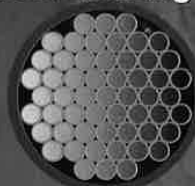


CHEMICAL ENGINEERING

December
2002

Heat-Exchanger



Fouling
Resistance
PAGE 46

www.che.com

Turning Up the Heat on Hazardous Waste

PAGE 50

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Nanotechnology Update

**Ultrasonic Devices
for Leak Detection**

Level Measurement

**Inspecting Ultraclean
Process Environments**

XML for Batch Control

Focus on Dust Collection

**Outsourcing
Water Treatment**

**Biennial Personal
Achievement Award**

A Chemical Week Associates Publication

MSI, Ex. 1012, p. 1



Cover Story

Facing increasingly strict global standards regulating their hazardous-waste-combustion units, chemical process operators must remain abreast of the latest technology options. A wide array of standard and specialized combustion-related technologies are available to convert toxic industrial waste streams into more-benign byproducts that meet the regulatory standards for discharge. Meanwhile, many technologies are also available to capture, neutralize or destroy the acidic, particle-laden, and metals-laden emissions that form during hazardous-waste combustion

MANAGING COMBUSTION EMISSIONS 50

The ability to produce, functionalize and employ substances with particle sizes less than 100 nanometers can improve the thermal and electrical conductivity, surface chemistry, photonic behavior, and catalytic properties of many materials. Nanotechnology is being exploited to produce better composites, gas sensors, consumer goods and self-cleaning surfaces, and to improve drug delivery in the human body

NANOTECHNOLOGY: THE SKY'S THE LIMIT 23

Environmental Manager

The use of third-party service providers to manage water and wastewater treatment is helping some operating companies to trim investment and operating costs. Read on to see if such an arrangement might be right for you

OUTSOURCING WATER TREATMENT 64



IN THIS ISSUE

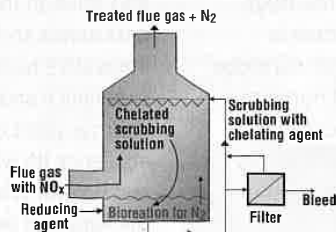
COVER STORY

50 Feature Report: Hazardous-waste incineration — don't overlook emissions controls Many combustion technologies, including rotary-kiln, fixed-hearth and fluidized-bed incinerators, cement kilns, boilers, and materials-recovery furnaces, can be used to treat hazardous wastes produced during chemical process operations. Proper system selection and design ensures that both waste volume and toxicity are reduced to safe levels. However, equally important is the selection control system to ensure that emissions — which often contain metals, particulate matter and acids — are treated in accordance with regulatory requirements

NEWS

13 Chementator: • Plastic wastes as an ammonia feedstock • This mass flowmeter handles two-phase flow • Thermal process slashes N_2O emissions • Fostering new technologies with low greenhouse gas emissions • Drugs from plants • Gas and petroleum outlook (p. 13) • A shorter route for polymer dis-

persions • Improving butadiene disersions by hydrogenation • Hybrid process for MDI purification • Surfactant captures spilled oil (p. 15) • Building functional ultrathin films, layer by layer • A simplified route for making automotive emissions-control catalysts • A less-costly way to separate *para*-xylene • 'Clean coal' • Hydrogen as a vehicle fuel (p. 17) • A biological process for destroying NO_x • Nanogels scavenge unwanted drugs from blood • Shell invests in new hydrogen-purification technology • 'Extreme' microbugs • 'Cheap' air conditioning (p. 19)



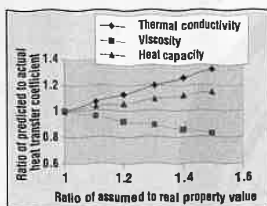
• More states tackle greenhouse gases • Corn modified for drugs inadvertently gets mixed with food crops • Congress postpones energy bill debate, and sets up new

Security Dept. • DOE seeks ideas for promising climate-change counter-measures • Europe's 'motor challenge' (pp. 21, 23)

- 23 Newsfront: Nanotechnology faces a big future** As the functional advantages of ultra-small particles continue to be deciphered, and new processes to produce and manipulate them are perfected, there seems to be no limit to what nanoparticles and other nanomaterials can do
- 29 Newsfront: Level measurement goes the distance** To meet challenging chemical process needs, many of the latest devices can measure both liquids and solids, through walls, or inside and over the top of vessels
- 34 Personal Achievement: Honors for two topflight engineers** Please join us as we salute AspenTech founder and simulation expert Lawrence Evans, and distillation guru Henry Kister. Winners of CE's 2002 Award for Personal Achievement in Chemical Engineering, both have had distinguished careers and made exemplary contributions to their profession

Feature Report

When designing heat-exchanger networks, engineers have long relied on a term called the "fouling factor" to help estimate the overall resistance to heat transfer within an exchanger. However, too often, engineers rely on this factor as a catch-all, to compensate for all of the uncertainties associated with predicting exchanger performance. This article discusses a more-realistic approach to process design and specification of heat exchangers



HEAT-EXCHANGER FOULING FACTORS 46

Newsfront

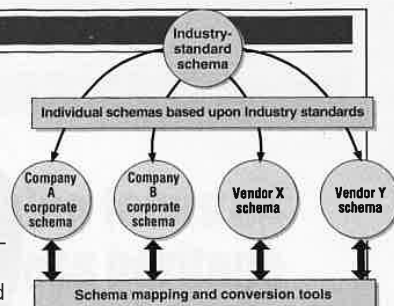
Accurate level measurement can mean the difference between a tank that is filled to capacity and one that is overflowing. If the product is hazardous, potential consequences for human health and the environment can be enormous. And if the product is valuable, losses will impact the bottom line. Profiled here are some recent advances in level measurement



KEEPING AN EYE ON TANK LEVELS 29

Engineering Practice

Last spring, the World Batch Forum released two sets of extensible-markup language (XML) schemas: Batch Markup Language (BatchML), to foster the standardized exchange of data during batch operations, and Business To Manufacturing Markup Language (B2MML), to standardize data exchange between enterprise and control systems. Both are based on the ANSI/ISA 88 and 95 standards. This article helps engineers to put these new offerings to use, to improve operations



NEW XML SCHEMAS FOR BATCH CONTROL 58

Pristine Processing

Biopharmaceutical manufacturers are under tremendous pressure to get their production systems validated, to meet international regulations. The inspection requirements of various equipment components can be rigorous, so increasingly, operating companies are turning to their equipment suppliers for help



THIRD-PARTY EQUIPMENT INSPECTIONS 36

ENGINEERING

36 Pristine Processing: Making the case for third-party inspections Shifting the burden of equipment inspection back to the supplier can save biopharmaceutical companies and manufacturers of other ultra-high-purity products time and money

46 Feature Report: Farewell fouling factor When sizing heat exchangers, many engineers still use fouling factors that were derived more than 60 years ago to help estimate the overall resistance to heat transfer occurring within the exchanger. What many don't know is that more-reliable overall coefficients can now be predicted with greater accuracy

58 Engineering Practice: Standardizing data exchange during batch and enterprise-wide operations Offered freely by the World Batch Forum, these new templates foster the exchange of data, in accordance with ANSI/ISA 88 and 95 standards

67 Operations & Maintenance: Detecting leaks with ultrasound Relying on acoustical wavelengths that are frequently the same size as fissures, today's state-of-the-art ultra-

sonic devices are especially effective in identifying the presence and location of a leak in vessels, tanks and piping

ENVIRONMENTAL

64 Environmental Manager: Outsourcing water and waste-water treatment With the ability to offer specialized technical expertise, access to a broad base of technologies, and lower raw-material costs through bulk purchasing, third-party water-treatment firms are increasingly being used by chemical process facilities

EQUIPMENT & SERVICES

62 Focus: Dust collection This roundup of products includes a variety of cartridge filters; pulse-jet collectors; particle-size analyzers; polypropylene- and polyester-felt filter bags; and HEPA filters; and a portable dust-collection trolley for machine shops; a filtration system to collect powder-paint dust for reuse; and more



BUSINESS

87 Mergers and acquisitions; Construction spotlight

OPINION & COMMENTARY

7 Editor's Page: A forward-looking focus on chemical-process heritage The Chemical Heritage Foundation was established 20 years ago to advance the heritage of chemical and molecular sciences. In addition to its focus on history and heritage, CHF also plays a role in disseminating information on ongoing technology and business developments

DEPARTMENTS

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COMING IN JANUARY

Look for: Articles on safeguarding process plants against terrorism and other threats; tuning PID controllers; electrostatic precipitators for capturing particulate emissions; Web-based tools for automating procurement; stress and corrosion cracking; particle sizing; **Plus:** Updates on nanotube production and use; steam generation and handling; membranes; column internals; chemical engineering salaries; and more.

Cover photography was provided by Von Roll America, Inc.

December New Products

Packing gland maintains tube and probe pressure sealing

Accommodating a 1 to 1.25-in. dia. tube or probe or 0.75-in. pipe, the PG7 packing gland (photo, top left) features soft sealant technology for effective pressure or vacuum sealing of instruments such as thermocouples, dial-type thermometers and glass thermometers, in liquid or gas environments. A 3-in. dia., reusable fitting — made of 316 Series stainless steel — is easily assembled in the field by simply inserting the element and torquing the cap. The replaceable sealant, which may be Viton, Teflon, Lava or Grafoil, permits repeated use of the same fitting. Depending on the sealant used, the assembly is rated for pressures from vacuum to 1,000 psi, at temperatures of -400 to 1,600°F. — *Conax Buffalo Technologies, LLC, Buffalo, N.Y.*

conaxbuffalo.com

This instrument automates ion-chromatography applications

The 816 IC Eluent Selector (photo, bottom right) is a step gradient, 3-port selector, which can select one of three solutions (eluent) for ion chromatography applications. Switching can be carried out manually, or automatically through the manufacturer's Metrodata IC-Net 2.1 software. The eluent change, or step gradient, can be programmed within a chromatogram. In this way, even analytes with very different retention behaviors can be determined in a single run. — *Metrohm-Peak, Houston, Tex.*

metrohm-peak.com

These temperature transmitters can handle curve matching

YTA Series temperature transmitters are suitable for a wide range of applications. They include a smart single-

input transmitter; a high-end transmitter that handles curve matching; and a multivariate model that is capable of dual inputs, hot sensor backup, differential and average-temperature measurements. All models handle up to 20 inputs, covering most standard RTD, thermocouple, d.c.-mV and ohm inputs. The YTA 310/320 can also handle up to 40 points of custom curve input. — *Yokogawa Corp., Newnan, Ga.*

Solids shredder backpeddles quickly at the onset of a jam

The Super Shredder in-line disintegrator easily reduces the particle size of tough solids directly in process, sludge or sewage lines. The unit's design provides a high level of open area to fluid flow, enabling the heavy-duty size-reduction processor to handle high flows with minimal head loss. A patented spherical shredding mechanism cuts and shears tough sewage solids into fine bits; and the hard-faced stainless steel cutters offer unsurpassed wear resistance. Because of the spherical rotor design, the shredder has far fewer moving parts and therefore requires far less maintenance than units with banks of cutter disks. Included with the unit is a S-250 Auto-Reversing control system

that senses jam conditions and automatically reverses. — *Franklin Miller, Inc., Livingston, N.J.*

franklinmiller.com

Test sieve arrives sealed inside a plastic bag to ensure accuracy

Certified to ASTM E-11 and ISO9002 certified manufacturing process, this manufacturer's test sieves (photo, top right) boast accurate, dependable results for precise particle size analysis. The sieve mesh is compared to precise standards on a microscopic projector and then sealed in a plastic bag inside a box. Made in either brass or stainless steel, the sieves are offered in full or half height, from 3 to 18 in. dia. — *CSC Scientific Company, Inc., Fairfax, Va.*

cscscientific.com

Thermoplastically lined piping covers corrosive environments

Armourplastic piping systems are used in bleaching applications, steel pickling, semi conductor and other processing industries, where environmental corrosion is of concern. The seamless liners are offered in PVC, CPVC, PP, PVDF, ECTFE and FEP and are overwrapped with corrosion-resistant FRP, to withstand a wide range of chemicals and temperatures. Piping is available in pipe sizes



Metrohm-Peak

New Products

through 96 in. dia., and can be supplied for flanged components, or in a pre-spooled construction. — *Fabricated Plastics Limited, Toronto, Ont.*
fabricatedplastics.com

Mini-cartridge pressure regulator maintains a low profile

The 9028 Series miniature-cartridge pressure regulator (photo, left) is designed specifically for instrument applications, such as portable chemical analyzers. The 9028 uses all available sensing area to provide precision-set pressure control in installations where limited space is available. The new regulator design is suitable for inlet pressures up to 750 psi, and the outlet is factory preset for pressures from 2 to 10 psi. The cartridge can be used in a single cavity or a manifold. The cavity required is 1.50 in. in diameter, and the valve spring housing projects above the manifold top surface by less than 0.5 in. Materials of construction are Type 316 stainless steel, brass or aluminum, for compatibility with most gases and liquids. — *U.S. Para Plate Corp., a div. of Circor International, Inc., Auburn, Calif.*
usparaplate.com

Digital mass-flow controller provides a readout in the field

Smart-Trak digital mass flow controllers boast maximum flexibility, an easy-to-use interface, rugged stainless steel construction, and true digital performance — all at the price of an analog flow controller. The instrument's Dial-A-Gas feature is used to change gases and other critical parameters in the field. Pre-programmed for ten gases that are commonly used in biotech, pharmaceutical, analytical and research applications, the micro-processor accepts other gas specifications to deliver a custom instrument. Expensive control or readout electronics are replaced by a small, convenient pilot-module interface that can be mounted directly on the instrument, or remotely up to 50 ft. from the controller. The instrument's small footprint (1 in. × 3 in. × 5 in.) permits easy drop-in replacement for other mass flow controllers. — *Sierra Instruments, Inc., Monterey, Calif.*
sierrainstruments.com



U.S. Para Plate Corp

Standard shop vacs don't meet all industrial needs

When used for industrial applications, traditional shop vacuums are expensive to operate, noisy and inefficient. But this manufacturer says that its powerful line of vacuum cleaning systems — often custom designed for specific applications, but also available pre-engineered — is becoming an integral part of industrial processes. These include reclamation of production material, maintaining and cleaning critical production equipment to reduce downtime, and extraordinary "housekeeping" such as removal of hazardous waste or material that is too heavy to be handled safely by human labor. Options include continuous pulse filter cleaning, HEPA filter for hazardous materials, and a large variety of filter media. — *Vac-U-Max, Belleville, N.J.*

vac-u-max.com

Sealless pump now comes in a close-coupled mag-drive version

Chemsteel, this manufacturer's sealless rotary gear pump (photo, right), is now available in a close-coupled mag-drive version. With its basic stainless-steel and Alloy C constructions, the unit offers a wider range of chemical compatibility — including corrosive, volatile and thin non-lubricating fluids — preserving the integrity of the chemical, while preventing environmental hazards. An upper drive is standard; however, it can be modified to a lower drive configuration if needed. Additionally, helical gears



offer noise reduction of up to 10 db. The full-size bearings eliminate the need for wear plates and are available in Carbon, Teflon or Rulon. — *Oberdorfer Pumps, Syracuse, N.Y.*
oberdorfer-pumps.com

This automation system now supports Profibus DP devices

This manufacturer's I/A Series A2 automation system now offers a cost-efficient option for seamlessly integrating Profibus DP slave devices into the system. With this enhancement, users of the system can choose from Profibus, HART, Foundation Fieldbus, and/or FoxCom intelligent devices, based on the strengths of each and the unique requirements of their application. The new Profibus Modules operate in conjunction with the I/A Series Control Processor 6Q to provide realtime access to process data and status, plus access to field device parameters and diagnostics, which support configuration, maintenance, and asset-management applications. — *Foxboro, a div. of Invensys plc, Foxboro, Mass.*
invensys.com

For remote monitoring, just hook it up and log on

The Instruwatch Remote Monitoring System checks inputs from equipment remotely and provides automatic notification of alarm events by fax, page, or email — all for a small monthly fee. Connect your analog or discrete outputs to an Instruwatch unit, and the monitor notifies you through a wireless data network to the vendor's secure Internet website. No special software training is needed. Besides alarm notification, the Web-browser interface allows you to configure alarms and download data. The system can monitor and control cathodic equipment, storage tanks, pumping stations, gas compressors, refrigeration units, elevators, pipes, railroad crossings, meters and all other varieties of industrial equipment. — *Siemens Energy & Automation, Munich, Germany*
sea.siemens.com/ia

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This calibrator is compatible with most gas analyzers

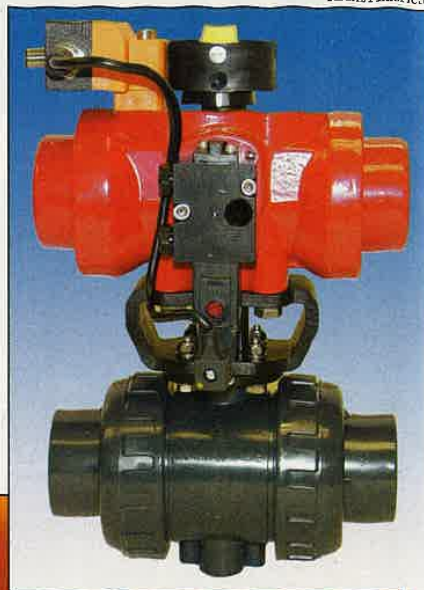
The 491MB Gas Standards Generator (photo, top left) is a laboratory instrument designed to calibrate most types of gas analyzers, including gas chromatographs, mass spectrometers and ion-mobility spectrometers. The unit uses Trace Source Permeation Tubes to generate low concentration (1,000 ppm to ppb) gas standards for VOCs, acid gases, amines, sulfurs and hydrocarbons (over 400 compounds). The standards are traceable to NIST. — *Kin-Tek Laboratories, Inc., La Marque, Tex.*
kin-tek.com

Kin-Tek Laboratories



AS-i bus control system improves valve diagnostics

For precise on-off control of multiple automated valves, this manufacturer's AS-I control system (photo, top right) communicates via the Actuator-Sensor-Interface (AS-i) bus protocol. The interoperable network system is said to simplify installation, maintenance and diagnostics, creating a low-cost solution for a variety of applications — including those in wastewater treatment and chemical processing. Providing reliable control for binary and analog devices, the AS-I can be used to complement a higher-level bus control system, as well as for stand-alone process control. If a gateway is installed, the interface can expand existing systems, responding well with products from other manufacturers. In standard networking, the AS-I is capable of attaching up to 31 devices (248 digital I/O) to a single self-sealing two-wire cable, with a cycle time of 5 ms, for a distance up to 100 m. A farther distance at a maximum of 300 m can be achieved by utilizing repeaters. — *Asahi/America, Inc., Malden, Mass.*
asahi-america.com



Fluid Components Intl.

$\pm 0.5\%$ of full scale. This performance covers a wide range of critical applications in chemical refining, electrical-power generation, steel production and other high-temperature processes. The ST98 features a broad flow range from 2 to 3,183 ft³/min in air at standard conditions for 70°F and 14.7 psia, typical to most gases. The ST98 offers low-flow sensitivity, and is still able to operate at turndown ratios from 10:1 to 100:1. The ST98 meets ASME, BPE, Cenelec and CE Mark requirements; and Factory Mutual, CSA and CRN approvals are pending. — *Fluid Components Intl., Chicago, Ill.*
fluidcomponents.com

through design and installation ease. Many customers are using more advanced network protocols to lower overall maintenance costs, says this manufacturer. The network delivers information like cycle time, valve torque, air consumption, and cycle speed, so users can monitor valve performance and schedule routine maintenance. The Avid Network Solutions product currently supports the following network protocols: AS-Interface, DeviceNet, Profibus, LonWorks, Modbus, and Foundation Fieldbus. — *Tyco Valves & Controls, Pembroke, Bermuda*
tycovalves.com

High-temperature flowmeter offers impressive results

Capable of withstanding temperatures of up to 500°F, the thermal mass Flex-Masster ST98 (photo, bottom) Flowmeter Series delivers precision gas flow measurement, while delivering repeatability of $\pm 0.5\%$ of reading and accuracy of $\pm 1\%$ of reading plus

Integrate actuators into network communication systems

This manufacturer's Avid Network Solutions products enable integration of either pneumatic or electric actuators in networked communication systems. This development is consistent with growing customer demand for network communication systems, which significantly lower end-user capital costs

Gas seals perform much better with a reliable gas supply around

Designed to consistently deliver clean, dry, properly pressurized gas to seals, the Gas Conditioning Unit (GCU) seal-support system is said to advance the performance of dry gas seals by solving several critical gas-supply issues. Unlike conventional gas panels that incorporate coalescing filters only, the GCU features a knockout fil-

elevate, dry, heat, cool, scalp, separate, condition

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New Products

ter/coalescer vessel that removes solid particulates, as well as free liquids and aerosols. A heater controller also monitors and maintains gas temperature. In startup, slow-roll and settle-out, the GCU maintains adequate gas flow using a seal gas pressure amplifier. A pressure or flow switch signals the amplifier control, which automati-

cally activates and deactivates the amplifier as needed. The GCU's functions are automatic and self-regulating. The new system can be used as a "bolt on" to existing gas panels or incorporated into new panels. — *John Crane Lemco, a div of John Crane, Inc., Morton Grove, Ill.*
johncrane.com



An interior coating improves these compression fitting nuts

With the introduction of their Moly Inside compression fitting nuts (photo), this manufacturer aims to eliminate the problems of inconsistent remakes or product galling that plague the assembly of stainless-steel tubing systems. The inside of each new nut features a bonded coating of molybdenum disulfide that serves as a barrier between the threads of both the nut and the fitting body. The coating also functions as a lubricant, which means the fitting can be installed with less torque in most applications, when compared to fittings without this feature. The Moly Inside nuts can be used on this manufacturer's A-Lok or CPI brands of compression fittings. — *Parker Hannifin Corp., Instrumentation Connectors Div., Huntsville, Ala.*
parker.com

Monitor hydrogen sulfide gas from as far as 3,700 ft away

The S4000T hydrogen-sulfide gas detector performs long-distance remote mounting up to 3,700 ft, dual redundant Modbus communications, 8-amp relays, three-digit display, 4-20 mA output, and indication of remaining sensor life. The unit is a microprocessor-based intelligent transmitter designed for use with the manufacturer's Metal Oxide Semiconductor (MOS) sensor. Designed to detect hydrogen sulfide in ranges of 0-20, 0-50 and 0-100 parts-per-million (ppm) levels, the S4000T provides status indication, alarm outputs and fault codes for troubleshooting, and prompts when calibration is needed. At that point, one operator can instigate the instrument's self-calibration feature simply by activating a magnetic switch and applying gas. All of the electronics are contained within an explosion-proof housing, so that sensor information can be processed at the sensor site. — *General Monitors, Lake Forest, Calif.*
generalmonitors.com

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Treat compressor condensate onsite, instead of outsourcing it

Disposing of compressed-air-system condensate is a major environmental concern. The oil-water mixture is classified as a hazardous waste and cannot be discharged directly into sanitary drains, unless the oil is first separated from the water. With its four-stage separation technology, the Aquamat condensate-management system automatically separates oil from condensate. In most cases, claims the vendor, this eliminates the need for expensive disposal by outside contractors. Models are available in six sizes, featuring rugged construction and an integrated manifold system, which allows several condensate lines to be attached to one unit. Additionally, the system requires no electricity and relatively low maintenance. — *Kaesers Compressors, Fredericksburg, Va.*
kaeser.com



Avoid cross-contamination in pneumatic conveying systems

The Flex Tube Diverter (photo) is designed to handle dry materials in dilute-phase pneumatic conveying systems up to 15 psig. By holding a positive seal across the closed port and eliminating internal ledges and pockets where material can lodge and remain trapped, the units can avoid material cross-contamination. Stainless steel housing provides support for flexible tube and ensures material containment. Tube and pipe sizes from 2 to 8 in. are accommodated. — *Salina Vortex Corp., Salina, Kan.*
salinavortex.com

Mechanical heat-exchanger design takes a software approach

This suite of heat exchanger design software includes three modules: TEMA Exchanger, ASME Exchanger, and Tubesheet Layout Program. Each exchanger program performs complete mechanical design and rating calculations on shell-and-tube heat exchangers. In this process, the entire exchanger is designed as a single unit, with consideration of force balance among shell, tubes and tubesheets. Physical property data are supplied in an internal database, and operation is wizard driven and automated. Shell and nozzle calculations are per ASME VIII. Both TEMA and ASME Appendix AA tubesheet designs can be performed simultaneously, for comparison of results (thinnest required tubesheet). The Tubesheet Layout Program optimizes tubesheet design by finding the largest number of tubes that can be placed in a given

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New Products

tubesheet. It also determines how large the tubesheet must be to accommodate the required number of tubes. Output includes drawings in dxf format and a list of tube center locations. — *Codeware, Houston, Tex.*
codeware.com

Process safety management tool aids design and maintenance

The Pressure Protection Manager version 2.7 (PPM) utilizes up to date and recognized "best practice" pressure-relief and effluent-handling system design methodologies, says this manufacturer. The tool's interactive relational-database management system captures the relationships between overpressure scenarios, equipment, and pressure relief devices, and strategically manages a facility's effluent-handling-system capacity, as it relates to capital projects, new relief loads from existing units, and increased production rates. A new hy-

draulic modeling tool now solves pressure profiles for complex relief header networks; and pump suction pressures can be calculated within the software as a function of upstream pressure, fluid density and the elevation difference. Other enhancements include support of multi-sectioned vessels for volume and wetted-area calculations in flammability-estimation and equipment-related calculations. Furthermore, the ability to calculate wetted-area contributions from liquid on trays has also been added. Lastly, a depressurizing module allows for the analysis of a depressurizing event. — *Berwanger, Inc., Houston, Tex.*
berwanger.com

Plastic ball valves withstand tough process conditions

This line of pneumatically powered ball valves (photo) is constructed of Corzan CPVC for use in applications that require elevated-temperature



and corrosion resistance. All models are designed for on-off service; and the actuator will close the valve automatically in the event of a power failure. In applications where the valve should not close — such as water cooled processes — the actuator can be modified to open the valve automatically during power loss. For those applications that require an additional measure of safety, a manual override is available. Sizes from 1/2 through 2 in. are available, with a variety of connection types. — *Plast-O-Matic Valves, Inc., Cedar Grove, N.J.*
plastomatic.com

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Mustang Engineers
and Constructors
16001 Park Ten Place
Houston, Texas 77084
Tel: 713/215-8000
Fax: 713/215-8506
Web: www.mustangeng.com
E-mail: ron.jackson@mustangeng.com
che.com/adlinks and enter 46

