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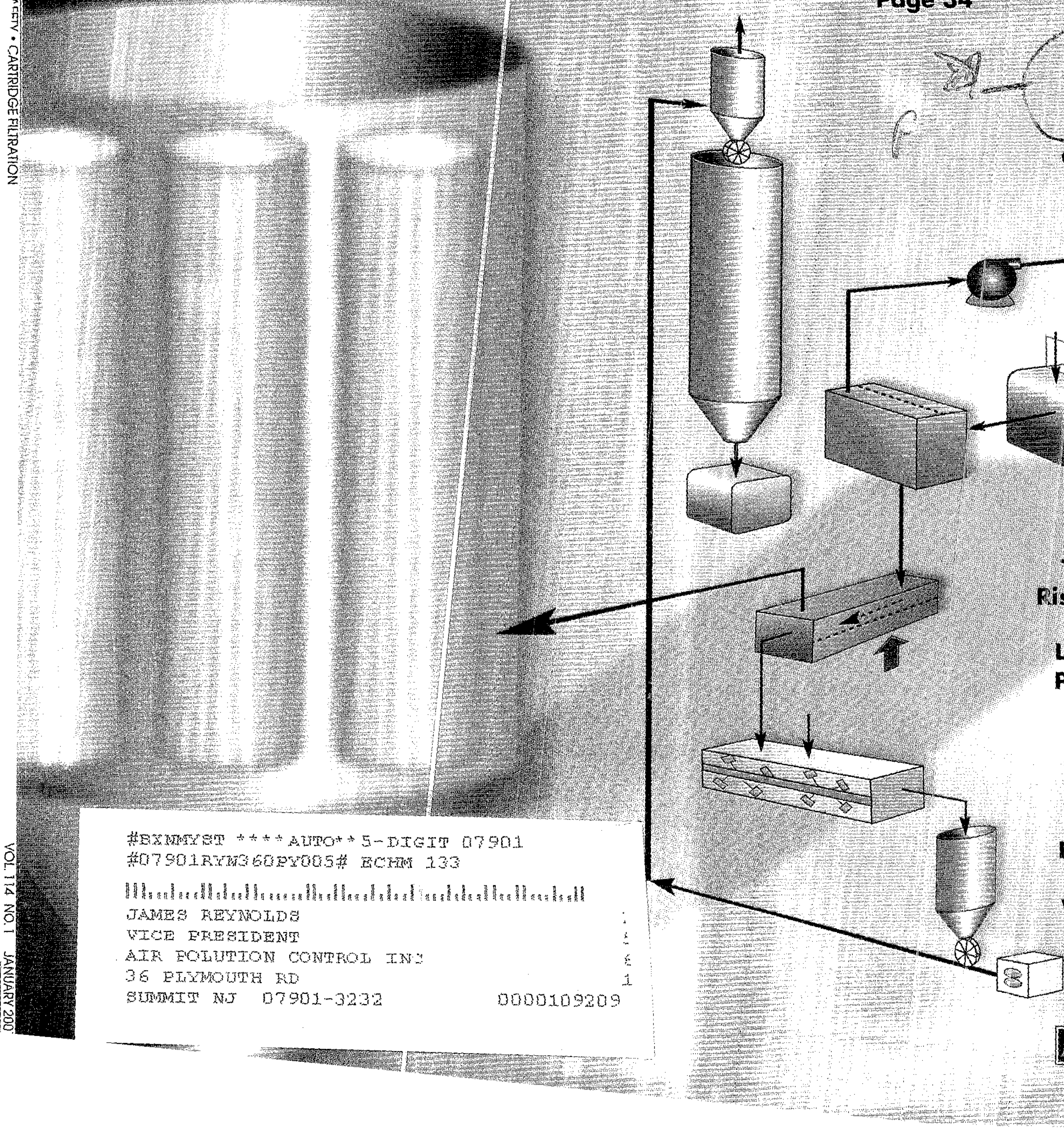

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MERCURY EMISSIONS-CONTROL PROCESSES GO COMMERCIAL

Activated-carbon absorption has the lead, but other methods show promise

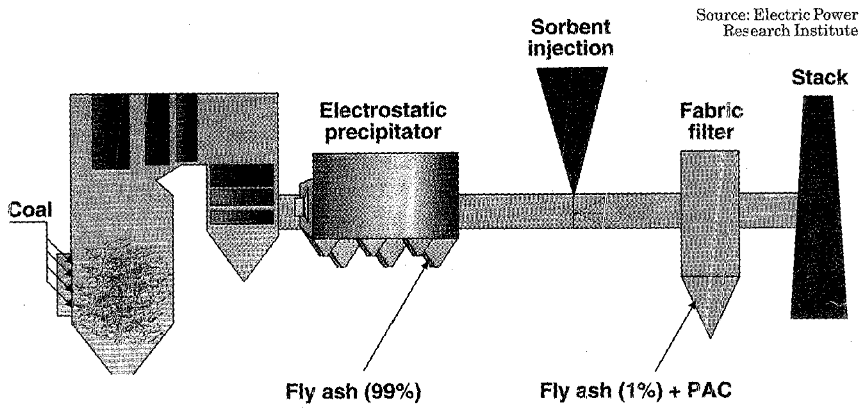


FIGURE 1. EPRI's Toxecon process avoids carbon contamination of fly ash by injecting activated carbon downstream of an ESP, or into the latter fields of an ESP

November 17 was the deadline for states to submit their plans for the control of mercury emissions from power plants to the U.S. Environmental Protection Agency (EPA, Washington D.C.; epa.gov), but mercury-control processes are already being commercialized. The Institute of Clean Air Companies (ICAC, Washington D.C.; icac.com) reports that its members have booked contracts for mercury-control equipment for more than two dozen plants. Most involve activated-carbon injection to absorb mercury from fluegas.

"It's astonishing there are so many contracts for a market that's so new," says David Foerter, executive director of ICAC, who notes that many of the installations are part of a consent decree or voluntary emission-abatement plan. One engineering firm, ADA-ES, Inc. (Littleton, Colo.; adaes.com), says it has nine contracts for mercury control projects — one online, one in startup, and seven in various stages of progress. "Business is very brisk," says Sharon Sjostrom, director of technology development.

The activity is well in advance of EPA's national regulation, which calls for a reduction in U.S. mercury emissions from an estimated 48 tons in 2002 to 38 tons/yr by 2010 (a drop of 21%), and to 15 tons/yr by 2018, for a total decrease of 69%. To help utilities meet those goals, the U.S. Dept. of Energy's National Energy Technology Laboratory (NETL, Pittsburgh, Pa.; netl.doe.gov) is entering Phase III of its research, development and demonstration (RD&D) program to advance the performance and economics of mercury-control technologies.

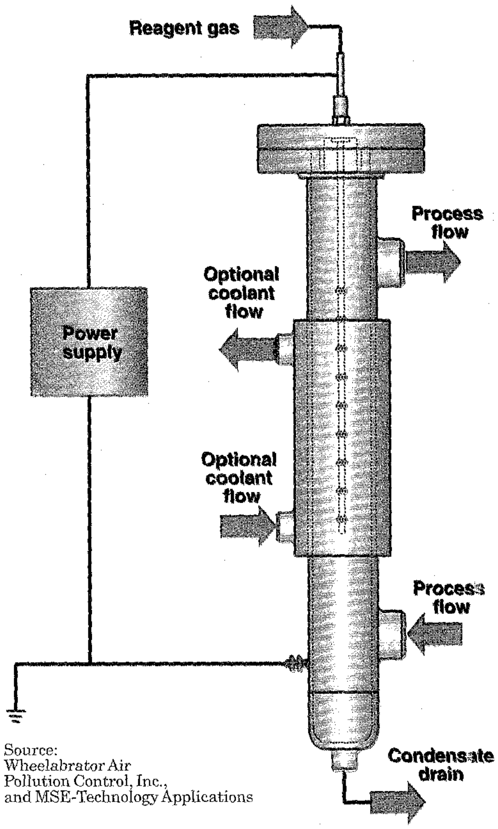
NETL's annual budget for the program has been around $12–15 million for the past several years, says Thomas Feeley III, NETL's technology manager. In addition, probably $10 million/yr is invested by industry and other organizations, adds Ramsay Chang, manager of air emissions control with the Electric Power Research Institute (EPRI; Palo Alto, Calif; epri.com).

In general, field tests done under Phase II of NETL's program have met the near-term goal of demonstrating technologies that can achieve 50–70% mercury capture and be ready for commercial demonstration by 2007, says Feeley. He adds that the estimated cost of control is generally below DOE's goal of $25,000–$50,000/lb Hg removed, or 25–50% less than the baseline estimates of $50,000–$70,000/lb. Phase III calls for technologies to achieve at least 90% capture and to be ready for commercial demonstration by 2010.

In the field tests, performed in commercial plants or in pilot units, activated carbon injection (ACI) has shown the most promise as a near-term control technology, says Feeley. In a typical configuration, powdered activated carbon (PAC) is injected downstream of a plant's air preheater (APH) and upstream of the particulate control device — an electrostatic precipitator (ESP) or fabric filter. The PAC absorbs Hg from the fluegas and is subsequently captured along with the fly ash.

One drawback of this technique is that fly ash is often sold for use as a concrete additive and PAC changes the properties of the ash, rendering it unsuitable for concrete. A process called Toxecon, developed by EPRI, avoids this problem by injecting PAC

PEESP



Source:
Wheelabrator Air
Pollution Control, Inc.,
and MSE-Technology Applications

FIGURE 2. Elemental mercury is ionized by injecting a reactant gas through a specially designed electrode in the Plasma Enhanced Electrostatic Precipitation (PEESP) process

into the fluegas downstream of the primary particulate filter, then capturing the mercury-laden sorbent in a secondary filter or baghouse.

The first commercial installation of the Toxecon process started up last January at We Energies' power plant in Marquette, Mich., as a five-year, $53-million demonstration project under DOE's Clean Coal Power Initiative. DOE is contributing $24.9 million. So far the process has achieved 70–90% Hg removal, says Chang.

In a newer version of the process, Toxecon II, sorbent is injected into the latter fields of an ESP, rather than further downstream. This allows the recovery and sale of most of the ash from the first fields and avoids the cost of a second collection system. In field tests the process has obtained 60–80% Hg removal.

An elemental problem

However, ACI is by no means a panacea for mercury cleanup, since coal properties vary widely. Fluegas from the combustion of lignites and sub-bituminous coals, for example, is laden with elemental mercury, which is not amenable to absorption. The reason is that such coals contain much less chlorine and other oxidants than does bituminous coal, explains John Pavlish, a senior research advisor with the Energy & Environmental Research Center (EERC, Grand Forks, N.D.; undeerc.org).

One solution is to use a catalyst or chemical to oxidize elemental mercury to the ionic form. EERC has field-tested various chemical sorbent-enhancement additives (SEAs) to promote mercury oxidation and reports Hg removal of 87% in a test of calcium chloride, and better than 90% removal for a combination of PAC with a proprietary additive.

ADA-ES has tested a number of halogen-doped carbons, particularly brominated carbon, for cases where there is insufficient halogen in the fluegas. "We have got up to 90% mercury removal with BrACI at 3–4 lb/MMacf of gas, compared with 70–80% removal for standard carbon," says Sjostrom.

Normally, sorbent is injected into the lower part of a fluegas stream, where the temperature is low enough to get good physical absorption. An exception to this practice is the Mer-Cure process, developed by Alstom Power, Inc. (Windsor, Conn.; power.alstom.com). In the Mer-Cure process, injection takes place above the air heater, at 600–800°F. At these temperatures, the sorbent becomes a catalyst that oxidizes the Hg and enhances its capture, explains Shin Kang, Alstom's technology manager.

Mer-Cure uses PAC treated with proprietary chemicals to allow high-temperature use. In field tests, it has achieved better than 90% Hg removal, says Kang. High-sulfur coals present a challenge, he says, because SO_3 competes with Hg for sorbent space. Alstom is formulating a sorbent to minimize SO_3 interaction.

Praxair, Inc. (Danbury, Conn.; praxair.com) is developing a process that allows plant operators to produce PAC from a plant's pulverized coal. The process can produce doped PAC for less than 40% of the cost of currently available PAC, according to Praxair. The coal is rapidly heated and burned at up to 4,300°F by an oxygen-enriched gas stream in Praxair's hot oxygen burner (HOB). In field tests, HOB-produced PAC has achieved 85–94% Hg capture.

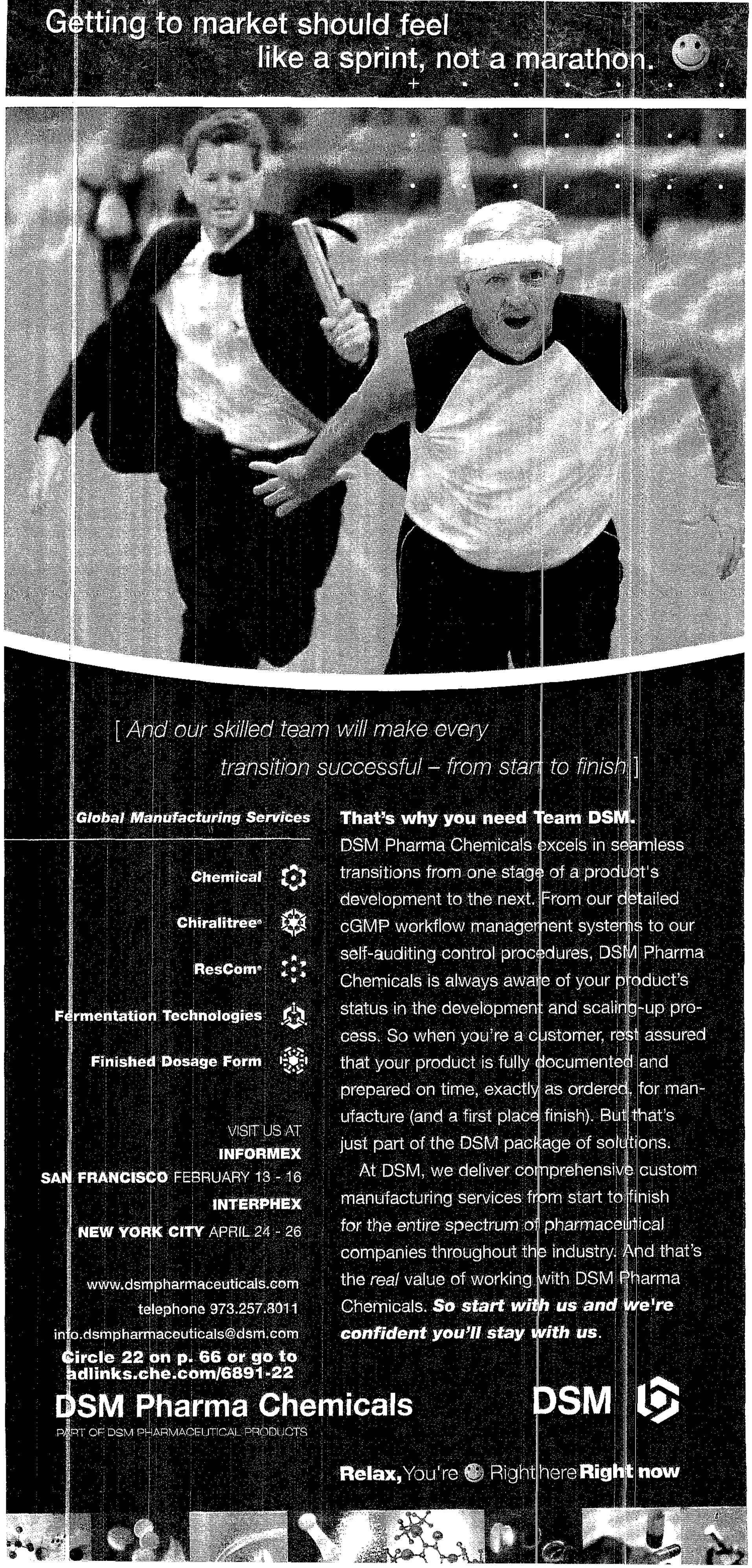
A process whose cost is expected to be only one-tenth that of ACI per lb of Hg removed is being developed by Consol Energy (Pittsburgh, Pa.; consolenergy.com). In the Low-Temperature Mercury Control (LTMC) process, fluegas is cooled to about 220°F, so that Hg is absorbed on carbon inherent in the fly ash. The ash is then removed by an ESP. In field tests the process has reduced Hg emissions by more than 90%, says Consol.

Oxidation without sorbents

Elemental mercury in fluegas is oxidized by injecting a reactant gas into a wet electrostatic precipitator (WESP) in a process being developed by Wheelabrator Air Pollution Control Inc. (a Siemens company, Pittsburgh, Pa.; wapc.com) and MSE-Technology Applications (Butte, Mont.; mse-ta.com), with support from EPRI and Southern Company (Atlanta, Ga.; southerncompany.com). The resultant water-soluble compound can be removed by the WESP or by a downstream wet or dry fluegas desulfurization (FGD) system, says Dan Battleson, a senior manager with MSE-TA.

During the process, called Plasma Enhanced Electrostatic Precipitation (PEESP), the proprietary reactant gas is injected through a specially designed electrode that is located just upstream of the WESP or FGD system. The electrode's corona discharge ionizes the reactant gas as it is introduced into the fluegas stream, where it reacts with elemental mercury.

In pilot tests on a 5,000-acfm slipstream at Alabama Power's Miller Power Plant, near Birmingham, Ala., the process has achieved better than 90% oxidation of elemental mercury and 70% total Hg removal, says Battleson. Discussions are ongoing with several utilities, with the expectation



that a demonstration unit will be installed in 2007.

Battleson says the process promises to be cost-competitive because, unlike ACI, its only waste stream is the normal WESP or WFGD slurry. Also, the equipment occupies no more space than a regular WESP and the reactant gas is inexpensive.

URS Corp. (Austin, Tex; urscorp.com) has field-tested Hg-oxidation catalysts of palladium and gold for oxidizing elemental mercury. Designed for plants that have wet flue-gas desulfurization (FGD) systems, the honeycomb catalyst is installed between the particulate-control device and the FGD system. The oxidized Hg is scrubbed in the FGD absorber. Hg removal rates of up to 90% have been obtained with both metals, says Gary Blythe, project manager, adding that the catalyst is readily regenerated by heating.

Researchers are also working on ways to remove mercury from coal prior to combustion. A group headed by Western Research Institute (Laramie, Wy.; uwyo.edu) is developing a fluidized-bed process in which Hg is stripped from low-rank coals in gaseous form at temperatures up to 600°F. In tests, the process has removed 50–57% of the Hg from lignite and over 70% from sub-bituminous coal.

Somewhat paradoxically, plants that have both a wet FGD system and selective catalytic reduction (SCR) for control of oxides of nitrogen (NOx) may be able to meet the EPA's mercury emissions goals without installing specific mercury-control systems. In such plants, the SCR catalyst does the double duty of reducing NOx and oxidizing elemental mercury, while the FGD system scrubs both sulfur and mercury. However, the efficiency of mercury removal varies from plant to plant, says Feeley, of NETL.

At present, he says, about one-third of the coal-fired power plants in the U.S. have wet scrubbers (although not necessarily SCR). EPA has estimated that two-thirds will have wet FGD by 2020 in order to meet the requirements of the Clean Air Interstate Rule (CAIR), which calls for reductions in both SO_2 and NOx emissions. ■

Gerald Parkinson