

ceptors of long-term exposure to known admixtures of pollutants. Nevertheless, many proposed air standards for urban areas are predicated on consideration of the exposure effects of a single pollutant at a time.

The final medical factor is individual sensitivity or allergic reaction. Heretofore this has been a rather vague and nebulous concept, but recent evidence is accumulating to verify this phenomenon.

Methods of reducing SO_2 and SO_3 emissions from coal

Based upon statistics available for the year 1962, and by combining a knowledge of the sulfur content of coal seams being mined in various states, Table I indicates the range of sulfur contents and the corresponding percentages consumed in the United States.

In view of the very large estimated demand for electric power generation in geographic areas where coal is the preferred fuel, the quantities of SO_2 released to the atmosphere will rise alarmingly unless means are developed either to remove the sulfur before combustion or to remove the SO_2 from the stack gases. One of the prime difficulties in achieving the former objective is that a portion of the sulfur content (20-60 percent) is chemically bound as organic sulfur, and this can only be removed by very complex and expensive chemical processes.

At present, three high-temperature processes¹ are being operationally tested for electric utility applications. These are: the alkaliized alumina, the Reinluft, and the Pennsylvania Electric.

Bureau of Mines' alkaliized alumina process. In this process, flue gas containing SO_2 and SO_3 are absorbed by alkaliized alumina— $\text{Al}(\text{OH})_3$ —in a vessel at a temperature of 625°F (see Fig. 9). The alkaliized alumina is regenerated in a second vessel at 1200°F, by using producer gas or re-formed natural gas. The product gas from the regenerator is then introduced to a sulfur recovery plant in which elemental sulfur is produced.

The flue gas used in the Bureau's pilot plant is made from the combustion of powdered coal and it contains all the impurities that might affect the absorption and regeneration cycles. Tests have been conducted to establish the optimum conditions of temperature and time for both the absorption and regeneration, and various procedures for preparing the alkaliized alumina have been tried because, in the repeated cycles, physical and chemical changes occur that may degrade or poison the absorbent.

The experimentation with this process has led to the construction of a larger pilot plant in which variables can be studied more efficiently. The advantages of the process include a low pressure drop of the flue gas during absorption, operation over a wide temperature range of 250°-650°F, and the ability to obtain elemental sulfur as the end by-product.

Reinluft process. In this method, flue gas at 300°F is forced upward through a filter bed of activated charcoal (see Fig. 10) that is slowly descending through the adsorber. The SO_2 is adsorbed directly and the flue gas is then cooled to 220°F. At this temperature, SO_2 is oxidized to SO_3 , which is then adsorbed on the activated charcoal. The SO_3 combines with the adsorbed water from the flue gas to form dilute H_2SO_4 .

The activated charcoal, with the adsorbed dilute H_2SO_4 , is next regenerated in a separate vessel by the recirculation of product gas heated to 700°F. The dissociated H_2SO_4

products react chemically with a portion of the carbon to form a gas that contains a high concentration of C_2O and SO_2 . The latter gas is converted to H_2SO_4 in a contact acid plant. After cleansing, the regenerated char is recycled to the adsorber.

At present, two commercial plants are under construction in Germany to use this method of SO_2 removal. One of these plants will service flue gases produced from low-grade fuel oil, and the other will be used in connection with a coal-fired installation.

The Reinluft process is particularly feasible if there is a nearby industrial requirement for sulfuric acid.

The Pennsylvania Electric process. The Pennsylvania Electric Company has constructed a pilot plant at its Sewart generating station to remove SO_2 by the catalytic conversion of SO_2 to SO_3 . Sulfuric acid is formed and collected on the cooling water stream that contains the SO_3 . The objectives of the pilot plant are fourfold:

1. To determine the effect of actual flue gas, with time, on catalyst activity.
2. To establish the degree to which the flue gases must be precleaned to prevent catalyst fouling.
3. To calibrate the rate of catalytic oxidation of SO_2 and flue gas pressure drop so that large-scale plants can be sized.
4. To determine removal methods for the acid and the quality of the acid produced.

Reports indicate that the pilot plant has been operated successfully and that adequate data have been gathered for the design and construction of a full-scale plant. Many variables, however, still must be investigated, such as the life expectancy of the equipment, required construction materials, and the character of the maintenance problems that will be experienced.

At the present time there is insufficient information

I. Quality of coal used by electric utility industry in the United States—1962

Sulfur Content, percent	Production, percent
0-1.5	32.0
1.5-2.0	9.0
2.0-2.5	6.6
2.5-3.0	19.7
3.0-3.5	23.0
3.5 plus	9.7

"Despite the evidence of our senses, only in relatively recent years have we recognized that pollutants in the air have a direct bearing on health. And there are still doubting Thomases who maintain that pollution cannot be linked to disease because no specific etiologic agent in the air has been identified as responsible for a specific disease."

—James E. Perkins, M.D.,
Managing Director,
National Tuberculosis Association