

The orange clouds of dust—mainly iron oxide—pouring out of smokestacks carry the major pollutants that the steel industry generates. Not long ago steel companies in Chicago, with a combined ingot capacity of about 13 million tons a year, agreed to eliminate all dust by 1971 at a reported capital cost of approximately \$30 million. This suggests a cost of about \$2.50 per ton of capacity. Since steel companies in several other cities are pushing ahead with controls or replacing open hearths with basic oxygen furnaces—all of which have controls—it appears that as much as two-thirds of the country's approximately 150 million tons of steelmaking capacity may be operating with "clean stacks" by the early 1970's. Generously assuming that it might cost as much as \$5 per ton of capacity to equip the remaining third, or about \$250 million, the industry would have approximately to double its spending on air-pollution equipment in the years ahead.

The chemical industry, turning out thousands of different products, emits a bewildering variety of gases and exotic odors. Lots of chemical plants, as one industry spokesman concedes, are "quite flavorful" to human noses, which have a remarkable sensitivity to noisome odors. A lot of the effluent is potentially dangerous, too. The phosphate fertilizer plants in Polk and Hillsborough counties in Florida used to emit large quantities of fluorides that damaged citrus crops and caused the teeth of cattle to drop out. But in the last five years the plants have installed about \$22 million worth of equipment and cut emissions by more than half, while increasing production 43 percent. One of them, faced with a shutdown by a court injunction, managed to reduce its daily fluoride emissions from 900 to 300 pounds in only sixty days. The members of the Manufacturing Chemists Association, which embraces most of the industry, have invested a total of \$212 million in air-pollution control facilities to date, and expect to spend another \$49 million in the next five years. This does not include additional operating costs or research, which together come to \$26,600,000 a year. Rough estimates of what it would cost to bring all the country's chemical plants up to the level of the cleanest ones range up to \$500 million just for equipment, not counting outlays already planned, but half that amount might do the job.

The cleanest petroleum refineries in the nation are to be found, not surprisingly, in the Los Angeles area. Standard Oil of California's refinery at El Segundo, partly screened by trees, emits little besides innocuous steam to the atmosphere and cannot be smelled more than half a block away. To comply with Los Angeles' strict rules, oilmen say, would probably add between 5 and 10 percent to the cost of a new refinery. While no recent figures are available, a 1961 survey showed that U.S. petroleum refineries were spending about \$18 million a year on pollution-abatement equipment. But 44 percent of the money was being spent on the West Coast. Bringing all U.S. refineries up to Los Angeles standards, therefore, might require the expenditure of an additional \$10 million a year on equipment. Some of this would pay for itself by recovering valuable substances. Indeed, it has been estimated that four-fifths of the sulfur dioxide which U.S. petroleum refineries might otherwise be venting to the atmosphere is now captured as sulfuric acid or elemental sulfur.

#### The particulars on particulate matter

The troublesome pollutants from electric power stations are particulate matter, in the form of fly ash, and sulfur dioxide. The first comes almost entirely from coal-burning generating plants, and the techniques for controlling it have been around for decades. In 1962, according to the Edison Electric Institute, private power companies kept nine million tons of fly ash from entering the sky, far more than the approximately two million tons that escaped. Electrostatic precipitators in the newest plants catch 99 percent of the stuff, and a still newer unit at a mine-mouth plant going up in western Pennsylvania will be the first in the U.S. to remove 99.5 percent. Unfortunately, new plants are still being built in some areas with mechanical collection systems that keep no more than 70 percent out of the air. To bring all the country's 130 million kilowatts of coal-burning generating capacity up to the 99.5 percent level might cost about \$300 million.

The cost of collecting fly ash has only a negligible effect on the price of electricity—well under 1 percent by one estimate, counting the write-off of equipment. The control of sulfur dioxide, on the other hand, could have a sizable effect on consumers' monthly bills. Electric generating stations are the country's biggest single source of this gas, and capturing it before it goes out the stack is one of the really tough problems in cleaning up the air. Most of the gas comes from the burning of coal, which contains about 2.5 percent sulfur on the average, and which is used to generate 54 percent of the nation's electricity. Oil accounts for a much smaller share, but heavy residual fuel oil, which generally has about the same percentage of sulfur, is used extensively in places like New York City.

Sulfur dioxide is the most worrisome of the major pollutants, and 23 million tons of it are currently being discharged into the country's air. It has been implicated in most of the famous air-pollution disasters, such as the 1948 one at Donora, Pennsylvania (twenty dead), and the 400 "excess deaths" recorded during a fifteen-day smog episode in New York City early in 1963. While not toxic to man in the concentrations ordinarily found in the atmosphere, it can cause acute crop damage in relatively small concentrations. In industrial regions it causes nickel to corrode twenty-five times as fast as in rural air, and copper five times as fast. And under certain conditions it kills people. One of its derivatives, sulfuric acid mist, can get past the body's natural filtration system and penetrate deep into the lungs, causing severe damage. While the sulfur dioxide in New York City, which has the highest concentration, averages only 0.16 parts per million, it has flared up as high as 2.64 p.p.m.—enough to kill some persons already suffering from respiratory ailments.

Until now, no economically feasible way has been found to curb the emissions of this gas from coal- and oil-burning power stations. The only solution has been for the electric companies to build tall stacks so that the sulfur dioxide will not reach the ground until it is far away and greatly diluted. But electric-power consumption in the U.S. is doubling every twelve years, and the consumption of coal by utilities is expected to rise almost as rapidly in the years ahead. Some air-pollution men already question the efficacy of building ever higher stacks in the nation's fast-