard); and OD 1.5, 2, 2.5 and 3 in. (OD pipe standard). The ex-

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

tended range of valves is available for manual operation with NC/NO pneumatic actuators made from synthetic material or stainless steel. Hall 4.1, Stand D13–G22 — *GEA Tuchenhagen GmbH, Büchen, Germany*
www.tuchenhagen.com


GEA Ecoflex

Christ Water Technology


AM Technology

Operate under harsh conditions with ceramic membranes
The CeraMem proprietary technology platform (photo, p. 40I-1) provides ceramic membrane performance at comparable lifecycle costs to polymeric membranes. The design, which is a combination of unique materials of construction and novel membrane chemistry, allows the utilization of large-diameter ceramic monolith microfiltration membranes and ultrafiltration that reduce the overall footprint of installed equipment. These features allow operation in harsh environments, including processing high temperature feed, resistance to chemical and abrasive attacks, and membrane elements inert to all solvents. Hall 4.1, Stand J8–J10 — *Veolia Water Solutions & Technologies, Saint Maurice, France*
www.veoliawaterst.com

Pump hazardous liquids without the risk of corrosion or leaks
Designed for pumping hazardous and chemically aggressive liquids, this sealless PTFE/PFA-lined chemical pump (photo, p. 40I-1) complies with DIN EN 22858 and Atex. The pump provides virtually leak-free operation and unrestricted corrosion resistance, even at temperatures of 160°C and higher. The pump features PTFE impellers with shovels, PTFE-lined, carbon-fiber isolation shells, and delivers maximum flowrates of up to 180 m^3/h. Modular design permits the use of either a bear-shaft or block-type design, both of which are interchangeable. Pumps with mechanical seals are also available. Hall 8, Stand J45–J48 — *GEKO-Pumpen GmbH, Eltville, Germany*
www.geko-pumpen.de

This heat exchanger holds up to a thousand plates in its frame
The new NT 500 plate heat exchanger (photo) sets new performance standards with a volume flow of up to 4,500 m^3/h. The steel frame can hold up to a thousand plates, and the largest version is 4.7-m high and 1.6-m wide. The unit is available in three different plate lengths, and the plates can be supplied in three different embossing patterns. Maximum operating pressure is 16 bars, and the firm's OptiWave technology guarantees the best flow behavior across the full plate width, says the manufacturer. The NT 500 is fitted with glue-less EcoLoc gaskets, which can be replaced quickly and easily. Thanks to the PosLoc system, the plate heat exchanger has a self-centering plate pack, which guarantees a perfect fit of the plates to ensure safe process reliability. Hall 4.0, Stand A13–G22 — *GEA Ecoflex GmbH, Sarstedt, Germany*
www.gea-ecoflex.de

Handle difficult liquids on a small scale with this flow reactor
The Coflore ACR (photo) is a new type of flow reactor for use in laboratories and pilot plants. The use of multiple reaction cells and dynamic mixing gives the reactor much greater flexibility and ability to handle problem fluids. Free-floating agitator elements eliminate the need for mechanical seals and rotating shafts. The reactor has a flexible throughput (10–5,000 mL/h) and has a very low pressure drop. It is able to handle problem fluids (slurries, high viscosity fluids, slow reactions). All wetted surfaces can be assessed for cleaning, and dismantling and assembly takes less than 10 minutes. The ACR is intended for small-scale production, process development and scale up studies. Hall 6.2, Stand F21 — *AM Technology, Runcorn, U.K.*
www.amtechuk.com

Measure distances up to 40m with this level measurement device
Nivobob (photo, p. 40I-1) is a re-engineered model of this firm's popular plumb-bob range of level measurement technology. Among the enhancements offered are: increased durability via a brushless motor; a new rope system, which extends the time between servicing; and a larger measurement distance of up to 40 m (with the tape version). For small plants,

an additional remote box is available for controlling up to 10 instruments. In addition to the 4–20-mA output, both Modbus and Profibus DP communication is offered for integrating measured data into existing control systems. Hall 9.2, Stand K35–L36 — *UWT GmbH, Betzigau, Germany*
www.uwt.de

This EDI module also has a membrane stage
Septron Bio-Safe (photo, p. 40I-2) is said to be the world's first electro-deionization (EDI) module with an integrated membrane stage. It is based on proven and patented spiral-wound technology and has an additional membrane stage for removal of particles and bacteria. The EDI module is available in a cold-water version and a version that can be sanitized with hot (>80°C) water. Both versions are available in various sizes with outputs of 500 to 3,000 L/h. The combination of this module with a preceding reverse-osmosis stage makes it possible — without additional ultrafiltration — to produce highly purified water with bacterial counts of less than 10 calorie forming units per 1,200 mL. The module can be retrofitted on existing Osmatron systems. Hall 4.1, Stand F3–G7 — *Christ Water Technology Group, Aesch, Switzerland*
www.christwater.com

These dryers collect powder down to the micrometer range
Spray Bag Dryers (BDP; photo) feature a heat-resistant, cloth-made drying chamber, which allows for a fast heat up of the machine, as well as a low risk of impurities. BDPs are especially suitable for ceramics of all kinds. The drying air and evaporated water penetrate the filter bag and are drawn off by an exhaust system, while product powders, as small as micrometer range, are held back and collected at the base point. There is a single powder collection point and no aero-cyclone or filters are necessary, resulting in a homogeneous powder mixture and a very compact design. Water evaporation capacities range from 5 to 80 kg/h. Hall 4.0 Stand D3 — *Ohkawara Kakohki Co., Ltd., Yokohama, Japan*
www.oc-sd.co.jp


Flexim


Ohkawara Kakohki


Franken Filtertechnik

Separate droplets as small as 1 micrometer in diameter
Coalescers of type Phase Separator PT 800 and PT 500 (photo) were developed for an application to separate micro droplets of hydrochloric acid from silicone oil, and vice versa. The pressure vessels are made of carbon steel with an inner, 3-mm-thick PVDF lining. Unlike pressure vessels of pure PVDF or of glass-reinforced PVDF, the lined-carbon-steel type of vessel can be fabricated according to any user-defined design code, design pressure and vessel size. The coalescer elements and other internals are also constructed of PVDF with coalescing media of a special, acid-resistant micro-glass fiber with an optional PTFE microfiber. Droplets as small as 1 µm in diameter can be separated with this custom-designed coalescer. Hall 5.0, Stand H10–H13 — *Franken Filtertechnik KG, Huerth, Germany*
www.frankenfilter.com

Measure flow with only two transducer pairs over a diameter
With the new Fluxus F601 ultrasonic flowmeter (photo), a reliable flow measurement can be obtained in a few minutes. No zeroing procedure is necessary since calibration data and transducer parameters are saved in a transducer internal memory and automatically sent to the electronics unit upon connection. Only two transducer pairs are needed to cover the diameters most common in industrial applications (DN10 to DN2500), and the full range covers DN6 to DN6500. Among the flowmeter's features are the Hy-

Hitech Instruments


Fritsch

Fine Care Biosystems

Progressive Instruments

bridTrek measuring mode, which ensures a high operational safety in case of fluids with a high concentration of gas or solids. An advanced correction algorithm for pipe wall echoes, and transducer positioning, increase the accuracy in difficult measuring conditions. Hall 10.2, Stand D27–E28 — *Flexim GmbH, Berlin, Germany*
www.flexim.de

Ensure accurate measurement with this micropipette
Precision, accuracy, durability and ergonomics are benefits of Smart, the fully autoclavable micropipette (photo). With a highly sensitive volume display, a micropipette with 100–1,000-µL volume range has an increment of 1 µL instead of the typical 5 µL. Ensuring precision, design features include a counter-lock mechanism that prevents accidental volume change, as well as a re-calibration knob that is easily accessible, yet prevents any accidental deflection. The pipette can be completely disassembled for servicing and maintenance without any special tool. Hall 6.3, Stand J5 — *Fine Care Biosystems, India*
www.accumaximum.com

Titrate automatically based on changes in solution voltage
This company has recently introduced the Potentiometric titrator (photo), suitable to conduct aqueous/non-aqueous, oxidation-reduction and a range of other titrations. The main feature of this titrator is that the endpoint of the titration is determined automatically, by detecting maximum change in mV per unit of titrant added. A precision dispensing pump is used to add the titrant accurately, eliminating the need for a piston-type syringe pump and non-return valves. The endpoint of the titration is determined by “Maximum Change in mV” per unit addition of titrant. Hall 5.1, Stand B7 — *Progressive Instruments, Mumbai, India*
www.veegoindia.com

A centrifuge pump allows users to analyze heavy particles
The Analysette 22 MicroTec Plus (photo) is the latest generation of this company’s particle measurement technology. The instrument covers a range of 0.08 to 2,000 µm with a resolution of up to 108 measuring channels. The wet dispersion unit is equipped with a centrifuge pump for the optimal transport of process streams with a high concentration of heavy particles. The measuring cells are located in convenient cartridges, which are simply exchanged during the switch between wet to dry measurements. Hall 6.1, Stand J9–J12 — *Fritsch GmbH, Idar-Oberstein, Germany*
www.fritsch-laser.com

Measure oxygen levels remotely with zirconia sensors
This company’s range of zirconia oxygen analyzers measure oxygen, from % to ppm levels. The accompanying software allows the user to view readings, set output and perform calibration remotely via a fully bi-directional RS-232 port. The Z1030 is a panel mount instrument with a remote mounted sensor unit. The Z230 (photo) is a robust, portable instrument for benchtop use with an integral, long-life sensor. Both feature a zirconia sensor, which has very fast response and short warm-up time. The Z1030 and Z230 are both supplied complete with inlets, valves, flowmeter and sensor. Typical applications include nitrogen generators, purge gas soldering systems, air separations and glove boxes. Hall 10.1, Stand A9 — *Hitech Instruments Ltd., Luton, U.K.*
www.hitech-inst.co.uk

This mixer comes in a variety of sizes, for pilot to industrial scale
The Helical Dryer series HD (photo, p. 40I-8) was designed to meet the requirements of multipurpose produc-

tion, as specified by a study group that included major European pharmaceutical manufacturers. The dryer incorporates an optimized mixing assembly, which features a mechanical seal (without product contact); rugged bearings; a small surface area (for reduced product hold-up); a reduced gap to the vessel wall (for enhanced mixing performance); and a 30% reduction in shaft length (so there is no bending moment). An integrated containment filter is included for processing active agents. The overall height of the HD has been reduced due to a patented bowl design. The dryer is available as a mobile unit, with a usable volume of 15–30 L, or a stationary version, with a usable volume of 100–4,000 L. Particle sizes up to 5 mm can be handled. Hall 5.0, Stand D13–E16 — *KMPT AG, Vierkirchen, Germany*
www.kmpt.com

KMPT

High-throughput characterization of proteins, peptides & particles
Using dynamic light scattering, the BioDLS (photo) allows automatic particle sizing using industry-standard well plates. The BioDLS measures proteins, peptides, micelles and other nanoparticles in a highly efficient, high-throughput manner useful for the pharmaceutical industry. Up to 768 samples can be measured without operator intervention. An optional, pre-programmed cooling chamber keeps samples and trays at the specified holding temperature. The measuring cell has independent temperature control, allowing thermal studies related to stability and aggregation on individual samples. Hall 5.1, Stand C7 — *Brookhaven Instruments Corp., Holtsville, N.Y.*
www.bic.com


Brookhaven Instruments

Use this viscometer for continuous measurement
The new goVisc 500 is a compact, high-performance precision viscometer with realtime viscosity outputs. It can be used in any laboratory-scale application for continuous viscosity measurement, and it is especially suitable for automated applications. The hygienic sensor is an all-welded construction that can be used in any orientation, with a smooth, crevice-free surface that resists fouling and facilitates cleaning. The goVisc 500 has excellent repeatability and high sensitivity while being unaffected by flowrate or the presence of suspended solids or gases. The associated PC-based VisCoLink software has a multi-screen interface incorporating a display of


Alfa Laval

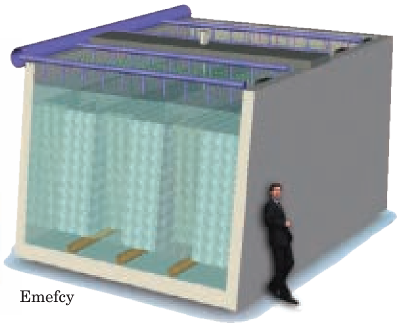
live viscosity, current temperature and temperature-corrected viscosity as well as options for configuring the system. Hall 10.2, Stand F5–F6 — *Hydramotion Ltd., North Yorkshire, U.K.*
www.hydramotion.com

Flange joint software for calculation and simulation
For safe operation of a flange joint, it is important to consider a number of parameters that have an impact on the bolts, gasket and flanges. The relatively large number of mathematical operations and the need for managing a large number of data and specific knowledge represent a highly demanding task for flange joint designers. The DON 3.0 software offers the possibility to handle this complex task in a user-friendly and more reliable way, while providing considerable savings of time required to perform such a calculation. The calculation of flange joints is carried out according to EN 1591-1. Hall 8, Stand D25–D26 — *Donit Tesnit, Medvode, Slovenia*
www.donittesnit.si

Separation solutions that meet the demands of today's markets
A new modular-based separator will make its debut at Achema 2009. This separator can reduce energy consumption by up to 50%, depending on the media and application, says the firm. Also on display will be the complete line of BD-range of high-speed separators that have been especially designed for biodiesel processes, and the SG2 700 decanter for grain-based fuel ethanol processes. Also to be launched is the Culturefuge 400 (photo), which expands the portfolio of hermetic, purpose-built cell culture centrifuges. The expanded capacity enables applications for mammalian cell cultures and precipitated protein. Hall 4.0, Stand H2–J8 — *Alfa Laval Lund AB, Lund, Sweden*
www.alfalaval.com

This capsule-filling machine can run any combination of products
IN-CAP, an automatic, bench-top capsule filling machine (photo, p. 40I-10), is made completely in AISI 304 stainless steel with the parts in contact with product made in AISI 316 L stainless steel. The unit can operate either inside or outside an isolator transitioning easily on its carriage with sliding guides. Its design enables operation and cleaning without contaminating the working environment. It is fully washable as it has IP 65 protection. Upon request, the unit can be supplied with instrumented pins in order to detect pressing force during slug formation. The output of this unit is 3,000 capsules/h, and it can run all possible combinations of products, such as powder/pellets, powder/tablets, pow-

Sierra Instruments



Emefcy

Dott

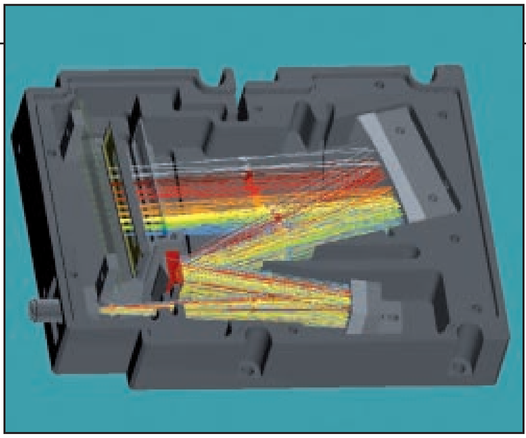
der/liquids, two powders, two pellets and so on. Hall 3.0, Stand S10 — *Dott. Bonapace & C. Srl, Milan, Italy*
www.dottbonapace.com

Turn wastewater into a source of low-cost electricity

The Megawatter platform (photo) is a commercial implementation of Microbial Fuel Cells (MFC) technology for direct electricity or hydrogen generation on a large scale, while using wastewater as fuel by treating the organic materials dissolved in water as a source of energy. The systems produce electricity that can be fed into the grid on a constant baseload basis. Benefits of this technology include: wastewater treatment as a by-product of energy generation; carbon-free energy generation; reduced sludge; and efficiency even in extreme wastewater conditions. Megawatter systems have a number of targeted applications, including direct electricity generation, direct hydrogen production, de-nitrification of wastewater and heavy-metal removal from contaminated soil. Hall 4.2, Stand G23 — *Emefcy, Caesarea, Israel*
www.emefcy.com

These mass flowmeters are multi-gas capable

Max-Trak Model 180 Industrial Mass Flowmeters and Controllers (photo) are now available with 316-stainless-steel (ANSI or DIN) flange mounting for gas flowrates up to 1,000 L/min with pipe sizes up to 1 in. The major de-



Avantes

sign enhancement of Model 180 is the use of this firm's Dial-A-Gas technology, which makes Max-Trak the industry's only multi-gas capable mass flow controller, according to the manufacturer. The Model 180 has an accuracy within ±1% and repeatability within ±0.2%. Max-Trak can communicate to a user workstation via RS-232, RS-485 or one of four analog signals. Max-Trak is NEMA 6/IP67 rated, conforming to rigorous water-resistant requirements. Hall 10.1, Stand F20–G21 — *Sierra Instruments, Inc., Monterey, Calif.*
www.sierrainstruments.com

A miniature spectrometer offers ultralow stray light
The new Avabench-75-ULS optical bench (photo) for the AvaSpeck family of fiber-optic spectrometers has a dual, internal modestripper along with multiple compound-parabolic concentrators to further reduce stray-light levels to less than 0.04% The new optical-bench design also features much higher rigidity, resulting in a factor of 20 decrease in strain sensitivity caused by microbending. The new optical bench is integrated into the AvaSpec 2046-USL, which is available in a variety of slit and grating configurations covering wavelengths from 200 to 1,100 nm, and features a 2,048-pixel detector array for high-resolution applications. Hall 5.1, Stand J17. — *Avantes, Eerbeek, Netherlands*
www.avantes.com

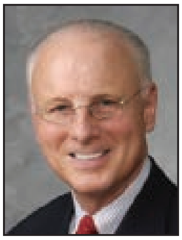
These electromechanical pumps transfer high viscosity materials
Electromechanical (EM) pumps are widely used in wastewater and sewage treatment, chemical and ceramic industries, mining, power plants, marine and offshore applications. With RAN EM diaphragm pumps, capacities up to 30 m^3/h can be transferred. Body material options are aluminum, AISI 304 stainless steel, cast iron and polypropylene. Explosion-proof motors are also available. Although the initial pump price of an EM pump is higher than that of an air-operated diaphragm pump, EM pumps have higher energy efficiency, making their life-cycle cost lower. RAN EM series pumps are sealless, self priming, dry-running, low shear and have versatile fluid handling capability. Hall: 9.1, Stand A20–A21 — *Gisan Makine San. Tic. Ltd. Sti., Istanbul, Turkey*
www.ranpump.com ■

Gerald Ondrey and Kate Torzewski

WHO'S WHO


Lawal


Neethling


Schloesser


Krisanda


Madden

Oliver Lawal becomes vice-president at **Aquionics** (Erlanger, Ky.).

Edwards (Crawley, West Sussex, U.K.) names *Ron Krisanda* operations and technology director.

Bentley Systems (Exton, Pa.) appoints *Pieter Neethling* to the newly created position of solutions executive, mining and metals.

Richard Schloesser becomes CEO of **Toray Plastics America** (North Kingstown, R.I.).

Tom Madden is now managing director of **Blackmer** (Grand Rapids, Mich.).

Richard Davis becomes president of **the Society of Fire Protection Engineers** (Bethesda, Md.).

Engineered Software (Lacey, Wash.) names *Michael Blondin* as COO, and *Christy Bermensolo* as vice-president of engineering. *Ray Hardee* now operates solely as chief executive officer.

John Molloy, president and CEO of **H2M Labs** (Melville, N.Y.), is now chairman of **The American Council of Independent Laboratories** (Melville, N.Y.) .

Joseph T.C. Vu is named applications engineer at **Macro Sensors** (Pennsauken, N.J.).

Continental Disc Corp. (Liberty, Mo.) names *Tom MacGibbon* vice-president of sales and marketing.

InduSoft (Austin, Tex.) names *Dave Hellyer executive sales manager.* ■

Suzanne Shelley

Combining Rupture Disks with Safety Relief Valves

Geof Brazier
BS&B Safety Sytems, LLC

A rupture disk serves as a barrier, protecting the safety relief valve from process media. This barrier extends the life of the relief valve and prevents leakage to the atmosphere

Protecting process systems from overpressurization is vital throughout the chemical process industries (CPI). Both safety relief valves and rupture disks are commonly used for this purpose. Sometimes the combination of a relief valve with a rupture disk can add service life to the relief valve and prevent process leakage, which is important from safety, conservation and financial standpoints.

This article explores the advantages of combining the two devices and provides suggestions for when to use the combination versus when a rupture disk alone might be better. Additional considerations, such as sizing are also discussed. More detailed considerations for rupture disks alone are discussed in Part 2 of this feature report (pp. 45–47).

Advantages of a disk and valve

Isolating a safety relief valve with a rupture disk prevents process materials from coming in contact with the safety relief valve under normal operating conditions (Figure 1). This barrier stops the process from entering the mechanics of the relief valve, which keeps the relief valve from coming into contact with caustic materials. The rupture disk also protects against highly viscous materials that risk potentially "gumming up" the relief valve. In the case of overpressurization when both a rupture disk and relief valve are used, the rupture disk will burst followed by a release from the relief valve (Figure 2). Once the pressure drops to a safe level, the valve reseats itself and continues to protect the system.

Under normal operating conditions, the rupture disk barrier keeps process fluids from leaking into the atmosphere. Consider, for instance, that on conventional safety valves, API Standard 527 allows for an orifice size of F and smaller to have the maximum allowable leakage rate of 40 bubbles per minute (approximately 6 ft^3 per 24 hours, or 2,190 ft^3 per year). Unchecked, this leakage seeps into the environment, loses expensive product every hour of every day eroding profits, or requires the installation of a means to either recover or handle this leakage as waste. Rupture disks stop the leakage to protect the environment and to protect plant profits. Besides zero process leakage, other advantages of using a rupture disk at the inlet of a safety relief valve include the following:

Allows safety relief valve to be 'tested in place'. When a rupture disk is used to isolate a safety relief valve, the valve can be field tested in place. With a suitable, reverse-buckling rupture disk installed at the valve inlet, the safety relief valve can be tested on the spot by a single person with a portable pressure source. To accomplish this without opening up the process piping, itself, air, nitrogen or another acceptable fluid is injected from an outside source into the chamber between the rupture disk and the safety-relief-valve inlet. The test pressure is increased until a popping action is heard from the valve. The observed test pressure should be within the set pressure tolerance of the valve. Upon removal of the portable pressure source, both the rupture disk and relief valve are ready to immediately resume service.

Valve life is extended. Extending the life of the safety relief valve is a major advantage of using a disk-valve combination. The rupture disk acts as a solid barrier between the valve and the process. The disk prevents product buildup from adhering to mechanical components of the valve that otherwise would affect valve performance and safety of the pressurized system. Since the process fluid will not come in contact with internal surfaces and components of the valve, it will remain in pristine condition until called upon to relieve pressure.

Longer periods between major overhauls. Because the valve internals are not normally exposed to process contamination, they remain in "like new" condition, allowing longer periods between major overhauls.

Less expensive valve material can be used. The large, initial cost of a safety relief valve can be reduced by ordering the valve in a less expensive metal and isolating it with a suitable rupture disk. As an example, if the process fluid requires that Hastelloy be the preferred material of construction for continuous contact, use a carbon-steel valve with Hastelloy trim combined with a Hastelloy rupture-disk device, thereby saving over half the cost of the valve.

When to use only a rupture disk

A question is often posed as to when to use a rupture disk by itself and when to use a rupture disk combined with a safety relief valve. The benefits of using only a rupture disk begin with

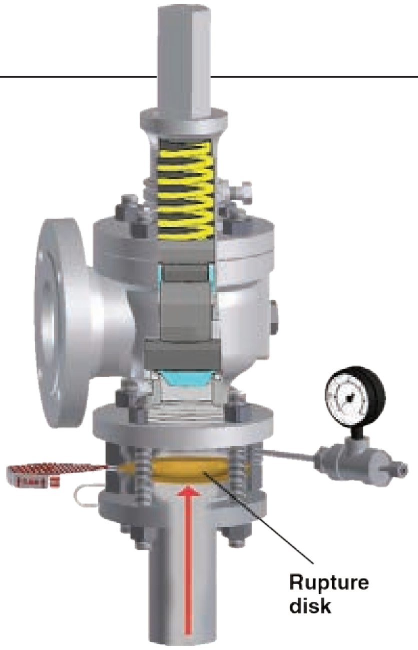


FIGURE 1. The rupture disk is used at the inlet of the relief valve, acting as a barrier between the process and the valve

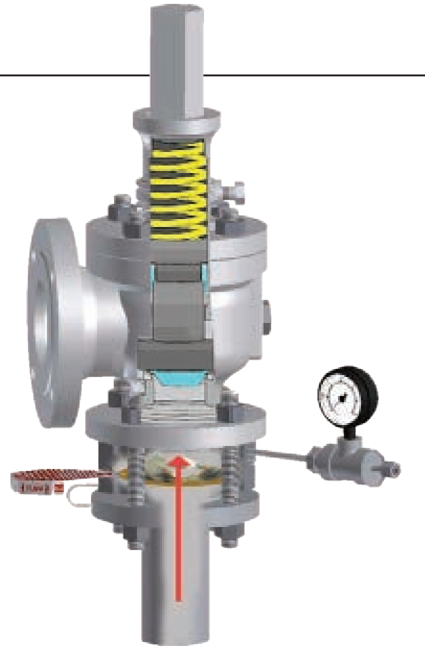


FIGURE 2. When rupture disks are used to isolate safety relief valves, the rupture disk is first to open in the event of system overpressurization. The vented process fluid then contacts the safety relief valve, which releases the fluid if the pressure is excessive

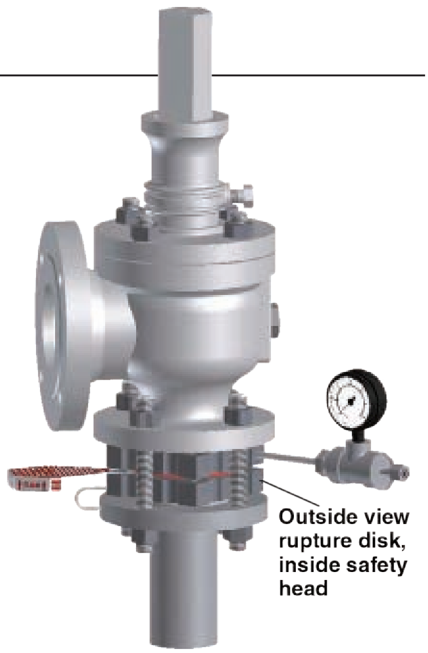


FIGURE 3. A rupture-disk and relief-valve combination will be the unrivaled choice when a leak-tight seal is needed because the system contains a corrosive, hazardous or expensive substance

cost. Rupture disks are significantly less expensive than safety relief valves — particularly when constructed of exotic materials — and require little to no maintenance.

The quick bursting action of a rupture disk makes it a first consideration when the potential for runaway reactions exists. Safety relief valves, by themselves, will not react fast enough to protect from the pressure of a deflagration or a detonation.

Also consider that some liquids may freeze or cause icing under rapid depressurization leading to blockage within a safety relief valve, rendering it ineffective. Highly viscous liquids, such as polymers, may not relieve fast enough through a safety relief valve and create a danger of plugging the valve.

Individually, a rupture disk is an excellent choice for overpressure protection when process contents are inexpensive, non-hazardous and environmentally safe, or when hazardous material can be released to a safe recovery or waste station. With the availability of rupture disk technology that is capable of a 100% operating ratio and superior process control technology, the benefits of rupture disk devices can be fully realized.

When to use a combination

A rupture-disk and relief-valve combination will be the unrivaled choice when a leak-tight seal of the pressurized system is needed combined with the conservation of product within the pressurized system because the system contains a corrosive, hazardous or expensive substance (Figure 3). As mentioned earlier, the installation of a rupture disk upstream serves as a barrier between the process fluid and the relief valve. The disk prevents product buildup from adhering to mechanical components of the valve. Since the process fluid will not come in contact with internal surfaces of the valve, the valve will remain in pristine condition until called upon to relieve overpressure.

The benefits of rupture disk isolation to a relief valve can also be applied to the downstream discharge connection of the valve (Figure 4). For example, this technique will prevent potential contaminants from reaching the downstream components of all relief valves connected to a common header. For relief valves whose set pressure is influenced by back pressure, downstream isolation with a rupture disk will also prevent the momentary back pressure from an active relief device from affecting the performance of the other valves connected to the header system, thereby maintaining the intended safety of each of the pressurized systems connected to the header.

Even when the process fluid is not labeled as corrosive, hazardous or expensive, the arguments for the application of rupture-disk and relief-valve combinations make for compelling best engineering practice with respect to both safety and economics.

Sizing

When sizing a relief valve, the engineer determines the required fluid-flow capacity while analyzing emergency scenarios, such as fire, loss of process cooling and equipment failure. The capacity requirements are then entered into a sizing equation to determine the relief valve area. In most cases, engineers can select the calculated relief valve area from relief valve manufacturer's data sheets, which present information derived from ASME-Code-mandated capacity testing.

When sizing a relief-valve and rupture-disk combination, the flow capacity of the combination must be confirmed to support the selection of both the valve and the rupture disk. A combination capacity factor (CCF) is used in support of this design safety decision. The CCF is often determined from ASME certified capacity testing, where first the capacity of the stand-alone safety relief valve is determined followed by that of the rupture-disk and relief-valve combination. The combination capacity factor is calculated as the ratio of the rupture-disk and relief-valve combination capacity to the stand-alone relief valve capacity. The CCF should not be greater than 1.

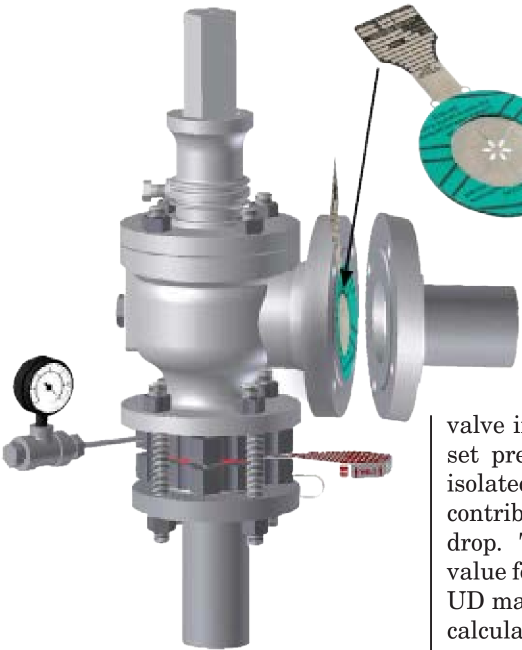


FIGURE 4. The benefits of rupture disk isolation to a relief valve can also be applied to the downstream discharge connection of the valve to prevent back pressure and potential contaminants from reaching the valve downstream components as occurs when several relief valves are connected to a single header

CCF = Flow capacity of combination / Flow capacity of relief valve

Example combination capacity factor: An example of the CCF is given for Dresser valve types 1900, 1900/p, 1900-30, 1900-30p, 1900-35; disk type RLS. For this example, the CCF is 0.974*.

If the safety relief valve has a marked capacity of 10,000 scfm, the 10,000 is multiplied by the 0.974 CCF, which determines the combination capacity of 9,740 scfm. The person implementing this combination device is required by the ASME Code to tag it accordingly (see ASME Section VIII, Division 1, paragraphs UG119-137).

If the CCF is unknown, the ASME Code allows for a default CCF value of 0.9 to be used in place of a tested, certified value, provided that the rupture disk device has a certified flow-resistance value (K_R) of equal to or less than 6. A low flow-resistance value is indicative of a rupture disk device that provides a clear opening upon activation.

Pressure drop

What about the pressure drop between a vessel and a rupture disk isolated relief valve? The proper function of a relief valve requires that the pressure drop between the vessel it protects and the valve inlet is not more than 3% of its set pressure. When a relief valve is isolated by a rupture disk device, this contributes to the piping pressure drop. The certified flow resistance value for rupture disks that are ASME UD marked (K_R) is used to accurately calculate pressure drop. With many rupture disk devices having low flow-resistance values, the pressure drop target is routinely achieved.

Differential pressure

Rupture disks respond to differential pressure, which must be monitored. The maintenance of a known pressure differential across the rupture disk device in a rupture-disk and relief-valve combination is conveniently achieved by the use of the “tell-tale” assembly shown in each of Figures 1–4. The tell-tale assembly combines an excess flow valve to maintain atmospheric pressure in the space between the rupture disk and the relief valve with a pressure gage to provide local confirmation of pressure status. The tell-tale assembly is a requirement of the ASME Code as it relates to rupture-disk and relief-valve combinations; other monitoring methods, such as a pressure switch that will generate a remote electrical signal, are permitted. ■

Edited by Dorothy Lozowski

*BS&B Safety Systems has established certified CCF values for the combination of many rupture disk types with the products of the leading manufacturers of relief valves. These CCF values are published in Flow Coefficient Catalog 77-1006a, which can be found at www.bsbsystems.com

Author

Geof Brazier serves as president of Industrial Protection Devices, LLC and as the director of product and market development for BS&B Safety Systems, LLC (7455 East 46th St., Tulsa, OK 74145; Phone: 918–622-5950; Email: gbrazier@bsbsystems.com). Brazier has more than 20 U.S. patents in the areas of pressure relief devices and industrial wireless and over 25 years of experience in developing new technologies for BS&B. He was educated at the University of Bristol in England as a physicist.

Getting the Most Out of Your Rupture Disc

For optimum rupture-disc performance, pay attention to installation, operation and maintenance

Dean Miller
Fike Corp.

Rupture disc devices provide overpressure protection for a variety of storage and process vessels and equipment. The objective of the rupture disc is to maintain a leak-tight seal and be a passive bystander until called upon to relieve excess pressure. While this is generally the case, there are times when rupture disc performance can be adversely affected through various installation, operation and maintenance practices.

This article reviews some of these practices, real-life observed consequences, and corrective or preventative measures that can improve rupture disc performance. Part 1 of this feature report (pp. 42–44) discusses situations where combinations of rupture discs with relief valves should be considered.

Liquid service

Liquid-full systems create a number of processing challenges, many of which apply to rupture discs. Pressure spikes and water hammer generated by rapid opening or closing of valves somewhere in the process frequently do affect the rupture disc. The typical rupture disc begins to respond to pressure in excess of the burst pressure in less than 1 millisecond. This means that a short-duration pressure spike that is not detectable by normal process instrumentation can and will affect the rupture disc. Ways to avoid pressure spike problems include: avoiding the use of rupture discs on long, liquid-filled lines, eliminating fast-closing-and-opening process valves, and using pressure accumulators to absorb the unavoidable pressure spikes.

Common indications that you have a water hammer or another pressure spike problem include the following:

- The rupture disc appears to burst at a pressure lower than the marked burst pressure
- The rupture disc is only partially open
- Ruptures are observed during or immediately after some non-steady state condition in the process

Solidifying materials

This is a combination rupture-disc-selection and piping-design problem. Many process materials are prone to building up and solidifying on internal surfaces. This can create a problem for the typical vessel discharge port that may become partially or completely blocked, resulting in potentially higher than expected rupture-disc burst pressures and restricted discharge flow. Common solutions to this problem include the following:

- Use of heat tracing or steam jacketing around the vessel nozzle and rupture disc holder
- Use of a "viscous tee" style holder (Figure 1), which continually wipes the disc surface, preventing product buildup
- Use of a flush-mount-style rupture-disc assembly, which eliminates any dead space in the vessel nozzle that could accumulate solidified materials

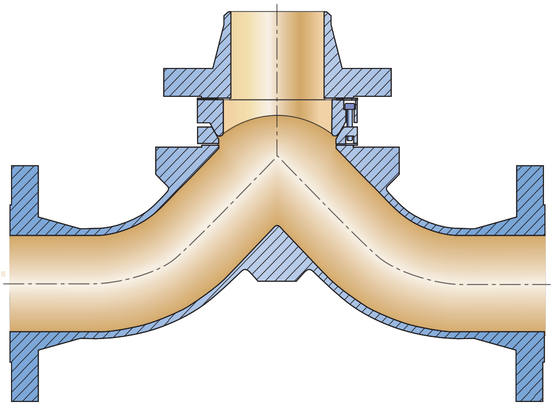


FIGURE 1. This viscous-tee holder design continually wipes the disc surface, preventing product buildup

Piping

The influence of piping and piping-support design on the rupture disc is often overlooked but has been the source of many problems. The most common problem is the transfer of excessive piping loads to the rupture disc. This can be caused by very tall discharge pipes; long, horizontal pipe runs; or severely misaligned pipe flanges.

The most common symptom of a piping problem is rupture disc leakage due to uneven loading of the metal-to-metal sealing surfaces. This issue can usually be resolved with strategic placement of piping supports.

Another piping-related source of trouble is the failure to vent or account for drainage of discharge lines. Heavy corrosion of the rupture disc holder can result (Figure 2). Also, condensate in the discharge lines can freeze, and the expansion during the freezing process can collapse a forward-acting rupture disc (Figure 3).

Flange connections

Most rupture discs function in conjunction with a holder that contains key interface features that help control bursting characteristics and effect a leak-tight seal. The goal of the flange connection is to apply the proper

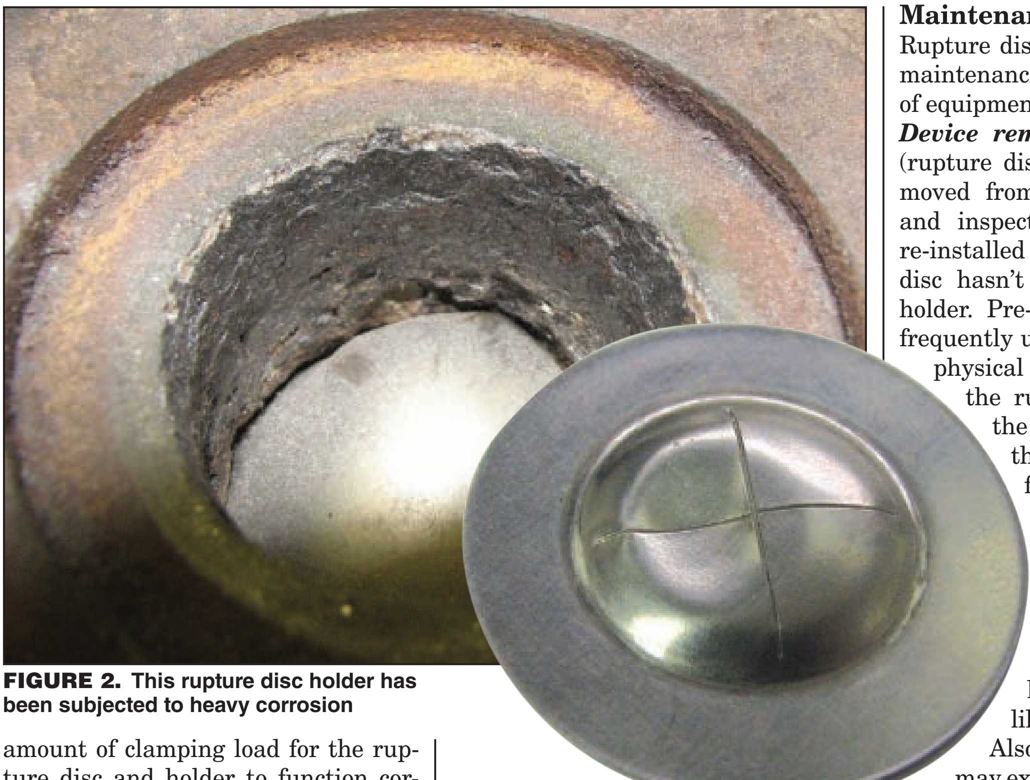


FIGURE 2. This rupture disc holder has been subjected to heavy corrosion

amount of clamping load for the rupture disc and holder to function correctly. This clamping load is affected by the torque applied to the studs, the type of lubrication on the studs, the type of flange gaskets used, and the general alignment of the pipe flanges.

Indications that you have an under or unevenly loaded rupture disc include the following:

- Leakage between the rupture disc and holder
- Rupture disc slippage
- Increased variation in burst pressure

Indications that you may have an over-loaded rupture disc include the following:

- Leakage between the rupture disc and holder
- Increased variation in burst pressure
- Permanent damage to the holder

Torque: All rupture discs have a recommended torque provided by the manufacturer. This information may be located on the rupture disc tag or in the installation instructions provided. This torque value is generally associated with some common thread lubricant. Torquing should always be done in a criss-cross pattern in increments of no more that 25% of the final torque value to ensure evenly developed loading (Figure 4). It is generally a good practice to re-torque the studs after a period of time and after the system has come up to operating temperature to compensate for the normal relaxation of bolt loads.

FIGURE 3. The damage on this forward-acting rupture disc is a result of freezing condensate

Lubrication: Thread lubrication can drastically affect the resultant load achieved from an applied torque. Dry unlubricated threads are more prone to corrosion and galling, resulting in an under-loaded rupture disc that might exhibit leakage, slippage, or inconsistent burst pressures. Threads lubricated with high performance lubricants, such as PTFE, moly-disulfide or graphite, may result in an overload condition.

Gaskets: Flange gaskets have an effect on the applied load as well. Soft gaskets, such as PTFE, while great at conforming to imperfect surfaces, are subject to cold flow. The result is that a short period of time after applying the correct load, the gasket will have further compressed and released most of the load. Some gaskets may have a higher required load than that of the rupture disc. Consult the disc manufacturer to verify the higher load will be acceptable.

Maintenance activities

Rupture disc devices require periodic maintenance just like any other piece of equipment.

Device removal: The entire device (rupture disc and holder) can be removed from the flanged connection and inspected. The device may be re-installed if desired as long as the disc hasn't been removed from the holder. Pre-torque style holders are frequently used in applications where physical inspection and re-use of the rupture disc is desired as the holder maintains load on the disc even after removal from the pipe flanges. Once the disc has been removed from the holder it is recommended that the disc be replaced. Due to the metal-to-metal sealing surfaces, any re-installation of a rupture disc is likely to seal less effectively. Also, some rupture disc types may exhibit increased burst pressure variability when re-installed.

Disc inspection: The value of rupture disc inspection is limited to signs of damage, corrosion, or product buildup. No information about the disc integrity or remaining life can be determined through visual or dimensional inspection.

Holder inspection: Holder inspection should include examination of the seating surfaces for damage, corrosion, or product buildup. A quick way to check for holder damage due to over-torque is to put a straight edge along the gasket face and look for signs of significant bending (Figure 5).

Maintenance frequency

While rupture disc manufacturers would like to recommend replacement of every rupture disc every year, that is not a realistic expectation. As shutdowns for maintenance activities are stretched further and further apart, it is not unusual to expect 3 to 5 years of service from the rupture disc. Rupture disc life is generally tied to the stress history (pressure and temperature) applied to the disc. Relatively low pressures and static conditions will generally result in very long disc life, while cyclic conditions approach-

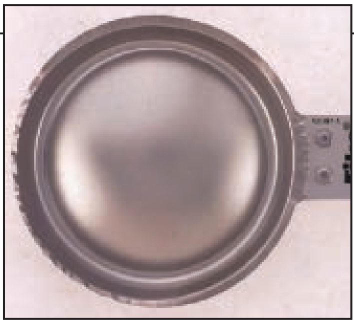


FIGURE 4. Wrinkles on the outer edge of a rupture disc indicate slippage from uneven torque

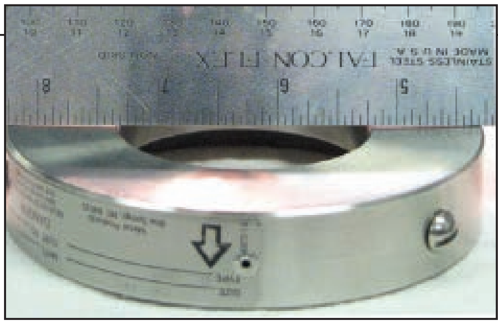


FIGURE 5. This holder shows deformity due to excessive torque. Ideally there should be no gaps between the holder and a straight edge

ing the burst pressure will result in shorter disc life. There is no one, right answer regarding replacement frequency, but common considerations include the following:

- *Severity:* What is the severity of the service the rupture disc is subjected to? Consider corrosion, operating pressure, cyclic duty and so on.
- *History:* What is the history of the rupture disc location? Has it been prone to premature fatigue type failures?
- *Cost:* What is the cost of an unexpected outage due to premature burst versus the cost of a replacement rupture disc during planned downtime?
- *Upgrade:* Are there other disc materials or newer disc technologies that will allow the maintenance interval to extend beyond current limitations? What is the payback on such an upgrade?

When a rupture disc bursts unexpectedly, the user should look for the obvious pressure or temperature excursions in the process that may have initiated the bursting of the disc. If the cause is not apparent, it is time to engage the manufacturer to assist in troubleshooting the problem. When rupture disc problems are experienced, it is important to gather as much information as possible to arrive at resolution quickly. The following items form a good starting point for data collection:

- Rupture disc lot number
- Date installed
- Date of burst
- Actual normal and maximum operating pressure
- Actual normal and maximum operating temperature
- Vacuum conditions: yes or no
- Cyclic conditions: If yes, describe
- Liquid or vapor
- Discharge to atmosphere, pressure relief valve or header
- Rupture-disc performance history in this location
- Photos of rupture disc, holder, installation
- Signs of abnormal operation: for example, pin-hole opening, partial opening, slippage and corrosion products

Rupture discs generally provide highly reliable pressure relief, so in the case of problem installations there are likely actions that can be taken to improve rupture disc performance. Partnering with your rupture disc supplier to investigate and evaluate these situations will promote opportunities to improve rupture disc performance, extend maintenance cycles and reduce long-term costs. ■

Edited by Dorothy Lozowski

Author

Dean Miller is the manager of mechanical engineering with Fike Corp. (704 SW 10th St., Blue Springs, MO 64015; Phone: 816–655-4729; Email: dean.miller@fike.com). He has technical responsibility for a variety of products including rupture discs, explosion vents, and mechanical explosion and fire-protection products. He received a B.S. degree in mechanical engineering from the University of Missouri-Kansas City and an M.B.A. from Keller Graduate School of Management. He has 23 years of experience in the pressure relief industry and serves as a member of the ASME subcommittee on Safety Valve Requirements, ASME committee on Boiler & Pressure Vessel Conformity Assessment, API Task Force on RP520, STD521, and STD2000, and the U.S. Technical Advisory Group for ISO TC-185.

Editor's note

Both disk and disc are commonly used spellings of the word in industry. The editors have chosen to use the spelling of the author in each article of this series.

Industrial Gas Applications

Discover technical solutions, hardware and supply options for a broad range of uses in fine and specialty chemicals production

Hans-R. Himmen
and **Hans-Jürgen Reinhardt**
Linde AG, Gas Division

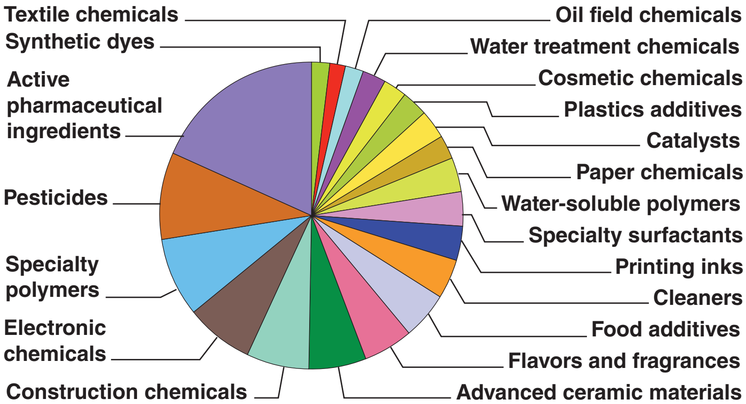


FIGURE 1. Fine and speciality chemistry supports a diverse mix of product groups [2]

Technical and specialty gases find use in many synthesis processes and a number of unit operations, in analysis and in plant maintenance. This article outlines applications for gases in fine and specialty chemistry, ranging from synthesis processes and inerting to off-gas treatment and industrial services.

For each one, processes and the field of use are briefly explained, and existing technical solutions are presented to illustrate the hardware involved. Finally, options for gas supply are summarized and forecasts are made for development in this field.

Fine and specialty chemistry

Fine and specialty chemistry is an important segment of the chemical process industries (CPI). Products include complex mixtures as well as pure chemical substances. Most of these are manufactured in multi-product plants using stirred-tank reactors, often with several process steps combined in one reactor. Typical uses are as follows:

- Gases and gas mixtures for synthesis reactions
- Instrumentation and controls for inerting with nitrogen or CO_2
- Inert gas locks for vessels or reactors
- Processes and apparatuses for cooling reactors with liquid nitrogen as well as heating
- Processes and apparatuses for treating off-gases by cryocondensation of hydrocarbons with liquid nitrogen
- Processes and apparatuses for particle size reduction using liquid nitrogen (cold milling, prilling)
- Service procedures for cleaning, inerting and drying apparatuses as well as equipment for cleaning with CO_2 particles or CO_2 snow

The worldwide market for fine chemicals is estimated at $75 billion [*1*]. Major product groups include pharmaceuticals, adhesives, pesticides, catalysts and enzymes, dyes and pigments, chemicals for the electronics industry, flavors and fragrances, food and feed additives, and special polymers (Figure 1).

Facilities for manufacturing such products have capacities between a few hundred and 10,000 metric tons per year (m.t./yr). Table 1 describes selected products by industry, nature of reaction, scale of production and type of reactor [*3*].

The following are the main process steps in the manufacture of fine and specialty chemicals:

- Storage and conditioning of feedstocks (such as size reduction, weighing, metering)
- Chemical synthesis (hydrogenation, for instance)
- Biotechnological (fermentation, for instance)
- Separation and purification (such as distillation, extraction, crystallization and centrifugation)
- Drying
- Product conditioning (pelletizing, for instance)
- Storage and packaging

A frequently taken approach to ensuring effective capacity utilization and high flexibility in terms of substances, technologies and conditions is the use of multi-product plants. Figure 2 is a block diagram of a batch multi-product facility [*4*]. Many of the unit operations illustrated are carried out in stirred-tank reactors.

While batch operation predominates in fine and specialty chemistry, continuous multi-product systems are also used where high capacity is needed. These are single-train plants and are defined by the synthesis taking place and the product classes involved. Examples are hydrogenation and chlorination reactions.

Synthesis operations

Synthesis reactions are carried out in batch and continuous stirred tanks, bubble-column reactors and microreactors, as Table 1 shows in part. Stitt [*5*] has described reactor types for the manufacture of fine chemicals and listed their advantages and disadvantages. The most common type, the stirred tank reactor, is operated on small and large scales, with homogeneous or heterogeneous catalysts,

TABLE 1. SELECTED FINE CHEMICAL PRODUCTS [*3*]

No.	Product	Typical use	Catalytic (C) or non-catalytic (NC)[a]	Scale of operation, ton/yr	Type of reactor[b]
1	Vitamin E (via trimethylhydroquinone; isophytol)	Vitamin	C (Homo; Het)	500 to 1,000	STR
2	Methyl heptenone	Pharmaceutical (pharma); aroma	NC and C (Het)	1,000 to 2,000	CR (nozzle)
3	Vitamin A (Wittig reaction)	Vitamin	NC	1,000	CR (nozzle)
4	Ibuprofen (via isobutylbenzene)	Pharma (nonsteroidal analgesic)	C (Homo; Het)	1,000 to 3,000	STR
5	Fenvalerate *p*-Hydroxybenzaldehyde	Agrochemical	C (PTC)	300 to 500	STR
6	*p*-Anisic aldehyde	Pharma; aroma and flavor; agrochemical	C (Homo; Het)	1,000 to 3,000	STR; EC
7	Catechol; hydroquinone	Agrochemical; aroma and flavor; photography; additives (antioxidants)	C (Homo) and NC	1,000 to 5,000	STR; BCR
8	*p*-Amino phenol	Pharma	C (Het) and NC	1,000 to 5,000	STR; EC
9	Isocyanates[c]	Pharma; agrochemical; rubber	NC	300 to 2,000	STR
10	Citral	Aroma; pharma	C (Het)	1,000 to 3,000	CR (short bed)
11	2,6-di-*tert*-butylphenol	Additives (antioxidants)	C (Homo)	1,000 to 2,000	STR
12	Phenylglicine / *p*-hydroxyphenyl glycine	Pharma	NC and C (Bio)	1,500 to 2,000	STR; CR
13	*p*-tert-butylbenzaldehyde; benzaldehyde / benzyl alcohol	Aroma; pharma	C (Homo; Het)	1,000 to 5,000	STR
14	1,4-dihydroxymethylcyclohexane	Polyester	C (Het)	5,000	CR
15	Phenylethylalcohol	Aroma; pharma	C (Homo; Het)	1,000 to 3,000	STR
16	Anthraquinone (AQ) and 2-alkyl AQ's	Dyes; H_2O_2; Paper	C (Het)	500 to 3,000	STR
17	Indigo	Dyes	C (Het)	300 to 1,000	STR
18	Diphenyl ether; *m*-phenoxytoluene	Aroma; heat transfer fluids; agrochemical	C (Het)	1,000 to 10,000	CR
19	Benzyl toluenes	Heat transfer fluids	C (Het)	500 to 2,000	STR
20	*o*-, *m*-, and *p*-phenylenediamines	Dyes; agrochemical; aromatic polyamide fibers	C (Het)	1,000 to 3,000	STR
21	2,2,6,6-tetramethylpiperidinol	Additive (light stabilizer)	NC & C (Het)	1,000 to 2,000	CR
22	Glyoxalic acid	Pharma	NC	500 to 2,000	STR; BCR

a. Homogenous (Homo); Heterogeneous (Het); Biocatalytic (Bio); Phase transfer catalysis (PTC)
b. Stirred tank reactor (STR); bubble column reactor (BCR); continuous reactor (CR); electrochemical (EC)
c. Such as *n*-propyl/*n*-butyl; cyclohexyl; *p*-isopropylphenyl isocyanate; isophorone diisocyanate; 1,5-naphthalene diisocyanate

often with gas dispersion and with complete mixing by a variety of stirrers. A wide variety of synthesis reactions — 45 different ones just in the organic branch [*1*] — is performed in stirred-tank reactors.

Many syntheses involve gases or gas mixtures, some of which are referred to as specialty gases. Table 2 lists selected synthesis reactions with the gases involved. Purities are also indicated for pure gases.

When gases such as oxygen and acetylene are used in synthesis operations, specific equipment ensure fast and safe gas supply.

The principal use of oxygen is to boost process intensity, for example in the production of vinyl acetate from ethylene by multi-stage oxidation. An instrumentation and control unit and a gas injector are required along with an oxygen supply. The gas can be delivered in liquid form, generated onsite or supplied from a pipeline. The instrumentation and control unit ensures safe, reliable metering of oxygen in the various operational states of the reactor or system. The instrumentation and control unit, therefore, features a "block and bleed" system, which prevents oxygen getting into the reactor piping in case, for example, the air is cut off. This system also serves as the interface to the process instrumentation and control system.

The gas injector must be matched to the application in question. It ensures good mixing of oxygen with air. It is important that mixing takes place over a short distance, that the mixture be as homogeneous as possible and that the oxygen not impinge directly on a pipe wall.

Instead of a gas injector in the process air piping, a gas distributor can be placed in the reactor if it is advantageous to meter oxygen directly into the reactor and its contents.

Today, acetylene is used chiefly in processes of specialty and fine chemistry, such as the manufacture of vitamins, vinyl ether, fragrances, plastics additives and special plastics. Mobile acetylene delivery units (16-cylinder bundles, 8- and 16-bundle trailers) in conjunction with onsite pressure-control and safety equipment make it possible to supply acetylene quickly and safely to a multi-product plant.

Biotechnological processes are becoming increasingly important in fine and specialty chemistry. Many vitamins, amino acids, aromas, biopolymers and acids are already being manufactured by this route. Industrial gases are also required for the processes involved. Some aerobic fermentations are carried out with oxygen-enriched

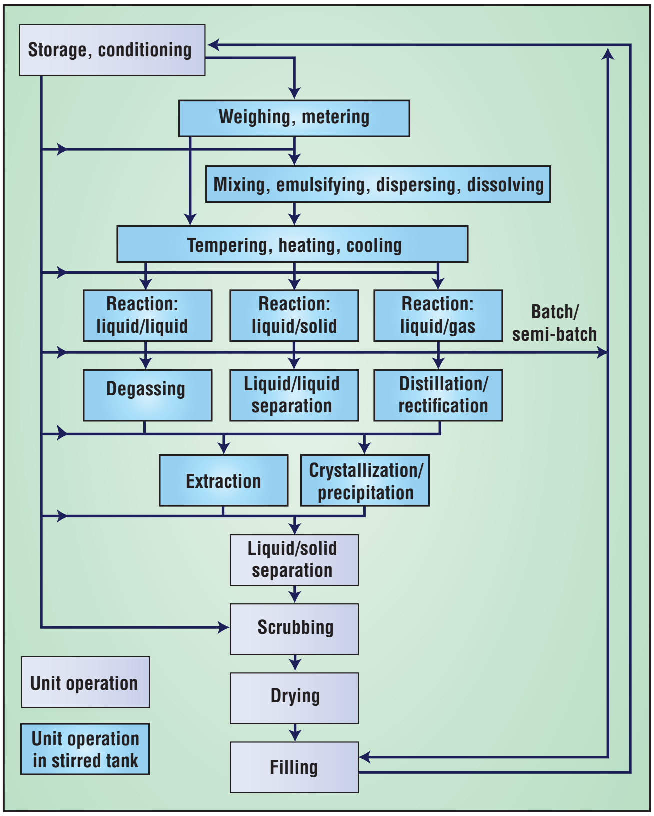


FIGURE 2. Batch multi-product plants are very common in fine and specialty chemical production, often employing stirred tank reactors [*4*]

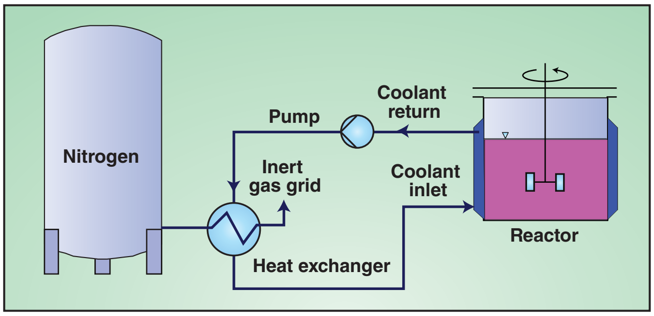


FIGURE 3. Liquid nitrogen is a good medium for producing temperatures below –40°C because the cooling capacity is highly flexible, and investment costs are lower than those for conventional refrigeration systems

TABLE 2. SELECTED SYNTHESIS REACTIONS IN FINE AND SPECIALTY CHEMISTRY, WITH GASES REQUIRED

Synthesis reaction	Gas	Available purities [*6*]
Amination	Ammonia	≥ 99.98 to 99.9999
Acetylation	Acetylene	≥ 99.6
Carbonylation	Carbon monoxide	≥ 99 to 99.997
Chlorination	Chlorine	≥ 99.8 to 99.999
Fermentation	Oxygen	Air, or oxygen-enriched air with up to 80% oxygen
Hydrogenation	Hydrogen	≥ 99.999 to 99.99999
Oxidation	Oxygen (or air)	≥ 99.6 to 99.9999

air. Nitrogen is used as a stripping gas, as an inert gas in the processing of flammable solvents and in the product quality assurance effort. It also serves for the conveying of liquids and solids in process systems. Liquid nitrogen is, furthermore, an effective coolant with applications that include freeze-drying. Carbon dioxide can function as a carbon source for autotrophic microorganisms and is also used in pH regulation. Ammonia gas is a good nitrogen source and also figures — frequently in the same pass — as a pH control agent.

Syntheses cooling and heating

Multiple synthesis reactions or unit operations are often conducted at different temperatures in stirred-tank reactors. A procedure specific to fine and specialty chemistry is low-temperature synthesis, which can require temperatures as low as –110°C. Low temperatures improve selectivity and lower the costs of isolating the products. In many cases the specified temperature must also be maintained very accurately in order to minimize the quantity of byproducts formed; temperature accuracies of ±1°C are feasible. Liquid nitrogen is a good medium for producing low temperatures (below –40°C) because the cooling capacity is highly flexible, and investment costs are lower than those for conventional refrigeration systems. Maintenance costs are much lower as well.

Typical low-temperature processes [*7*] include the following:

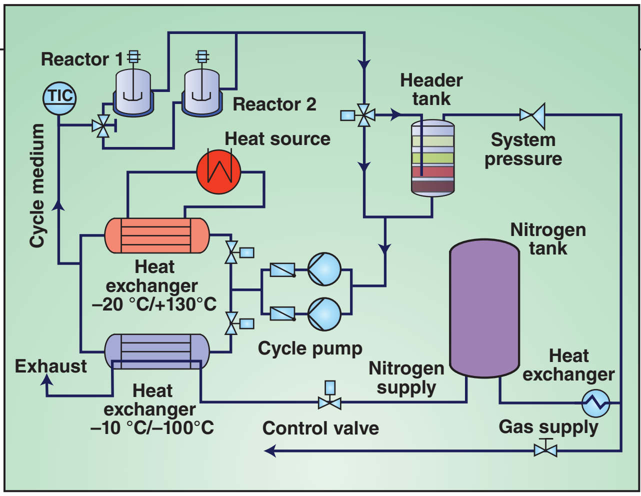
- Use of organolithium compounds
- Asymmetric syntheses
- Birch-Hückel reduction
- Grignard syntheses
- Reduction of metal hydrides
- Wittig reaction
- Low-temperature crystallization

For such processes, a variety of cooling methods are in use, including the following:

- Injecting liquid nitrogen to cool the reaction mass directly
- Injecting liquid nitrogen into an integral heat exchanger or cooling jacket to cool the reactor contents
- Cooling and/or heating a reactor via a secondary loop carrying a heat/cold transport medium cooled or heated in heat exchangers; liquid nitrogen is generally employed for cooling

Special systems have been developed for cooling. Figure 3 is a schematic diagram of a simple one.

Because reactor temperature control requirements are stringent — particularly in terms of broad temperature range and rate and accuracy of temperature adjustment — complete cooling and heating systems [*8*] have been developed. Figure 4 presents a typical scheme for such a system. The main elements are the heat exchangers for cooling and heating the heat transfer medium, one or two pumps to circulate it, an expansion vessel and valves that permit rapid, reliable temperature adjustment. The medium is cooled against liquid nitrogen and can be heated with electricity, steam or another heat loop. Technical implementation of such a broad temperature range also calls for a suitable heat transfer medium such as methylcyclopentane [*9*] or a well-defined mixture of hydrocarbons [*10*].



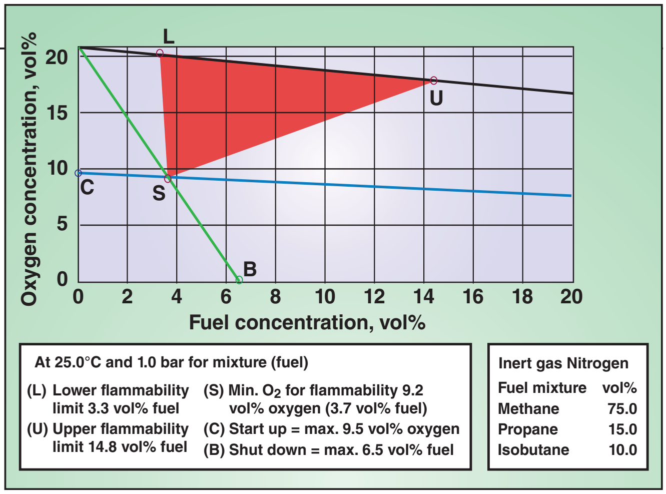


FIGURE 4. Heating and cooling systems that employ industrial gases as a heat transfer medium enable rapid and accurate temperature adjustment for broad temperature ranges common in reactors

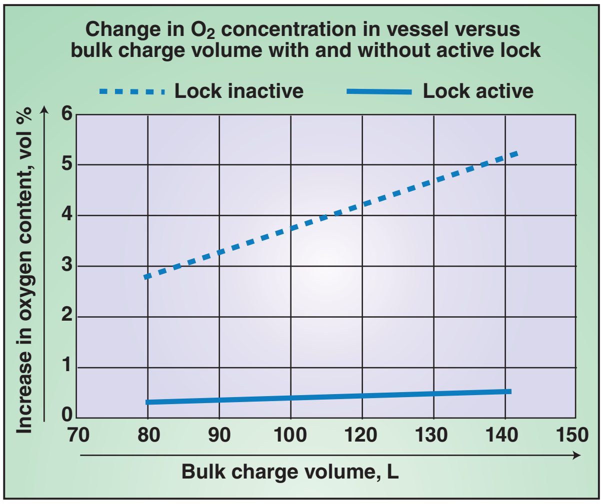


FIGURE 5. (above) A common use for industrial gases is to protect against an explosive atmosphere. Software for calculating explosion limits, such as illustrated here, is gaining in importance [*11*]

FIGURE 6. Inert gas locks make can help cut the rise in oxygen level from 2.9–5 vol.% to 0.3–0.6 vol.%, as illustrated by this example (left), which compares oxygen concentration with charge volume for vessels with and without an inert gas lock

Inerting

Inerting uses an inert gas, usually nitrogen but also carbon dioxide in some cases, to displace atmospheric oxygen, combustible gases and moisture. Inerting is employed for reasons of safety or to protect products. Safety concerns include the following:

- Safe startup and shutdown of the process units
- Prevention of explosive atmospheres
- Avoidance of explosion risks when handling combustible fluids

Products are protected by suppressing oxidation reactions with atmospheric oxygen and/or blocking the access of moisture.

The following techniques are used in inerting:

- Dilution purging
- Displacement purging
- Pressure-swing purging (pressure rise, pressure relief or vacuum)
- Blanketing

A knowledge of the explosion limits is essential for many processes and operations in fine and specialty chemistry. The explosion limits depend on the pressure and temperature as well as the composition of the mixture present. Along with experimental determinations, software for calculating the explosion limits is gaining in importance [*11*]. Figure 5 shows a calculated explosion triangle. Meanwhile, programs are available to compute in advance the time and the quantity of nitrogen required for various inerting techniques.

Inert gas locks. Fine and specialty chemical processes involve not only liquids and gases but also solids, for example in reactions carried out in stirred tanks. In order to ensure safe handling of solids and prevent side reactions such as oxidation, inert-gas locks [*12*] have been devised to block the entry of oxygen when solids are being charged manually into reactors and vessels. These fittings also prevent emissions and protect against moisture and electrostatic charge.

Among the features of inert gas locks are the following:

- Minimal access of oxygen to the vessel during opening and charging
- Low nitrogen consumption
- Inexpensive integration into charging ports of existing vessels
- Easy day-to-day handling
- Variety of designs to fit particular applications

Figure 6 is a plot of the oxygen concentration versus charge volume for a vessel being charged with and without an inert gas lock. The use of the lock makes it possible to cut the rise in oxygen level from between 2.9 and 5 vol.% to between 0.3 and 0.6 vol.%.

Locks are thus a simple but effective way of ensuring very slight access of oxygen and moisture to a vessel or reactor when it is charged with solids.

Cryocondensation

Cryocondensation means cooling offgas streams against liquid nitrogen in heat exchangers until the valuable or noxious substances contained in them condense or freeze onto the heat transfer surfaces. In the process, the liquid nitrogen is vaporized and becomes available for further use, such as in inerting.

The temperature necessary to get below the dewpoint or to attain compliance with regulatory limits can easily be adjusted and controlled through the use of liquid nitrogen (–196°C at 1 bar) as a cold transfer medium. Cryocondensation thus brings within reach the temperatures required, which can be below –150°C in some cases.

The technique is frequently employed in fine and specialty chemistry. Simple technology, high flexibility and increasingly stringent environmental regulations suggest that its use will increase.

Cryocondensation is employed mainly for the following purposes:

- Compliance with environmental regulations, such as the TA-Luft, a German air-quality directive
- Recovery of valuable substances, for

example by condensation and recycling of expensive hydrocarbons to the reactor
- Reduction of damage to downstream equipment, such as diminished corrosion due to removal of chlorinated hydrocarbons

Compared with other techniques for off-gas treatment, cryocondensation offers several advantages:
- It is environmentally safe because no secondary burdens are generated as, for example, in scrubbing or adsorption
- It involves no auxiliary materials as do processes such as absorption
- It yields low residual emission loads
- Condensate can be reused directly
- Nitrogen is used twice, for cooling and for inerting (in the plant nitrogen grid)
- Maintenance costs are low because the system has few moving parts
- The process is flexible in terms of the volatile organic compounds (VOC) load
- The unit is simple to operate and lends itself to full automation
- Investment costs are relatively low

In comparison with the use of refrigeration equipment, liquid nitrogen makes it possible to achieve the required temperatures economically and without difficulty. In particular, the condensation power can be adjusted relatively quickly and over a broad range by controlling the rate of injection of liquid nitrogen.

Cryocondensation can be used economically for treating off-gas streams heavily loaded with hydrocarbons and for achieving very low residual emissions. It finds successful use with substances such as dimethyl ether, toluene, tetrahydrofuran, ethyl acetate and acetone as well as mixtures such as dimethyl ether-methyl chloride or acetone-methanol-dichloromethane. After cryocondensation, the nitrogen gas can be delivered to the plant nitrogen grid, while the recovered hydrocarbons are recycled.

The ease of combining cryocondensation with other treatment and recovery processes — adsorption in particular — permits an expansion of the field of application. Throughputs of up to 1,500 Nm^3/h of off-gas and very high purities can be realized economically with such a combination.

Meanwhile, incorporating complete prefabricated cryocondensation equipment into existing systems is a quick and easy job.

Another application of cryocondensation is fractionating condensation [*13*], in which different temperatures levels are realized in each individual heat exchanger. Test units are available for such processes.

Hydrocarbon recovery from off-gases has both environmental and economic benefits. For example, pollution is reduced by averting the production of CO and CO_2, especially if the off-gases are burned. At the same time, plant investments for the recovery of valuable hydrocarbons by cryocondensation can pay for themselves within somewhere between 0.5 and 2 years, depending on prices and other conditions.

Also, off-the-shelf cryocondensation units have the advantages of ready availability and low cost.

Size reduction

Many fine and specialty chemicals have to meet rigorous standards not just on purity but also on particle form. Accordingly, size-reduction processes are important along with purification operations such as crystallization. Some size reduction processes, including cold milling and prilling, require industrial gases. Liquid nitrogen is employed as coolant when cold milling is performed in impact and centrifugal mills. The nitrogen supply system can be designed very quickly and adapted to a variety of requirements. Several useful effects can be achieved through the use of liquid nitrogen in milling:
- Fine grain size
- Free-flowing quality of product, hence good conveying properties
- Protection against fire and dust explosions by inert nitrogen
- Enhanced mill capacity

A further option for cooling and inerting is direct metering of liquid nitrogen into the mill.

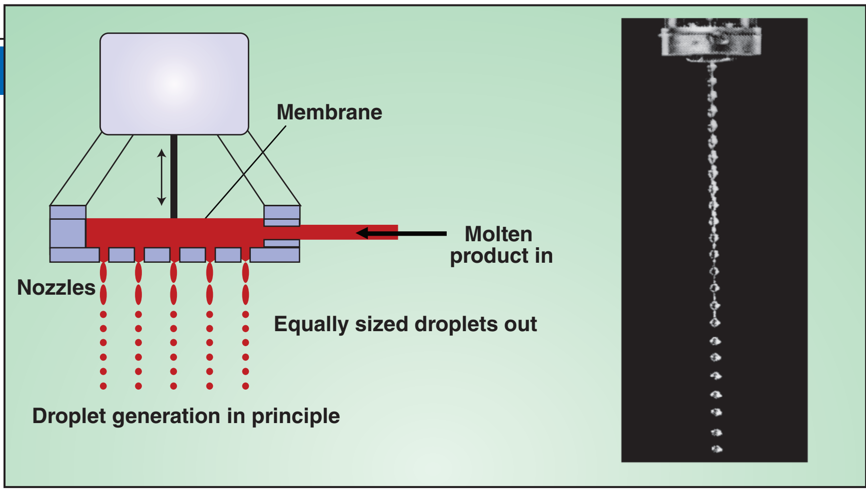


FIGURE 7. Prilling with liquid nitrogen is attractive when spherical particles with a very narrow size distribution and virtually dust-free environment are necessary

Prilling is an accepted method for generating particles from homogeneous melts such as waxes ad waxlike substances as well as unsaturated fatty acids. Prilling with liquid nitrogen is a good choice for many substances when spherical particles having the narrowest possible size distribution and a virtually dust-free environment are required. Many technical approaches are available, depending on the needed capacity. A special droplet-forming system can be used to break the liquid melt up into round particles of uniform shape (Figure 7).

The generated particles fall into a solidification pipe where the temperature is held very low by injection and vaporization of liquid nitrogen. As a result, the particles rapidly cool and take on a stable shape, while agglomeration and deformation are avoided. Particle size varies between 0.5 and 2 mm for the most part.

The nitrogen also produces an inert atmosphere, which can be maintained throughout the unit, thus automatically preventing oxidation and blocking the entry of moisture into the end product right up to the filling step.

Industrial services

Services to the fine and specialty chemicals industry involve a wide range of processes and hardware, some of it making use of gases. These services help reduce maintenance time and costs, ensure and enhance workplace

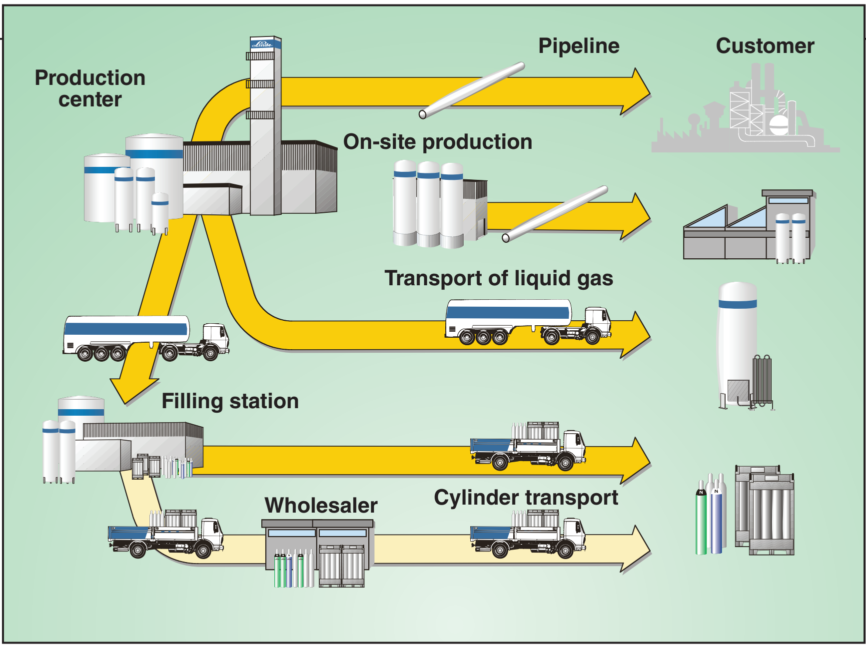


FIGURE 8. Depending on the quantity and type of gas needed, there is a variety of supply and delivery options that ranges from small containers to onsite production

safety and abate environmental pollution. Another important point is that the gases used, such as nitrogen, are nontoxic, incombustible and inert.

The following principal operations are encountered in industrial service:

- Purging and drying of plants with nitrogen
- Cleaning of units and piping
- Leak testing with N_2/He mixtures

In addition, carbon dioxide is increasingly used for cleaning [*15*], where surfaces to be cleaned are blasted with high-velocity CO_2 (dry ice) pellets. The process lends itself to cleaning not only freely accessible surfaces but also piping.

An example of the use of industrial gases in cleaning involves a stirrer used in paint manufacture. The advantages of the process are that it requires no solvents, the blasting medium leaves no residues behind and no wastewater is generated.

Gas supply

Gas demand in fine and specialty chemistry varies widely in terms of both quantity and gases used. Gases can be delivered in small containers, standard cylinders, cylinder bundles, steel drums, battery vehicles or bulk tank vehicles, or they can be generated onsite (Figure 8).

The gases most employed are nitrogen, oxygen and hydrogen. Along with other industrial gases such as carbon monoxide, synthesis gas and carbon dioxide, there is also a need for inorganic and organic gases at various purities as well as gas mixtures. Specialty gas catalogs [*6*] provide further details. What is more, specialized hardware and delivery platforms aid in safe handling of gases, facilitating, for instance, odorants for certain gases.

Outlook

The field of fine and specialty chemicals is expected to grow on average by 6% annually in the coming years [*1*]. Demand in biotechnological processes will grow even faster, 10–15% per year.

Future market development will be marked above all by globalization: Asia, especially China and India, will produce more and more fine and specialty chemical products. Product quality and environmental standards there will naturally become stricter as well. One implication is that more effort must be put into off-gas and wastewater treatment in order to meet emissions limits. This means greater demand for gases in these countries.

The U.S. and Europe will increasingly concentrate on the manufacture of end products and high-value specialty products. In this context special synthesis operations, such as low-temperature syntheses, may become more important in these markets.

Research and development will play an increasingly vital part in retaining production sites in the leading industrialized economies. Accordingly, product development — for instance, in nanoparticles — and an intensified search for new technologies and broader applications for these processes will be pushed. New openings for the use of technical and specialty gases in fine and specialty chemistry will appear as a result. ■

Edited by Rebekkah Marshall

References

1. Pollak, P., "Fine Chemicals: The Industry and the Business," John Wiley & Sons, New York, 2007.
2. Fink, U., others, "Overview of the Specialty Chemicals Industry," SRI Consulting, Menlo Park, 2006.
3. Cibulski, A. others, "Fine Chemicals Manufacture – Technology and Engineering" Elsevier, 2001.
4. Rauch, J., "Mehrproduktanlagen [Multi-product Plants]", Wiley-VCH, 1998.
5. Stitt, E. H., Alternative Multiphase Reactors for Fine Chemicals – A World Beyond Stirred Tanks? *Chem. Eng. J.* 90, 47–60 (2002).
6. "Spezialgasekatalog [Specialty Gases Catalogue]", Linde Gas, Munich, 2007.
7. Lesar, J. A., "Constructing a Frigid Process Facility," *Chem. Eng.*, June 2001, 74–78.
8. Reinhardt, H.- J. and Dürr, D., Safe Temperature Control – A Cryogenic Temperature Control System for Low-Temperature Processes, Linde Gas, Facts About Chemistry, 03, 2005.
9. Patent DE 42 40306 C2, Bayer AG, Leverkusen.
10. Linde Gas, Heat Transfer Fluids, Germany, Patent DE 102007061237.2.
11. Safety System / PAM Data Sheet, Linde Gas, Munich [work in progress].
12. N2LOCK Data Sheet, Linde Gas, Munich.
13. Linde Gas, Germany, Patent DE 102007001658.3.
14. Linde Gas, LINPRILL Data Sheet, Munich.
15. "Die coolste Reinigungsmethode aller Zeiten" [The Coolest Cleaning Method of All Time], , Linde Gas, Munich.

Author

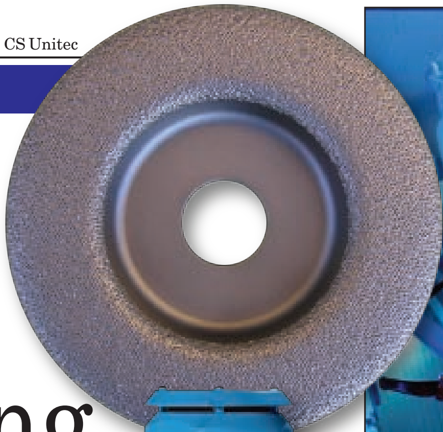
Hans-R. Himmen is a aenior project manager at Linde AG (Linde Gas Division, Carl-von-Linde-Str. 25, 85716, Unterschleissheim, Germany; Phone: +49-89-31001-5649; Fax: +49-89-31001-5643; Email: hans-rudolf.himmen@linde-gas.com). He studied process engineering at the Technical University of Braunschweig and joined the Linde Group in 1987. He is involved in the development, introduction and improvement of gas applications for the chemical process industries and for industrial services. His most important fields of work include liquid and gaseous nitrogen applications.

Hans-Jürgen Reinhardt is a retired department manager from Linde AG's Gas Division. He received his Ph.D. in process engineering from the Technical University Leuna-Merseburg, and worked in the chemical industry for many years before joining the Linde Group in 1996. At Linde, he was responsible for development and introduction of processes and hardware for use of gases in refineries and in the chemical industry. His most important fields of work include applications of nitrogen and processes for use of oxygen.

FOCUS ON

Milling & Grinding

CS Unitec



Moyno

Malvern Instruments

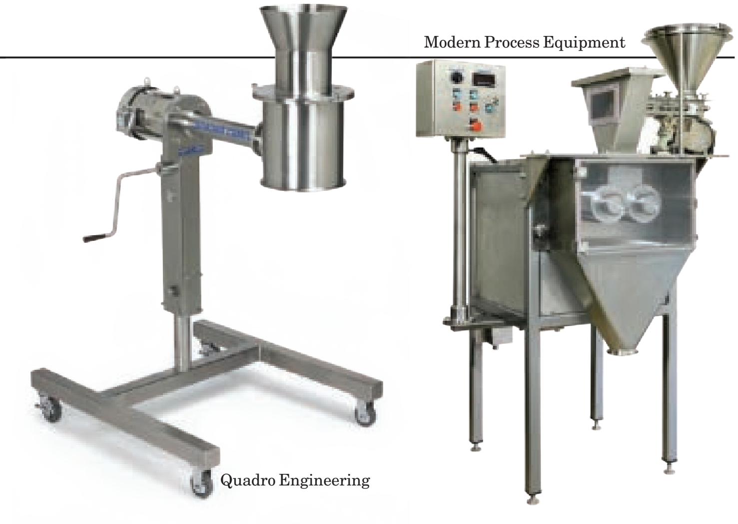
Union Process

The patented design of this unit improves grinder efficiency
The Annihilator (photo) is a twin-shaft, solids-reduction unit designed for a variety of industrial and municipal installations, including sewage lift stations, head works and sludge processing systems. The unit's counter-rotating, hexagonal-shaft design coupled with its five-tooth, hardened-steel cutters provide the maximum shredding strength necessary to process from 300 to 4,250 gal/min of influent. It is offered in various drive, housing, cutter, spacer/cutter and shaft options, and is available with 3 to 5 hp motors. An electronic control panel offers protection from overload. Because of its standard dimensions, the Annihilator can easily retrofit other twin-shaft grinders. — *Moyno, Inc., Springfield, Ohio*
www.moyno.com

When spark reduction is important, use these grinding discs
Eco Brazing (EB) diamond grinding discs (photo) reduce sparking to 1% of that produced by resinoid wheels, making these discs better for use in hazardous environments. The EB diamond grinding discs are ideal for grinding steel, stainless steel and other materials. The diamond grit protrudes higher off the EB diamond disc than traditional diamond wheels, providing greater durability and longer service life. Available in grits from 30–80 on disc sizes 4, 4-1/2, 5 and 7 in. in diameter, the disc's light weight allows for high-rotation grinding on portable angle grinders. The EB diamond wheel wears approximately 1% as much as a resinoid wheel, therefore increasing the tool life and significantly reducing the amount of abrasive dust emitted. — *CS Unitec, Inc., Norwalk, Conn.*
www.csunitec.com

Achieve small media milling with this production mill
This new production-sized, small-media mill is designed for the ink, coatings and paint markets. The DMQ-10 (photo) combines the best features of a traditional horizontal small-media mill with the added benefits of circulation grinding. Although the DMQ Series is able to operate in either circulation or continuous mode, using the mill for circulation grinding offers a narrower particle-size distribution, the ability to continuously monitor the slurry and the ability to sample or add ingredients to the premix tank at any time. The unit features a media separator at the end of the mill for easy servicing. Indexed discs provide uniform media distribution, while adjustable product discharge openings accommodate grinding media from 2 mm to as small as 0.3 mm. — *Union Process, Inc., Akron, Ohio*
www.unionprocess.com

Get tight control of a process with realtime remote mill operation
This firm has developed a real-time analysis system (photo), which was recently implemented at the Ferrari Granulati plant in Verona, Italy. Ferrari Granulati uses both in- and online particle-size analyzers from this firm to produce white marble powders



Modern Process Equipment

Quadro Engineering

for use in the paper, plastics and construction industries. Realtime data allow very tight control of particle-size distribution and full process optimization. An Insitec analyzer, installed online at the plant, instantaneously tracks the impact of changes on particle size. The analyzer is installed at the exit of a milling circuit that uses a novel vertical roller mill to reduce average particle size to between three and eight microns. — *Malvern Instruments, Malvern, U.K.*
www.malvern.com

This unit sizes toxic and corrosive chemicals

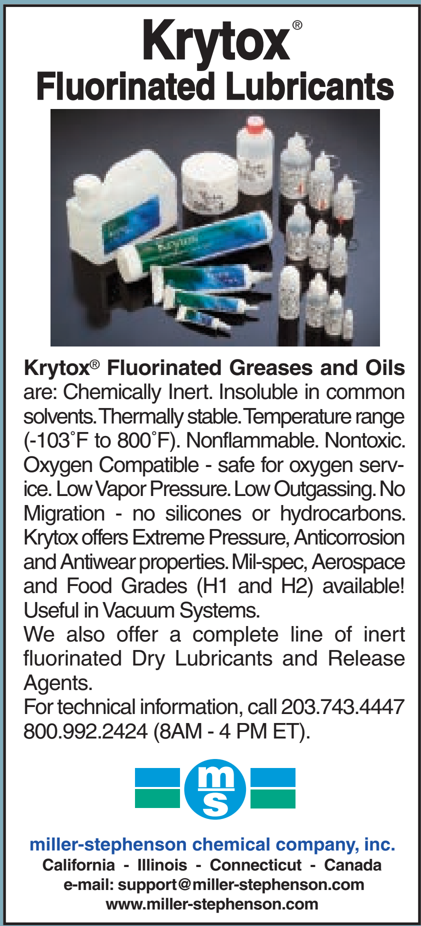
An international chemical manufacturer approached this company to develop a completely contained processing environment, requiring a highly toxic and potentially corrosive material to be milled. No ambient air introduction or dust release was permissible. The customer was looking for a size-reduction device capable of producing a lump-free final product of less than 0.25 in. This firm employed the high-capacity, low-dust Underdriven Comil (photo), which successfully contained and processed the material to 100% of the required target product size. Ten fully scalable Comil models are available for a variety of applications, and can range up to 54,500 kg/h. The unit meets all international safety standards including OSHA/CE/ATEX, and is manufactured to cGMP standards. — *Quadro Engineering Corp., Waterloo, Ontario, Canada*
www.quadro.com

This roller-style grinder is designed for the lab and pilot plant

This company recently introduced the LPP 6.5 Laboratory/Pilot Gran-U-Lizer (photo). Like all MPE roller-style Gran-U-Lizers, the LPP grinds material to a narrow particle-size distribution, with few unwanted fines, while minimizing impact and heat generation during the process. The LPP has independent control over the three important variables that affect ground product quality. First, the gap between the grinding rolls can be adjusted to 0.0005-in. accuracy. Additionally, the LPP includes independent drive control for each roll, allowing independent adjustment of roll speeds and the shear ratio between roll surfaces. Finally, the roll corrugation sizes and shapes are specifically tailored for the application, while the LPP also allows for simple replacement of the roll bodies. — *Modern Process Equipment Corp., Chicago, Ill.*
www.mpechicago.com ■

Kate Torzewski

Circle 201 on p. 62 or go to adlinks.che.com/23012-201



Circle 202 on p. 62 or go to adlinks.che.com/23012-202

Circle 203 on p. 62 or go to adlinks.che.com/23012-203

Circle 204 on p. 62 or go to adlinks.che.com/23012-204

Circle 205 on p. 62 or go to adlinks.che.com/23012-205

SOFTWARE

NEW & USED EQUIPMENT

NEW & USED EQUIPMENT

KILO LAB CENTRIFUGE

- For R & D, and Small Scale Processing
- Multiple capacities available
- Basket filtration or solid / liquid sedimentation capability
- Hard- and Soft-sided Containment for Potent Materials
- Rental Equipment Available
- Variable Speed up to 3000 RPM
- Ideal for Installation in a Fume Hood
- Explosion-Proof
- Cart-Mounted Installation for Easy Portability
- Available in 316L Stainless, 904L Stainless, and Hastelloy

ROUSSELET ROBATEL

703 West Housatonic Street – Ste L15,
Pittsfield, Massachusetts 01201-6616
Phone: 413.499.4818 • Fax: 413.499.5648
email: sales@robatel.com
www.rousselet-robatel.com/che09

Circle 248 on p. 62 or go to adlinks.che.com/23012-248

Filter Presses
Clarifiers
Sand Filters
Tanks Pumps
Filtration
Accessories

WATERWORKS 800.232.9334 219.663.8210

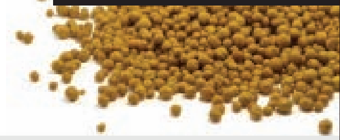
www.airtowater.com

NEW USED SURPLUS
Filtration Equipment

Circle 250 on p. 62 or go to adlinks.che.com/23012-250

API/Fine Chemical Facilities for Sale!

INTERPHEX BOOTH #558



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

141514 - Pilot Scale Manufacturing Process Plant
Location: Belgium

Pilot Scale & Production Equipment Available

131940 - (5) Appx 10,000 L Glass Lined Horizontal Single Wall Tanks
83228 - 1991 Summix Bolz 980L Stainless Steel Nauta Style Dryer
83218 - Guedu 90 No/Po 90 L Stainless Steel Pressure Dryer
83224 - Franco-Montan 600 L Stainless Steel Vacuum Tray Dryer
and many more ...

EquipNet.com/chemical +1.781.821-3482 EQUIPNET

Circle 251 on p. 62 or go to adlinks.che.com/23012-251

TOLL MANUFACTURING

NATUREX

TOLL MANUFACTURING SERVICES

- *Custom Spray Drying*
- *Custom Granulation*
- *Purification of Active Botanical Compounds*
- *Kosher, Halal and cGMP certified*
- *Full Service Lab*

CONTACT
Julius Myer
Key Account Executive
Email: j.myer@naturex.us
Phone: 201 440 5000
375 Huyler Street
South Hackensack, NJ 07606

Circle 249 on p. 62 or go to adlinks.che.com/23012-249

ADVERTISE IN THE CLASSIFIED

Contact Helene Hicks
Tel: 212-621-4958
Fax: 212-621-4976
Email: hhicks@che.com

CONSULTING

HFP ACOUSTICAL CONSULTANTS
NOISE CONTROL ENGINEERING

HOUSTON, TEXAS
(888) 789-9400
(713) 789-9400

CALGARY, AB
(888) 259-3600
(403) 259-6600

WWW.HFPACOUSTICAL.COM

Circle 252 on p. 62 or go to adlinks.che.com/23012-252

NEW RIBBON BLENDERS PRICED 30% LESS

World's #1 Manufacturer!

- All stainless, highest quality!
- Sizes 1 to 500 cu.ft.
- Many sizes in stock!

Call now!
1-800-243-ROSS

USA Tel: 631-234-0500 • Fax: 631-234-0691
www.ribbonblenders.com

ROSS

Circle 253 on p. 62 or go to adlinks.che.com/23012-253

CRYSTALLIZATION & PRECIPITATION

Dr. Wayne J. Genck Genck International
3 Somonauk Court, Park Forest, IL. 60466
Tel (708) 748-7200 Fax (708) 748-7208
genckintl@aol.com – http://www.genckintl.com

- Design/Scale-up
- Size Distribution
- Laboratory Investigations
- Filtration
- Troubleshooting
- Purity
- Caking
- Drying
- Particle Habit
- Product Micro-Analysis
- Polymorphism
- Kinetics Studies

◆◆◆ Industrial Seminars ◆◆◆

Circle 254 on p. 62 or go to adlinks.che.com/23012-254

NEW & USED EQUIPMENT

RECRUITMENT

Advertisers' Index

• International Section
* Additional information in 2006 Buyers' Guide

JustFAXit! or go to www.che.com/adlinks

Fill out the form and circle or write in the number(s) below, cut it out, and fax it to 800-571-7730.

Go on the Web and fill out the online reader service card.

Name ______________________ Title ______________________

Company ______________________

Address ______________________

City ______________ State/Province ______________ Zip/Postal Code ______________

Country\ ______________ Telephone ______________ Fax ______________

Email | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FREE PRODUCT INFO
(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

If number(s) do not appear above, please write them here and circle: ______________

Fax this page back to 800-571-7730

ADVERTISING SALES REPRESENTATIVES

Mike O'Rourke, Publisher
Chemical Engineering
5 Lynbrook Lane, Doylestown, PA 18901
Tel: 215-340-1366; Fax: 609-482-4146
E-mail: morourke@che.com
Alabama, Canada, Connecticut, Delaware, Florida, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York (minus Western New York), North & South Carolina, Pennsylvania (minus Western Pennsylvania), Rhode Island, Tennessee, Vermont, Virginia, Washington, D.C., West Virginia, Latin America

North America
Jason Bullock,
District Sales Manager
Chemical Engineering
8325 Broadway, Ste. 202/PMB 261
Pearland, TX 77581
Tel: 281-485-4077; Fax: 281-485-1285
E-mail: jbullock@che.com;
Arkansas, Arizona, California, Colorado, Georgia, Kansas, Louisiana, Missouri, Nevada, Oklahoma, Texas

George Gortz,
District Sales Manager
Chemical Engineering
2612 Edgerton Road
University Heights, OH 44118
Tel: 216-932-2700; Fax 216-932-5810
E-mail: ggortz@che.com
Indiana, Illinois, Iowa, Kentucky, Michigan, Minnesota, Ohio, Western New York, Western Pennsylvania, Wisconsin

Helene Hicks,
Inside Sales Manager
Chemical Engineering;
110 William St., New York, NY 10038-3901
Tel: 212-621-4958; Fax: 212-621-4976;
E-mail: hhicks@che.com
Product Showcase, Literature Reviews, Classified Display Advertising
Alaska, Hawaii, Idaho, Mississippi, Montana, Nebraska, New Mexico, North & South Dakota, Oregon, Utah, Washington, Wyoming

International
Petra Trautes
Chemical Engineering
Zeilweg 44
D-60439 Frankfurt am Main
Germany
Phone: +49-69-2547-2073
Fax: +49-69-5700-2484
Email: ptrautes@che.com
Austria, Czech Republic, Benelux, Eastern Europe, Germany, Scandinavia, Switzerland, United Kingdom

Dipali Dhar
Chemical Engineering
110 William St., New York, NY 10038-3901
Tel: 212-621-4919; Fax: 212-621-4990
E-mail: ddhar@chemweek.com
India

Katshuhiro Ishii
Chemical Engineering
Ace Media Service Inc., 12-6, 4-chome
Nishiiko, Adachi-ku, Tokyo 121, Japan
Tel: 81-3-5691-3335; Fax: 81-3-5691-3336
E-mail: amskatsu@dream.com
Japan

Ferruccio Silvera
Chemical Engineering
Silvera Pubblicita
Viale Monza, 24 Milano 20127, Italy
Tel: 39-02-284-6716; Fax: 39-02-289-3849
E-mail: ferruccio@silvera.it/www.silvera.it
Andorra, France, Gibraltar, Greece, Israel, Italy, Portugal, Spain

Rudy Teng
Chemical Engineering
Professional Publication Agency
6F-3 # 103 Fen Liau St Neihu
Taipei 114 Taiwan
Tel: 886-2-2799-3110 ext 330;
Fax: 886-2-2799-5560
E-mail: rudy_teng@ppa.com.tw
or idpt808@seed.net.tw
Asia-Pacific, Hong Kong, People's Republic of China, Taiwan

BUSINESS NEWS

PLANT WATCH

Dow to close LDPE plant in Freeport, Texas

February 12, 2009 — Driven by current economic conditions and overcapacity for low-density polyethylene (LDPE) in the North American marketplace, The Dow Chemical Co. (Midland, Mich.) has announced the shutdown of its Poly 2 LDPE plant in Freeport, Texas. The shutdown is expected to be completed by the end of March 2009. "The Basic Plastics business carefully evaluated several options, but the supply-demand outlook for LDPE in North America, combined with the age, cost position and the relatively old technology of the Poly 2 plant as well as the need for additional investment do not make continued operation a viable option," said Pieter Platteeuw, global business director, LDPE. Dow and its affiliates continue to operate 25 polyethylene plants around the world, and remain the world's largest producers of polyethylene.

New system produces water for injection at Leo Pharma

February 9, 2009 — Veolia Water Solutions and Technologies (Saint-Maurice Cedex, France) has designed and installed a system at Leo Pharma that produces, stores and distributes water for injection (WFI). The new purified water system is part of Leo Pharma's upgrade of its anti-thrombotic facility in Vernouillet, France. Softened water is purified by reverse osmosis and then polished by continuous electrodeionization (CEDI) to produce 4,000 L/h of purified water. WFI is then produced by distillation. The system delivers 2,800 L/h of WFI.

New coke plant for POSCO in South Korea

February 3, 2009 — POSCO Group (Seoul, South Korea), the world's fourth biggest steel producer, has commissioned Uhde GmbH (Dortmund, Germany) to provide extensive services for the construction of four new coke-oven batteries to expand coke production by more than 2.3-million metric tons per year (m.t./yr). The coke plant is to be built at Gwangyang, a port city on the south coast, some 300 km southeast of the capital, Seoul. Together, the four coke oven batteries will have a coal throughput of approximately 3.8-million m.t./yr and will produce a total of about 2.3-million m.t./yr of coke. The first two coke oven batteries are due to come onstream in Fall 2010, and the other two will start production a year later.

Wastewater treatment plant to be built in Thailand

January 29, 2009 — Siemens (Erlangen, Germany) has been awarded a contract from Advance Agro Ethanol, a subsidiary of Advance Agro Public Co., to provide process and electrical equipment for a wastewater treatment plant. The new plant will be located in Tha Toom, Prachinburi Province. The equipment, scheduled to be installed in the 4th Q of 2009, will treat the wastewater from ethanol production to meet effluent standards and to obtain biogas that will be used as an alternative energy source. The system is sized to treat an average of 5,000 m^3/day of wastewater, up to a maximum of 6,000 m^3/day.

ABB wins mining order in Canada

January 27, 2009 — ABB (Zurich, Switzerland) has won a contract valued over $28 million from Terrane Metals Corp., which includes the delivery of drive systems for the new Mount Milligan copper-gold mine in northwest Canada. The anticipated annual yield from the mine is about 40,000 m.t. of copper and 217,000 ounces of gold. Startup of the project is scheduled for 2012.

Praxair awarded hydrogen contract by Dynamic Fuels

January 23, 2009 — Praxair, Inc. (Danbury, Conn.) has been awarded a hydrogen supply contract from Dynamic Fuels, LLC, a joint venture between Tyson Foods, Inc. and Syntroleum Corp. Dynamic Fuels will use H_2 supplied by Praxair to produce renewable fuels from non-food-grade animal fats produced or procured by Tyson Foods, using Syntroleum's bio-synfining technology. By using fats, such as beef tallow, pork lard, chicken fat and used greases, high-quality diesel and jet fuels will be produced at Dynamic Fuels' Geismar, La., production facility. These fuels will offer the same benefits of synthetic fuels derived from coal or natural gas while providing substantial performance and environmental advantages over petroleum-based fuels. These benefits include higher cetane levels, which are a measure of combustion quality, and superior thermal stability, which qualify the fuel for advanced military applications. Dynamic Fuels' $138-million plant is currently scheduled to begin production in 2010, with a total capacity of 75 million gal/yr of fuel.

MERGERS AND ACQUISITIONS

Borgo Olona acquires Borealis' business and operations in Italy

February 3, 2009 — An agreement has been reached for the sale of Borealis' business and operations in Castellanza, Italy to Borgo Olona, a group of investors well known in the region. The new owner has decided to rename the company Chemisol Italia Srl. AMI Agrolinz Melamine International Italy, an affiliate of Borealis AG, manufactures a range of melamine-based resins for various applications and additives for the woodwork industry and is being sold as a result of Borealis' intention to focus on its base chemicals portfolio of core products, namely melamine, plant nutrients, phenol and olefins from its European cracker operations. The Castellanza plant, near Milan, has a production capacity of approximately 12,000 ton/yr of melamine resins and 3,000 ton/yr of additives.

Sulzer Chemtech acquires Freeze Tec

January 19, 2009 — Sulzer Chemtech Ltd. (Winterthur, Switzerland) has announced the acquisition of Freeze Tec B.V. (Raamsdonksveer, Netherlands). Freeze Tec is specialized in the field of melt suspension crystallization for chemical and food applications. Freeze Tec will be transferred to Winterthur in Switzerland and merged with Sulzer Chemtech's melt crystallization business. This acquisition broadens the current product portfolio of Sulzer Chemtech and allows access to new applications and markets. Furthermore, it enhances its capabilities in the crystallization business by combining the experience and best practices in suspension and layer crystallization to offer tailor-made and comprehensive solutions to its clients. ■

Dorothy Lozowski

For consideration in this section, please send press releases to biznews@che.com

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

March 2009; VOL. 116; NO. 3

Chemical Engineering copyright @ 2009 (ISSN 0009-2460) is published monthly, with an additional issue in October, by Access Intelligence, LLC, 4 Choke Cherry Road, 2nd Floor, Rockville, MD, 20850. Chemical Engineering Executive, Editorial, Advertising and Publication Offices: 110 William Street, 11th Floor, New York, NY 10038; Phone: 212-621-4674, Fax: 212-621-4694. Subscription rates: $59.00 U.S. and U.S. possessions, Canada, Mexico; $179 International. $20.00 Back issue & Single copy sales. Periodicals postage paid at Rockville, MD and additional mailing offices. Postmaster: Send address changes to Chemical Engineering, Fulfillment Manager, P.O. Box 3588, Northbrook, IL 60065-3588. Phone: 847-564-9290, Fax: 847-564-9453, email: clientservices@che.com. Change of address, two to eight week notice requested. For information regarding article reprints, please contact Angie Van Gorder at angie.vangorder@theygsgroup.com. Contents may not be reproduced in any form without written permission. **Publications Mail Product Sales Agreement No. 40558009. Return undeliverable Canadian Addresses to: P.O. Box 1632, Windsor, ON N9A7C9.**

FOR MORE ECONOMIC INDICATORS, SEE NEXT PAGE

Economic Indicators

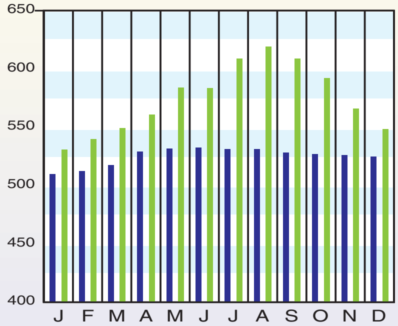
2009 2008 2007

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

CHEMICAL ENGINEERING PLANT COST INDEX (CEPCI)

(1957-59 = 100)	Dec.'08 Prelim.	Nov.'08 Final	Dec.'07 Final
***CE* INDEX**	548.4	566.2	525.0
Equipment	654.4	681.3	623.3
Heat exchangers & tanks	618.3	655.8	593.6
Process machinery	623.2	641.0	597.9
Pipe, valves & fittings	806.1	831.8	727.2
Process instruments	397.0	415.6	414.4
Pumps & compressors	891.3	896.5	840.0
Electrical equipment	459.7	461.7	436.3
Structural supports & misc	684.0	718.0	660.8
Construction labor	328.3	326.4	317.0
Buildings	503.6	514.0	477.0
Engineering & supervision	349.9	350.6	356.2

Annual Index:
- 2000 = 394.1
- 2001 = 394.3
- 2002 = 395.6
- 2003 = 402.0
- 2004 = 444.2
- 2005 = 468.2
- 2006 = 499.6
- 2007 = 525.4

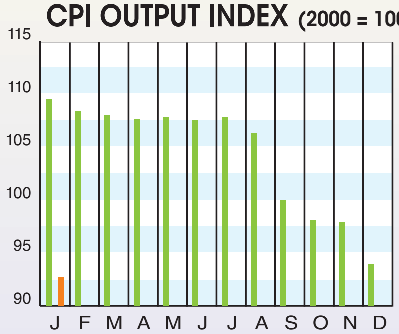


Starting with the April 2007 Final numbers, several of the data series for labor and compressors have been converted to accommodate series IDs that were discontinued by the U.S. Bureau of Labor Statistics

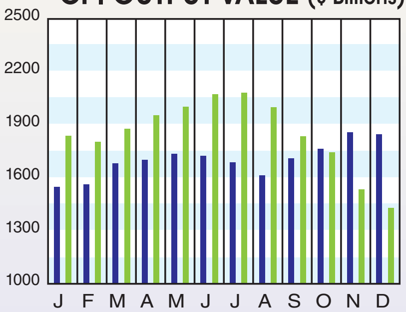
CURRENT BUSINESS INDICATORS

	LATEST		PREVIOUS				YEAR AGO	
CPI output index (2000 = 100)	Jan.'09	= 92.7	Dec.'08	= 93.9	Nov.'08	= 98.1	Jan.'08	= 109.2
CPI value of output, $ billions	Dec.'08	= 1,430.0	Nov.'08	= 1,535.2	Oct.'08	= 1,744.1	Dec.'07	= 1,846.4
CPI operating rate, %	Jan.'09	= 68.1	Dec.'08	= 69.0	Nov.'08	= 72.2	Jan.'08	= 81.4
Construction cost index (1967 = 100)	Feb.'09	= 794.4	Jan.'09	= 795.9	Dec.'08	= 796.1	Feb.'08	= 753.5
Producer prices, industrial chemicals (1982 = 100)	Jan.'09	= 226.2	Dec.'08	= 225.2	Nov.'08	= 260.6	Jan.'08	= 251.6
Industrial Production in Manufacturing (2002=100)*	Jan.'09	= 99.2	Dec.'08	= 101.8	Nov.'08	= 104.8	Jan.'08	= 113.8
Hourly earnings index, chemical & allied products (1992 = 100)	Jan.'09	= 144.8	Dec.'08	= 144.2	Nov.'08	= 144.3	Jan.'08	= 141.8
Productivity index, chemicals & allied products (1992 = 100)	Jan.'09	= 125.6	Dec.'08	= 125.7	Nov.'08	= 128.1	Jan.'08	= 136.0

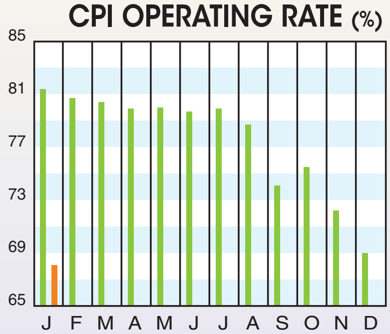
CPI OUTPUT INDEX (2000 = 100)



CPI OUTPUT VALUE ($ Billions)



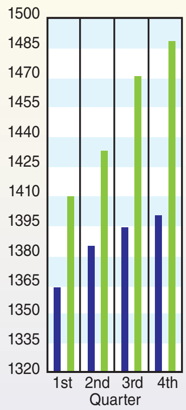
CPI OPERATING RATE (%)



*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)	4th Q 2008	3rd Q 2008	2nd Q 2008	1st Q 2008	4th Q 2007
M & S INDEX	1,487.2	1,469.5	1,431.7	1,408.6	1,399.2
Process industries, average	1,561.2	1,538.2	1,491.7	1,463.2	1,452.3
Cement	1,553.4	1,522.2	1,473.5	1,448.1	1,435.3
Chemicals	1,533.7	1,511.5	1,464.8	1,438.5	1,427.9
Clay products	1,524.4	1,495.6	1,453.5	1,429.1	1,415.0
Glass	1,448.1	1,432.4	1,385.1	1,359.7	1,348.8
Paint	1,564.2	1,543.9	1,494.8	1,467.6	1,457.1
Paper	1,462.9	1,443.1	1,400.0	1,377.7	1,369.2
Petroleum products	1,668.9	1,644.4	1,594.4	1,555.8	1,543.7
Rubber	1,604.6	1,575.6	1,537.5	1,512.3	1,500.1
Related industries					
Electrical power	1,454.2	1,454.4	1,412.8	1,380.4	1,374.9
Mining, milling	1,567.5	1,546.2	1,498.9	1,473.3	1,460.8
Refrigeration	1,818.1	1,793.1	1,741.4	1,711.9	1,698.8
Steam power	1,521.9	1,499.3	1,453.2	1,426.8	1,416.4



Annual Index:

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

CURRENT TRENDS

The CEPCI continues its decline in the December preliminary numbers (top), reflecting a substantial decrease in copper and steel prices, which is caused by an overall economic slowdown worldwide. Meanwhile, the drop in the CPI operating rate (middle) has not yet leveled.

Next month's issue will feature a helpful article on cost estimation as well as one describing the basis for the CEPCI.

Visit www.che.com/pci for more on the CEPCI. ■


What's scarier:
Forgetting your wedding anniversary again?
Or switching your current automation supplier?
Don't let the fear of switching automation suppliers get in the way of what's best for your plant. Emerson's expert team of migration specialists will support you every step of the way, and in steps that are right for you. We can even show you how to get the most out of your plant with today's leading digital automation architecture — PlantWeb.® So take the fear out of migrating your legacy system — partner with Emerson and get the absolute best in automation expertise, support and technology. Learn more at EmersonProcess.com/Solutions/Migration
Circle 03 on p. 62 or go to adlinks.che.com/23012-03
EMERSON.
Process Management
The Emerson logo is a trademark and a service mark of Emerson Electric Co. © 2007 Emerson Electric Co.
EMERSON. CONSIDER IT SOLVED.™