THE DEVELOPMENTS ARE DIVERSE

Filtration

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Of all the unit operations, filtration is undergoing some of the biggest improvements in efficiency. These involve throughput (flowrates), fine-particle-removal capabilities and dirt holding capacity.

Filtration technology is also facing some great challenges. One is the recognition that filtration cannot be considered as an isolated operation; that, instead, the technology must be integrated into the total process to assure optimization and maximum return on investment (ROI) for the whole unit, plant or complex. And the disposal costs associated with filtration are recognized for their significance, so firms are setting goals to minimize those costs.

Impact of a newcomer

Some of the major filtration innovations are occurring in a type of filter that did not even exist 100 years ago: cartridge filters. Cartridge filtration began to move heavily into industrial applications, particular the process industries, in the early 1950s, with string-wound units being utilized on paints and varnishes and fiberglass-foam insulation being adapted for use in fine-particle-removal applications. Although those products are still used today, this early technology almost caused the death of cartridge filtration, when the U. S. Environmental Protection Agency (EPA) imposed strict and expensive disposal requirements on filters used in toxic or hazardous service; meanwhile, occupational safety and health issues also had to be addressed. Companies that used large numbers of cartridge filters immediately began to look for alternatives to paying $400-$800 per drum of used cartridges being sent to Class I disposal sites.

The first part of the solution was to turn to pleated cartridges, to increase the filter surface area and to extend product life. But in the last five years, newly patented technology has doubled and tripled the surface area of cartridges filters, which has far-reaching implications. This new technology is analogous to multiple-effect evaporation: By using a series of segregated flow channels and separated flow chambers, the new type of cartridge filter becomes highly efficient while providing high capacity (HE/HC), and its throughput results in a quantum jump in dirt-holding capacity per unit of space occupied.

For example, in amine filtration (during sulfur removal operations), four HE/HC cartridge filters will do the work of as many as 1,500 string wound elements, while lasting six weeks instead of a few days. This dramatically reduces both labor and disposal costs by a factor of 12 or better. And skid-mounted vessels, either in parallel or in series, are light in weight.

The cost savings occur in both less-frequent changeouts and reduced capital expenditure. In that light, it is critical to calculate the total cost per pound of dirt removed or product recovered. This calculation should include maintenance, operating and disposal costs.

With cartridge filter technology changing so rapidly, the end user must take the responsibility of setting particulate-removal standards to include onsite, slipstream testing if necessary. Engineers should define their own test methods, with skid-mounted test filters being made available.

Filter selection today

Six specific considerations are especially important in the selection and use of filters: problem analysis, process analysis, process requirements, solids data, liquids data, and materials of construction One can select from over 300 different fibers, with woven or nonwoven cloths that vary from basic cellulose (paper) and felts to exotic polymers such as polybenzimidizole.

Matching the material to the entire

1962

***June 10, 1963**, p. 88:* Direct digital control (DDC), a technique that uses a digital computer system to supplant conventional process-control instrumentation, is getting an unexpected show of interest.

***June 24, 1963**, p. 33:* "Soft" detergents, which can be removed from waste water by regular biological treatment, are making big news. At least four firms have announced progress in developing soft detergents or intermediates.

***October 14, 1963**, p. 85:* While nylon and rayon continue their battle for supremacy in the tire-cord market, two other materials are quietly starting a push to gain wider recognition. Goodyear Tire & Rubber announced recently that it will soon produce a polyester-corded tire, and Firestone Tire & Rubber is talking seriously about passenger tires corded with glass fibers.

1963

***December 9, 1963**, p. 83:* Union Carbide's Linde Div. is going to offer distillation systems to the chemical process industries. According to Linde, the equipment incorporates a radically new tray design that can boost throughput as much as 120% and efficiencies as much as 40%, over conventional trays. The tray design is said to use vapor issuing from perforations to control and direct flow of liquid, and a simple device that is integral with the tray surface to insure uniform bubbling activity.

Cover from the ***November 25, 1963*** issue. Cover story: The market for manmade fibers

1964

***May 11, 1964**, P. 83:* A new computerized system for the design and drafting of complicated process piping systems is claimed to be a technological breakthrough by it developer, Badger Co., Cambridge, Mass.

***July 6, 1964**, p. 7:* Will there still be a distinct profession of chemical engineering twenty years from now? This question was posed in all seriousness by Jay Hedrick of Cornell University at a recent AIChE Tri-Section Symposium in Newark, N.J.

1965

***March 15, 1965**, p. 88:* If a process now getting a trial works out, kraft mills will be able to subsist without chlorine, sodium sulfate or sodium hydroxide, if they have access to sodium chlorate, sulfuric acid, salt and ideas developed by W.H. Rapson, University of Toronto.

***May 10, 1965**, p. 175:* Completely new ways have been developed for constructing electronic circuits. Since the obvious feature of the new technology is a gross reduction in size and weight of electronic component, the term "microelectronics" was coined.

process is essential for proper filter operation. This includes selection of the vessels, piping and pump system. The pump is an often ignored, yet critical, part of the filter system if one is to achieve optimized performance.

There are a large number of standard industrial classifications that make up the process industries, so both the diversity and the type of filtration varies widely, from handling minerals to handling molten plastics or metal. Research efforts on solid-liquid separation have focused on the individual filtration operation, and relatively little has been done on the integration of filtration with the systems problems of an entire plant. This state of affairs is changing; but very slowly, because most companies assign filtration operations to a process unit manager who is not schooled in fluid-particle separation.

The first place that this trend is changing is in the pretreatment before filtration. A major motivation is that the flocculants and other chemicals used for pretreatment are expensive. Firms are also looking at how to minimize or eliminate use of any filter aids having any environmental stigma.

Organic filter aids are getting a closer look, as are the HE/HC cartridge filters because they can be backwashed. Organics have the bonus that they can be burned, and, in the future, may even instead serve as feedstocks to partial-oxidation (POX) synthesis-gas units.

Some other filtration advances in the process industries involve electroflocculation, electroacoustic or acoustic dewatering, ultrafiltration, and membrane filtration. Membrane filtration is highly important in removal of very fine, nano-range particles, for high-purity electronics chemicals and bioprocessing.

Bioprocessing is presenting many challenges for filtration, with at least one study focused on how best to filter gels, slimes, flexible-particle flocs, emulsions, food products, biomasses and other flexible particulates (see also p. 127). Such materials commonly have an open structure, and squeeze through filter pores by changing shape. This leads to large particles working their way through a small filter hole or pore – or, filters quickly clog as the filter matrix becomes plugged. An additional concern at high pressure is whether the pore itself will change size or shape.

Other developments include: applying Tiller's unified theory (Frank Tiller is a chemical engineering professor at the University of Houston, Houston, Tex.) to real filtration problems, simultaneous reaction and separation process, Chiang-methodology of integrating filters with other types of separation equipment such as flotation devices (Shiao-Hung Chiang is at the University of Pittsburgh, Pittsburgh, Pa.), use of hollow wedge-wire heat exchanger/filters, and membrane catalytic reactor filters.

In looking at such technologies, filter companies, recognizing the need to support a system approach to process design, have introduced computerized assistance software programs that bring filter information to the process engineer via the Internet or through tutorial software. Of course, this strategy induces the customer toward the manufacturer who supplied the software.

In closing, we note that a single, simple filter may often prove to be the most economical solution to a liquid-particulate problem. But finding that best answer may take several carefully designed steps to assure overall process optimization. And occasionally the answer – the filtration solution – may actually lie in a process change upstream from the filter itself. ■

Authors

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Guy E. Weismantel is president of Weismantel International (P.O. Box 6269, Kingwood, TX 77339; Phone: 281-358-6308; Fax: 281-359-8345) a 23-year-old consulting firm specializing in processes and equipment used by chemical and mechanical engineers, including hardware and process control systems in the process, power, pipeline and oil and natural gas industries, and with extensive experience in environmental engineering involving air, water and solid waste. Providing technical and marketing support with respect to unit processes and unit operations, the company has particular expertise in filtration, heat transfer, corrosion and materials engineering. Weismantel is editor-in-chief of the "Paint Handbook" and the "Filtration Equipment Handbook," and the author of business books titled "Managing Growth, State-of-the-Art Due Diligence," and "What Peters and Drucker Didn't Tell You." He has published over 200 technical and management articles dealing with fluid-particle separation, nuclear power, supercritical-water oxidation, water treatment and disposal, and air quality. He published the first AIChE nomograph on solid waste, in 1974. He holds U.S. and foreign patents on process equipment and, in 1963, was given a "Los Angeles FIRST" award by that city for design of a portable-condenser to control volatile organic compounds. He has a B.S. in chemical engineering from Notre Dame University.

***July 19, 1965**, p.80:* A new chemical process for the air oxidation of propylene to propylene oxide was announced last month by Scientific Design Co.

***September 27, 1965**, p. 84:* A live, operating chemical plant [a contact sulfuric acid plant of Canadian Industries Ltd.] was successfully simulated by a digital computer system.

***May 23, 1966**, p. 74:* The toughest air-pollution law in the country was enacted in New York City this month. Among its provisions: at the end of two years, burning of bituminous coal for heating, and installation of incinerators in new buildings, will be prohibited.

***January 2, 1967**, p. 68:* The surge toward large, single-train plants has overtaken the CPI with dramatic suddenness. A recent 1,500-ton/day ammonia plant and upcoming 1-billion-lb/yr and larger ethylene plants are simply door-openers.

***September 11, 1967**, p. 165:* The latest survey of the Society of Women Engineers showed 243 girls enrolled in chemical engineering, compared with 199 in 1963 and 169 in 1961.

***December 4, 1967**, p. 81:* What are chemical engineers' ten biggest all-time feats? That's the question that AIChE recently put to a blue-ribbon panel of chemical engineering authorities. The panel's choices: synthesis of ammonia; antibiotics; the plastics industry; fissionable isotopes; petrochemicals; the synthetic-fibers industry; electrolytic production of aluminum; the synthetic-rubber industry; chemical fertilizers; high-octane gasoline.

***December 4, 1967**, p. 82:* Societe Francaise des Petroles BP will start building a $5.6-million plant next year at its Lavera refinery, to produce protein for farm-animal feed from a base of gas oil.

***March 25, 1968**, p. 41:* Astronomically large numbers are deftly handled by an electronic calculator announced this month by Hewlett-Packard. It weighs 40 lb., fits into a compact aluminum case, and costs $4,900.

***April 21, 1969**, p. 52:* Is too much nitrate in water or in vegetable tissues a threat to health and environment? If so, are fertilizers to blame? These questions were raised anew by Barry Commoner, chairman of the Dept. of Botany at Washington University.

1966 1967 1968 1969