

AMERICAN ASSOCIATION FOR  
THE ADVANCEMENT OF SCIENCE

*Science* serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

## Editorial Board

ROBERT L. BOWMAN	EVERETT I. MENDELSON
JOSEPH W. CHAMBERLAIN	NEAL E. MILLER
JOHN T. EDSALL	JOHN R. PIERCE
EMIL HAURY	KENNETH S. PITZER
ALEXANDER HOLLAENDER	ALEXANDER RICH
WILLARD F. LIBBY	DEWITT STETTEN, JR.
GORDON J. F. MACDONALD	CLARENCE M. ZENER

## Editorial Staff

## Editor

PHILIP H. ABELSON

## Publisher

DAEL WOLFE

## Business Manager

HANS NUSSBAUM

Managing Editor: ROBERT V. ORMES

Assistant Editors: ELLEN E. MURPHY, JOHN E. RINGLE

Assistant to the Editor: NANCY TEIMOURIAN

News Editor: DANIEL S. GREENBERG

News and Comment: Staff writers: JOHN WALSH\*, ELINOR LANGER, LUTHER J. CARTER, BRYCE NELSON, ROBERT J. SAMUELSON, KATHLEEN SPERRY, GILLIAN PARRILLO. Contributing correspondents: NIGEL CALDER, VICTOR K. McELHENY

Book Reviews: SYLVIA EBERHART

Editorial Assistants: JOANNE BELK, ISABELLA BOULDIN, ELEANORE BUTZ, BEN CARLIN, GRAYCE FINGER, NANCY HAMILTON, OLIVER HEATWOLE, ANNE HOLDSWORTH, KONSLYNNIETTA HUTCHINSON, ELEANOR JOHNSON, PAULA LECKY, KATHERINE LIVINGSTON, HELEN OLNEY, LEAH RYAN, BARBARA SHEFFER

\*European Office: Lime Tree Farm, East Hagbourne, Berkshire, England. Telephone Didcot 3317

## Advertising Staff

## Director

EARL J. SCHERAGO

## Production Manager

ROSE MARIE ROMAGNOLO

Advertising Sales Manager: RICHARD L. CHARLES

Sales: New York, N.Y., 11 W. 42 St. (212-PE-6-1858): ROBERT S. BUGBEE

Scotch Plains, N.J., 12 Unami Lane (201-889-4873): C. RICHARD CALLIS

Medfield, Mass. 02052, 4 Rolling Lane (617-359-2370): RICHARD M. EZEQUELLE

Chicago, Ill. 60611, 919 N. Michigan Ave., Room 426 (312-DE-7-4973): HERBERT L. BURKLUND

Los Angeles 45, Calif., 8255 Beverly Blvd. (213-653-9817): WINN NANCE

EDITORIAL CORRESPONDENCE: 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Phone: 202-387-7171. Cable: Advancesci, Washington. Copies of "Instructions for Contributors" can be obtained from the editorial office. ADVERTISING CORRESPONDENCE: Rm. 1740, 11 W. 42 St., New York, N.Y. 10036. Phone: 212-PE 6-1858.

## Diminishing the Role of Sulfur Oxides in Air Pollution

Each year, in the United States, more than 20 million tons of sulfur are discharged into the atmosphere, most of it in the form of  $\text{SO}_2$ . This gas is slowly converted into sulfuric acid, which is corrosive to many materials, including metals, building stones, and clothing. The toxicity of  $\text{SO}_2$  and  $\text{H}_2\text{SO}_4$  to plants and animals is controversial, as is the effect of these compounds when they are inhaled along with other components of smog. Because of the complexities of long-term and synergistic effects, many years must elapse before precise conclusions can be reached concerning the role of the sulfur compounds. In the meantime, the public is becoming impatient with slow progress made in overcoming air pollution. Already, in various cities restrictions are being placed on the amount of sulfur fuel may contain.

Principal targets for such restrictions are electric power generating plants. These are a major source of air pollutants when they use coal or residual oil as fuel. Coal, the principal fuel, contains various quantities of sulfur; a typical amount is 3 percent. Concern about air pollution has been a factor in the sudden acceptance of nuclear energy. Unless the pollution problems attending use of coal are solved, the coal industry will face a gloomy future, caused in part by regulation, in part by competition from other energy sources.

Five means of meeting the sulfur pollution problem seem feasible. One is to use fuel containing only small amounts of sulfur. A second is to discharge the fumes from tall smokestacks (more than 200 meters high). If stacks are tall enough to pierce the inversion layer, the pollutants are thoroughly diluted before reaching the ground. A third method is to add a material such as powdered limestone to the flue-gas stream, following combustion, to convert the gaseous sulfur oxides into a solid form. A fourth is to convert the coal to gas and to remove the sulfur from the gas prior to combustion. A fifth method, which seems very interesting, is to pass the flue gases through a chemical processing plant, the sulfur being recovered in elemental form or as  $\text{H}_2\text{SO}_4$ . A number of variants of this method are under investigation. The U.S. Bureau of Mines has been conducting pilot-plant tests of an alkalized alumina process. Oxides of sulfur are removed from flue gas by absorption on a hot alkaline solid. The absorbent is regenerated with a reducing agent such as  $\text{H}_2 + \text{CO}$ , yielding  $\text{H}_2\text{S}$  as a product. The latter is readily converted to elementary sulfur. In a variant of this process, announced recently by Atomic International, a molten mixture of carbonates is used as the absorbent. Monsanto Chemical Company is active in the development of a catalytic oxidation process. Flue gas is freed from fly ash and passed over a catalyst bed containing  $\text{V}_2\text{O}_5$ , the  $\text{SO}_2$  being oxidized to  $\text{SO}_3$ . This substance, on cooling, reacts with water vapor to form  $\text{H}_2\text{SO}_4$ .

Both the sulfur and the  $\text{H}_2\text{SO}_4$  are consumed on a large scale. The price of sulfur has advanced sharply during the last year and is currently quoted at close to \$50 a ton. With present technology the value of the sulfur recovered from coal-fired power plants would about offset the cost of investment and operation of the processing plants. A combination of better technology with a higher price for sulfur may eventually convert a nuisance into a valued asset.—PHILIP H. ABELSON