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CHEMICAL ENGINEERING

MARCH 1998


Fire protection
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CHEMISTRY

DISPLAY
105 (3)

Breaking wastewater emulsions

Advanced dryer control

Work and family

Engineering better wine

Chiral chemicals

Particle-size measurement

Dealing with jet lag

Sealing flow rates

Plantwide optimization

Organics destruction

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TOMORROW'S VALVE UNIVERSE

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CHEMICAL ENGINEERING

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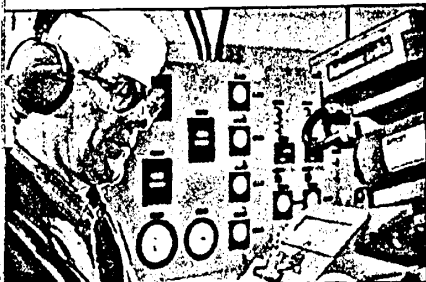
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A filter, as shown at right, can characterize the size range of particulate matter that must be captured by air-pollution control equipment



FLUEGAS PARTICLE SIZE

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Manufacturers and vendors can't just offer wares. They must be on the cutting edge in design, and must test and optimize products to meet customer needs

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Sampling of hazardous materials by means of an automated, enclosed sampler will eliminate exposure of workers

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Tighter margins and lower sales volumes are forcing vendor mergers and acquisitions. The resulting competition is generating customer benefits via new products and improved performance

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In the competition for a slice of the \$14-billion/yr business, small firms with synthesis experience are partnering with large ones that have scaleup strengths

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Portable equipment eases the task of handling complex problems in the field

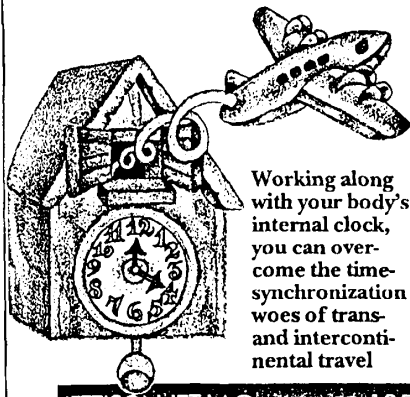
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Size may not be everything, but it is a key factor in the selection, design and analysis of air pollution control equipment

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A multiplate reactor effectively reduces COD, while generating methane for fuel

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Working along with your body's internal clock, you can overcome the time-synchronization woes of trans- and intercontinental travel

JETTISON JET LAG 125

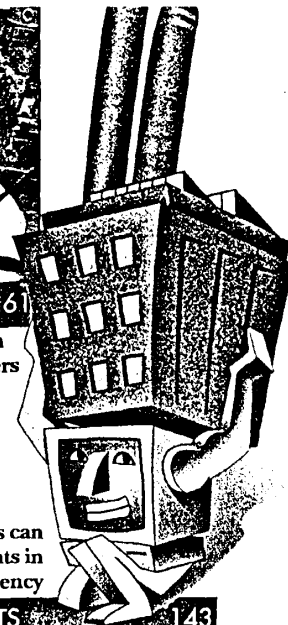
All kinds of equipment, from scrubbers to filters, are going portable, to control air pollution in remote locations

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Technology is enabling separation of chiral chemicals—stereoisomers with identical chemical formulas arranged as mirror images of each other, but having different properties



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Chemputers VI will be back
New C. Kopp, to be held at the George R. Brown Convention Center in Houston, June 3-4. Plan now to attend

Emulsions in wastewater pose a vexing problem for facilities attempting to recycle water and stay in compliance with permissible discharge limits. But the challenges are no less formidable for routine maintenance. The removal of emulsions, a major constituent of which are fats, oils and greases (FOGs), is necessary to prevent them from depositing on pipes and fouling filtration media.

Not even facilities that use crossflow membrane are exempt from the problem. Emulsions can be eliminated, but the cost may be exorbitant. The concentrate that accumulates during processing remains to be dealt with. The concentrate coats evaporator-heating elements, requiring frequent cleanup and disposal. Cost factors weigh in, with charges for hauling water ranging from 15¢ to more than \$1 per gallon.

As permissible discharge limits are lowered, facilities may find it increasingly difficult to stay in compliance. Indeed, a facility that is permitted to discharge 50 ppm of organic waste may believe it is in a safe range if the content of its water is only 30 ppm of oil. To

get rid of them. Those who choose not to take this methodical approach, may be lucky and select the proper removal method. Otherwise, they will be stumped from the beginning.

TABLE 1. HOW PARTICLE SIZE COLORS EMULSIONS

Particle size (µm)	Emulsion appearance
Macro globules	Two phases may be distinguished

1.0-100	Opaque white emulsion
0.1-0.05	Gray semitransparent
<0.05	Transparent microemulsion with three or more phases

EMULSION BASICS

Whenever two immiscible liquids, such as oil and water, contact each other, one liquid tends to disperse, but not dissolve, in the other. This dispersion of liquid, typically in an aqueous medium,

emulsifier, or stabilizer, that keeps the emulsion stable, binding the internal and external phases together, and preventing droplets from approaching each other and coalescing [2].

Usually emulsifiers are surfactants and soaps, present either by themselves or as part of the makeup of a detergent formulation. An emulsifier consists of a molecule with hydrophilic and hydrophobic ends. In the presence of immiscible liquids, the emulsifier migrates to the interface of the internal and external phases, forming a monolayer sheath around droplets of the dispersed phase, as shown in Figure 1. While the hydrophobic end of the molecule migrates, or partitions, into droplets, the hydrophilic end stays in the water [1, 2].

In effect, the emulsifier acts as a coupling agent, lowering the interfacial tension of the internal and external phases. When the interfacial tension is reduced to zero, an emulsion forms spontaneously. This means the surface area of the internal phase has reached its maximum. The dispersion of fine droplets, generally less than 1 µm dia-

The two main categories of emulsions are oil-in-water (O/W) and water-in-oil (W/O) with water including the most highly polar, hydrophilic (water-loving) liquids. Hydrophobic (water-hating) nonpolar liquids are oil-based. At equilibrium, the particle size of an emulsion's internal phase depends on the amount of emulsifier available to maintain that equilibrium. Hence, the concentration of an emulsifier must be balanced by its degradation to keep particles from growing too large.

Emulsions consist of three phases. The internal, or discontinuous, phase consists of finely divided droplets. The external, or continuous, phase is the liquid that keeps the dispersed phase from separating. The dispersed phase consists of

When attempts to recycle water in a closed-loop process, FOGs simply cannot be ignored.

Emulsions are a common problem in wastewater treatment. They can be difficult to remove. And for facilities that attempt to recycle water in a closed-loop process, FOGs simply cannot be ignored.

George Aker Biomix Inc.

PLUG THE RDEAKS ON



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THE RIGHT BALANCE

A key consideration in the formulation of emulsions and, therefore, a factor in determining how they can be broken — is the hydrophile vs. lipophile balance.

Water-soluble emulsifiers are hydrophilic, while sodium lauryl sulfate is hydrophobic. Here are recommended numbers of emulsifiers for application.

HLB NUMBER
1-3
3-6
7-9
8-18
13-15
15-18

contaminant to be solubilized in presence of a surfactant with a hydrophilic lipophile balance (HLB) of 15-18.

HLB NUMBER

1-3

3-6

7-9

8-18

13-15

15-18

When the surfactant is added to the container, the physical impact of the water on the oil will cause some droplets to emulsify, or disperse, in the water. When the surfactant ceases, oil droplets will coalesce quickly.

A surfactant or emulsifier added to the container will disperse the oil into the water. The system can be imagined as a collection of small spheres dispersed in the continuous water phase. Unless the droplets are small enough in diameter, they will separate from the water phase because their specific gravity is heavier than that of water.

Stokes Law governs the settling rate of an oil droplet in water. The settling rate increases, even though the particles do not behave like spheres, as Stokes Law demands [2].

Emulsifier solubility can be enhanced, if necessary, by adding a co-solvent or co-emulsifier, such as propylene glycol, that will act as a coupler to assist the emulsifier's activity.

Water temperature can influence the efficiency of an emulsifier. Nonionic surfactants in aqueous solutions tend to be more soluble when the water is cold. As the temperature increases, turbidity increases to a maximum cloud point by determining the cloud point.

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WASTEWATER EMULSIONS

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