lights easily and does not go out overnight; accordingly, the questions of coke reactivity and size become the pertinent issue and the metallurgical requirement is the direct contrary of the domestic need. There are, however, situations in which hard coke may suffice for the domestic boiler; they may be defined by suitable experiment.

Progress has been made in the Association's contribution to the provision of cheap and effective methods of liquid-effluent treatment and measures to be taken for the reduction of the emission of smoke, dust and grit at coke ovens. With regard to the former, the Association is supporting, both financially and technically, basic research at the University of Leeds into the biological treatment of gas liquors. Considerable strides have been made in the study of the activated sludge process as applied on a coke-oven plant and of the relative merits of percolating filter processes. It is most interesting to know that these microbiological processes can destroy such undesirable constituents of waste liquors as phenols, cyanides and thio-salts, including thiocyanates, substances which by their poisonous activity can persuade even the scientists to describe some of them as 'devil liquor'. Perhaps even more interesting to the layman is the fact that spoil heaps may be brought into service as percolating filters, and where they also have lagoons these may serve as means of aeration. To bring the rejected refuse of the mine back as an active agent in solving surface effluent problems is indeed to raise slumbering devils to serve mankind. The genus *Thiobacillus* would appear to give much scope for study, since preliminary results indicate that the organisms reported in the literature are only a fraction of those that exist in Nature. In the matter of atmospheric pollution much has been done in the mitigation of air pollution as the result of the training of coke-oven staff and operatives.

In the associated work of the Northern Coke Research Laboratory the tradition of the devotion to fundamental studies has been sustained. They involve methods of adsorption and microwave spectroscopy. The objectives include the unravelling of the mechanism of the adsorption on carbon of oxygen, carbon dioxide and nitrogen under controlled conditions. It is a problem which has challenged the scientific world since the earliest physical chemists applied the methods of chemical kinetics to the basic problems of combustion. The latest methods permit rapid determination of surface area, an essential parameter.

Coke science is not like nuclear science, a subject which makes popular news, but progress which is respected by that section of the scientific world able to appreciate the problems involved is just as worthy of recognition. The Council of the Association, its director, Mr. G. W. Lee, his colleagues and staff are therefore indeed to be congratulated on their achievements. R. J. SARJANT

GEOMETRICAL OPTICS

THE Optical Society of America, at its Rochester meeting in October 1962, awarded the Frederic Ives Medal for distinguished work in optics to Dr. M. J. Herzberger, the head of the geometrical optics department and senior research associate, Research Laboratories, Eastman Kodak Co. The Medal was presented on October 4 by D. L. MacAdam, the president of the Optical Society. A list of some 150 of Dr. Herzberger's publications is given in the June issue of the *Journal of the Optical Society of America* (**53**, 659; 1963) together with the text of his address entitled "Some Recent Ideas in the Field of Geometrical Optics". Dr. Herzberger discussed three particular optical problems on which he had worked—the analysis of optical images, the improvement of achromatic systems, and the algebraic method of designing optical systems. The use of spot diagrams to describe image formation in optical systems is illustrated by application to the analysis of the so-called 'rim-ray curves' and the four-element air-spaced compound triplet, an $f/5$, 300-mm 'Tessar'-type lens, is taken as a numerical example. The method will appeal to those who prefer to think in pictures rather than numerically. In 1959, Dr. Herzberger discovered that it was possible to design lenses, with or without fluorite, which were corrected for colour over a wide range of wave-lengths. The fundamental idea is to consider the refractive index n, and not its square, as a characteristic physical quantity, and to utilize the dispersion formula:

$$n = A + B\lambda + C/(\lambda^2 - \lambda_0^2) + D/(\lambda^2 - \lambda_0^2)^2$$

where λ_0 is a constant which for the wave-length range 365 mμ to 1·01μ and 176 glasses and other transparent substances used in optical design has the value 0·168μ. Four data are therefore required to fix the dispersion of an optical substance in the visible region. The data suggested are discussed, and it is shown that two glasses can be used to design an achromat, and if three lens elements made of different glasses are used a super-achromat can be designed which is corrected for four colours.

The basic mathematical problems associated with the algebraic design of optical systems, that is without ray tracing, have recently been solved by Dr. Herzberger, and the work remaining consists only of the elementary, but tedious, job of the algebraic solution of certain linear equations with algebraic coefficients and the same non-zero determinant for all orders. In his address Dr. Herzberger explained the meaning of the 'characteristic function' or 'eikonal' and posed the two questions, the answers to which would reduce the designing of lenses to pure mathematics. He then outlined the procedure adopted to determine the focal eikonal to any desired order for an image formation given by a single thick lens with two aspheric surfaces. Dr. Herzberger concluded by saying that he felt confident that it would not be long before the brain achieves a decisive advantage over the computer in the design of optical systems.

FLUOROCARBONS

THE origin of the organic fluorochemicals industry lay in the refrigeration industry wherein, following several fatal accidents, there arose an urgent demand for a non-inflammable, non-toxic, low boiling-point refrigerant. The pioneers working for General Motors were Drs. McNary, Midgley and Henne, who carried out research on compounds of carbon, fluorine and chlorine, particularly CCl_2F_2 made by the action of SbF_3 on carbon tetrachloride. Prof. M. Stacey of the University of Birmingham contributes an interesting article on this subject in the Spring 1963 issue of *Catalyst*, the excellently written and illustrated industrial journal of the Shell Chemical Co., London. "Success was immediate and dramatic", says the author, "and, in 1931, in collaboration with Du Pont, General Motors formed the corporation Kinetic Chemicals which began the commercial production of a range of colourless odourless non-toxic and non-inflammable fluorochlorocarbons which were named the Freons".