HOW TO ATTAIN CLEAN AIR?

The technology to do the job exists, but there is confusion over what to use, and whether the cost will be worth the effort.

In Congress' as-yet-unsuccessful efforts to revise the Clean Air Act (*CE*, Apr. 25, pp. 31–37), technology has been a key consideration because determining the cost and availability of controls is crucial to deciding questions of stringency — i.e., how pollutants must be controlled, and to what levels. Disagreement among members of Congress over how to deal with key issues such as acid rain, ozone and airborne toxics has prevented adoption of any final action. If the revision is not accomplished by Aug. 31, states must meet ground-level ozone and carbon monoxide limits as set forth in the Act, or be subject to federal sanctions.

The problem facing engineers and their companies is that the welter of bills being considered are often so vague that it is impossible to tell what the regulatory level will be for pollutants of concern. As a result, no one knows what will actually have to be done, or what the cost will be. Ironically, technology to meet almost any level of emission limitation exists. The question for which there is yet no answer is: When does cost exceed benefit?

A look at some options

To reduce SO_x and NO_x under the acid-rain portion of the measure, scrubbing of high-sulfur coal and switching to low-sulfur coal are seen as the most readily available options for emission sources. "It's all an economic tradeoff based on the type of boiler a source has, and the amount of reductions needed," says George Preston, director of the fossil fuel division of the Electric Power Research Institute (Palo Alto, Calif.). An electric utility or industrial source will look at the risks and incentives that apply to its individual situation before making a decision on a particular control technology.

Fluegas-desulfurization (FGD) scrubbers are now in use at 146 facilities, with 44 more units planned or already under construction, according to the Edison Electric Institute (Washington, D.C.). A typical unit for a 500-MW plant costs $100 million to build, or about one third of total plant cost, says EEI spokeswoman Susan Roth.

Both wet and dry FGD systems are in use. In the dry system, an alkaline solution is atomized into the fluegas and evaporates to dry particles while reacting with the SO_x. The reaction products are collected in a fabric filter or an electrostatic precipitator and disposed of as dry powder waste. In the wet system, the sulfur dioxide in the fluegas reacts with a shower of lime or limestone slurry, producing a reacted sludge that can be oxidized for landfilling, or purified to produce gypsum wallboard.

There are other options to scrubbing. If less than 90% removal is required, a utility may choose limestone injection or other kinds of dry-sorbent-injection processes to achieve a 50–70% removal rate, says Preston. For higher removal rates, two alternative technologies are being studied under the U.S. Dept. of Energy's Clean Coal Technology Program — fluidized-bed combustion (FBC) and coal gasification. (In fact, DOE opposes the SO_x and NO_x reductions being considered in Clean Air Act revisions, contending that more time is needed to use its Clean Coal Technology Program to develop cheaper alternatives to scrubbers. None of the seven Clean Coal projects now under way would be commercially ready in time to be of assistance in reaching the cutbacks required by the bill, says DOE spokesman Robert Porter.)

Fluidized-bed combustion is garnering considerable attention. (Fluidized beds themselves are also finding wider application in the CPI; see story on p. 30.) While atmospheric FBC is in commercial use at more than 100 industrial sources, research is progressing on combined-cycle pressurized FBC (typically referred to as PFBC). This technology permits the combustion of high-sulfur coals, along with a sorbent such as limestone or dolomite, in a fluidized-bed combustor at an elevated pressure. Use of a pressurized system can boost SO_x removal to 95%, compared with around 90% achieved by atmospheric units. Other benefits include: generation of dry solid wastes that can be readily disposed of; lower operating temperature, which substantially reduces NO_x emissions; and smaller dimensions than conventional units of comparable capacity.

Joy Technologies Inc., Western Precipitation Div.

This FGD unit helps keep the air clean in Illinois.

A demonstration project is under way at the Tidd Power Plant, Brilliant, Ohio, operated by the Ohio Power Co. The $167-million project, slated to begin operation in late 1989, will be the first to test the use of PFBC on a large scale at a commercial electricity-generating plant.

Longer-term options

If specific emissions controls and control techniques are not mandated until further down the line, Coal gasification and repowering will be attractive options for utilities and industries having large boilers, says EPRI's Ronald Wolk. These alternatives eliminate the need for FGD, reduce SO_x and NO_x emissions, and boost the output of boilers.

Integrated gasification combined cycle (IGCC) technology converts coal to a gas in a gasification reactor. The sulfur in the coal is then changed into hydrogen sulfide, which can eventually be converted to elemental sulfur. Sulfur-removal levels of 99% — 40% for NO_x — have been demonstrated.

The successful operation of the 100-MW Cool Water IGCC facility near Barstow, Calif., a joint venture by EPRI along with Southern California Edison Co. and other firms, has demonstrated the feasibility of the technology, says Wolk. Another pioneering IGCC facility is a 160-MW unit operated by Dow Chemical Co. in Plaquemine, La. The Potomac Electric Power Co. plans to build two 375-MW units near Washington, D.C.

A second-generation gasification system on the drawing board is claimed to have significant improvements over the Cool Water facility. DOE, M. W. Kellogg Co. (Houston) and Bechtel Inc. (San Francisco) have agreed to design and build a 60-MW advanced IGCC plant in Somerset County, Pa. Known as the "Appalachian Project," the plant will convert 551 tons/d of coal to fuel gas for combined-cycle power generation to feed a local-utility grid. The main advantage over the California facility will be a new system of hot cleanup of the gas between the time it emerges from the gasifier and when it goes into the turbine. The Cool Water plant had to first cool the gas before it could be cleansed, thereby requiring efficiency-robbing heat exchangers. The Appalachian plant should reduce costs, and provide higher thermal efficiency than do the first-generation systems, according to DOE's Porter.

An old power-generator could gain a new lease on life by being repowered with the addition of IGCC, a gasifier, a gas-stream cleanup unit, a gas turbine and waste heat recovery, resulting in extension of plant life, an increase in plant electrical output of from 50% to 150%, and significantly reduced emissions.

To reduce NO_x emissions to the level required by the bills, selective catalytic reduction (SCR) is expected to become a major control technology. Used mostly on natural-gas units at present, the technology also is in use in Japan and other countries to control coal-fired units, says Glen Reid, manager for business development at Johnson Matthey Inc. (Wayne, Pa.).

SCR involves injection of ammonia into the post-combustion regions of a boiler or engine whose exhausts contain significant amounts of oxygen.

Despite a 90% cut in emissions of volatile organic compounds, some 80 million U.S. residents live in areas where ozone exceeds federal limits.

When mixed with combustion products, the ammonia reacts with NO_x to form harmless nitrogen and water. In California, 18 gas-powered cogeneration units will soon be equipped with SCR control systems.

Taming other sources

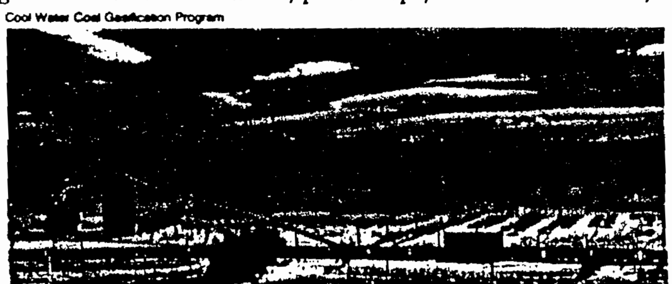
In the area of toxic emissions and nonattainment of mandated ozone and carbon monoxide levels, the challenge will be to capture and destroy VOCs — volatile organic compounds. (Ozone is a photochemical oxidant formed through complex chemical reactions involving VOCs and nitrogen oxides. VOCs are emitted by sources that are as diverse as autos, chemical plants, dry cleaning establishments, paint shops, and other facilities where solvents are handled.)

The ozone problem, particularly, is so intractable and frustrating because, although most of the large sources of ozone have been controlled, atmospheric ozone remains so pervasive that the U.S. Environmental Protection Agency (EPA) and individual states must go after smaller, more-expensive-to-control sources. Existing rules reducing emissions in 20 to 30 major source categories have resulted in industry-specific emissions cuts of up to 90%. Yet, some 80 million people still live in areas that exceed the federal ozone limit. At least 50 major metropolitan districts failed to meet federal limits that were to have been attained by Dec. 31, 1987. Congress has extended that deadline until Aug. 31.

By law, all sources of 100 tons/yr or more of VOCs should be (and most are) controlled by now. But those controls have not resulted in attainment of the federal standard for many areas, so pending Clean Air Act legislation seeks controls on 50-ton/yr — and, in some cases, 25-ton/yr — sources.

Control technique guidelines (CTGs) prepared by EPA explain what constitutes the best available control technology for each industrial category. States use these guidelines in many cases to set control technology rules for local sources. EPA has published about 29 CTGs, but state officials want to see another dozen for remaining major sources, such as synthetic-organic-chemical plants, and treatment, storage and disposal facilities in nonattainment areas.

CTGs are not required in areas that have met the ozone standard, so separate, nationwide controls on other VOC sources are sought for continuing to obtain reductions, says S. William Becker, executive director of the State and Territorial Air Pollution Program Administrators (Washington, D.C.). His organization seeks to have across-the-board limits set for the application of [illegible] military coatings, all of which are quite small in volume compared with industrial sources, but which

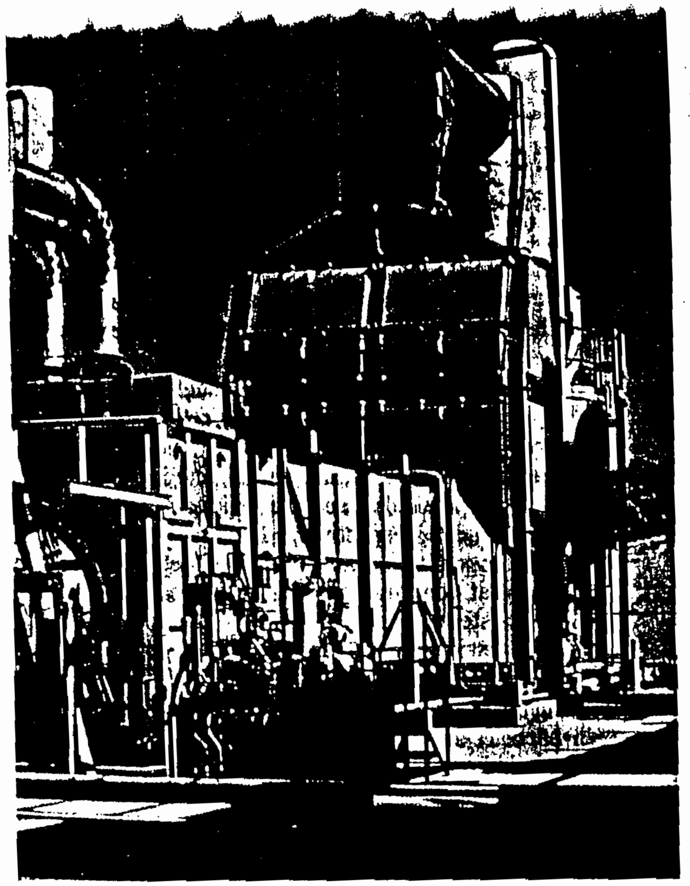


The Cool Water plant has demonstrated IGCC's feasibility.

nonetheless are significant contributors to the continuing ozone problem.

CPI concerns

As noted, major sources of VOC emissions are mostly under control. However, many chemical-process-industries (CPI) plants have leaking seals, valves and storage tanks that would be major targets for further control, says Jacoby Scher, a member of the air-quality taskforce of AIChE. There are tens of thousands of such seals and valves in a typical plant. But there are also a host of ways of eliminating emissions problems: recycling, neutralization, scrubbing, bubbling, flaring, catalysis, and thermal destruction. Methods vary in appropriateness, depending on whether or not the toxic in question is an organic.



SCR units are in the forefront of NO_x-removal efforts.

The pending bills do not require lots of new controls, says Ernest Rosenberg of the industry-funded Clean Air Act Project (Washington, D.C.), but they will be costly. Double-sealed valves, hoods to prevent leakage of fugitive emissions, and more-frequent monitoring are likely under the Senate's bill. Publicly-owned treatment works and surface impoundments would be hit hard, since they have been shown to be major sources of uncontrolled air toxics.

According to James K. Hambright, director of the Bureau of Air Quality Control for the Pennsylvania Dept. of Environmental Resources, adsorption, absorption and incineration processes can deal effectively with VOCs, while heavy metals and other particulates can be trapped by baghouse units, electrostastic precipitators and scrubbers. Disposal of this waste, however, poses yet another problem. The technology is there to take it out of the airstream but not necessarily to destroy it, he notes.

A major concern of the CPI is that a bill proposed by Sen. George Mitchell (D., Me.) appears to increase the stringency of controls required on chemical plants from reasonably available control technology (RACT) to the most stringent controls on the market, those that will result in the lowest achievable emissions rate (LAER). What has industry worried is the even-more-strict health-based standards that require that lifetime cancer risks be cut to less than 1 in 1 million (according to risk-assessment numbers established by EPA). If LAER doesn't reduce risk to those levels, industry may have to look at shutdowns, says Ann Mason, associate director of CMA's Environmental Division.

She believes the chemical industry has already achieved significant controls, citing EPA data that chemical plants are already controlling about 94% of VOCs in nonattainment areas of the U.S.

The most effective way to dispose of VOC emissions, say experts, is combustion. Catalytic oxidation is a highly efficient process that can destroy up to 99% of VOCs, says Bruce Bertelsen, executive director of the Manufacturers of Emissions Controls Assn. (MECA, Washington, D.C.). The technique is a chemical oxidation route in which hydrocarbons are combined with oxygen in the presence of a catalyst at specified temperatures, to yield carbon dioxide and water. The process runs at lower temperatures than are required for incineration, minimizing fuel and operating costs.

Catalytic oxidation began in the 1940s for energy recovery and odor control, rather than for air-pollutant reduction. Today, there are several hundred systems operating in the U.S. MECA's concern, however, is that while catalytic oxidation has been demonstrated as an effective technique for eliminating VOCs, it has been used in only a small fraction of the plants where it could be successfully applied.

An area where the limits of technology could be stretched is in mobile-source controls as required by the Mitchell bill, according to Tim MacCarthy, director of public affairs for the Motor Vehicle Manufacturers Assn. (MVMA, Washington, D.C.). The bill would tighten hydrocarbon (HC) standards and NO_x standards for automobiles, require onboard vapor-control devices, mandate a doubling of the life of emission-control-equipment warranties, and tighten the emissions testing of vehicles as they come off the assembly line. It also requires light-duty vehicles such as vans and compact trucks to meet the same emissions limitations as those for automobiles.

MVMA says existing law represents a 96% reduction in hydrocarbons and a 76% cut in NO_x emissions, leaving little room for making any measurable improvements. To achieve the reduction from 96% to 98% for hydrocarbons would dramatically reduce the fuel-to-air ratio in vehicles. This could lead to more-difficult starting and frequent stalling. Requiring vans and compact trucks to meet emissions rules for cars would lead to their virtual elimination because they cannot presently be redesigned to meet the emission limits and still preserve their load-carrying and trailer-towing abilities.

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(Washington, D.C.)

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Para reducir la cantidad de SO_2 y NO_2 que son los principales contaminantes en los gases de una combustión se hace por separado.

Para eliminar parcialmente el NO_2, se hace reaccionar éste con amoniaco después de la combustión para obtener nitrogeno y agua.

Para eliminar el SO_2 por Desulfurización (fuegas-desulfurization) existen 2 sistemas:

1.- SECO

Una solución alcalina (de sodio, potacio, litio etc.) es atomizada en los gases de combustión y evaporados para secar partículas mientras reacciona con el SO_2. Los productos de la reacción es colectada en un filtro ó un precipitador electrostático y desecharse como polvo.

2.- HUMEDO

El SO_2 en los gases de combustión reacciona con una lluvia de cal o Caliza en forma de lechada obteniendo de la reacción sedimentos en forma de lodos que pueden ser oxidados para rellenos ó purificados para producir cartón de Yeso.

Hay otras opsiones de lavado. Si se requiere eliminar menos del 90% se inyecta Caliza ó otras clases de procesos de inyección de absorventes secos como la dolomita para lograr de 50 - 70% de eliminación de Contaminantes.