In collaboration with the University Extension Committee of the Technical University of Denmark a series of lectures entitled "Atomic Energy—its Implications and Utilization" have been given in Hjørring and Elsinore. The Library issued 24,014 items on loan during the year,

and 2,045 books, periodicals and reports were borrowed from other libraries. On March 31, 1962, the total holding of the Library consisted of 95,000 bibliographical units, of which 30,000 were on microcards.

S. WEINTROUB

RADIATION HAZARDS IN PERSPECTIVE

THE Expert Committee on Radiation of the World Health Organization consists of a group of international experts under the chairmanship of Lord Adrian. The Committee, together with representatives of several other organizations, met in Geneva during October 24–30, 1961, to discuss the relative somatic and genetic effects of ionizing radiation and of other agents and substances in our environment which have toxic, carcinogenic or mutagenic properties. The report of that meeting has now been published*.

Prominence has been given in recent years to the hazards of ionizing radiation and intensive studies have been made of radiation injuries and elaborate protection measures devised. Emphasis, however, should also be given to the beneficial aspects of many procedures involving radiation exposure, for it is well known that the benefits of the appropriate medical use of radiation in diagnosis and therapy far outweigh the hazards. With adequate protective measures, radioactive materials and nuclear energy can be peacefully and usefully applied in industrial and technological fields.

The report warns that preoccupation with the problems of radiation hazards may obscure the fact that there are many other toxic agents in the environment, some very widespread, which could prove a greater menace to public health. Man-made hazards to health must be reviewed against the background of known or unknown causes of disease, co-extensive with the whole field of medicine. In less-developed areas, man-made hazards account for only a small proportion of illness, but in highly developed areas they are responsible for a significant fraction of illness and death. The statistics given in the report show that in many countries accidents rank third as a cause of death and constitute the leading cause of death in the younger and more productive age groups. Most of the reported injuries caused by chemical toxins have occurred in industry, but increasing attention is being directed to the dangers of air pollution, pesticide residues in food, and food additives. A wide variety of chemical compounds are now known to be carcinogenic and others have been shown experimentally to be capable of genetic changes.

Turning to self-imposed hazards, the report states that it appears quite obvious that cigarette smoking or something closely associated with it is largely responsible for the high incidence of bronchiogenic carcinoma in certain

countries. Some anomalies in the geographical distribution of lung cancer strongly suggest that other agents are partly responsible. The most substantial evidence appears to be the higher incidence in urban than in rural smokers. The medical use of radiation for therapy of non-malignant conditions and of diagnosis, where, in the early days of radiological practice, excessive doses may have been given, has occasionally been shown to lead to malignant disease, and there is still need for care and research in this field. The genetic effects of radiation, chemicals and temperature are discussed in some detail. The total incidence of hereditary diseases and defects in man may be estimated at about 6 per cent of all live births. The discovery recently that a surprisingly high frequency of defects in man are associated with anomalies of chromosome number or structural aberrations of the chromosomes suggest, since such types of abnormalities can be produced by radiation, that radiation hazard is more extensive than suspected before. The role of mutation in maintaining the hereditary burden in man is still under debate and an answer is likely to be arrived at very slowly. Mutations in all animals and plants occur naturally, and although the causes of these spontaneous mutations are not well understood, it is estimated that only a small fraction could be due to the natural background radiation to which all living things are exposed. There is no *a priori* reason for believing that ionizing radiation is the only, or even the main, environmental factor in the production of mutations. Some hundreds of chemical agents are known to be mutagenic, but none has been investigated in such detail as radiation. The report calls for more research to assess the genetic hazards of mutagenic chemicals and temperature.

In their concluding remarks, the Committee recommends that studies be undertaken to establish criteria for safe exposure-levels to toxic agents, both for individuals (as in the case of occupational exposure) and for populations (as in the case of pollution of water, food and air). The suggestions that certain chemical agents may have deleterious somatic and genetic effects similar to those produced by ionizing radiations should be investigated, and the international standards of statistical reporting of effects, damage, disability and death because of toxic materials should be improved. In addition, epidemiological and genetic studies of the effects of toxic materials should be made and intensive research stimulated on the mechanism of action of these materials including their carcinogenic and genetic effects.

* World Health Organization. Technical Report Series. No. 248. *Radiation Hazards in Perspective: Third Report of the Expert Committee on Radiation*. Pp. 37. (Geneva: World Health Organization. London: H.M.S.O., 1962.) 2 Swiss francs; 3s. 6d.; 0.60 dollars.

TOBERMORITE GEL IN CONCRETE

TOBERMORITE is now known to be the chief cementing compound in hardened Portland cement and its structure largely determines the properties of concrete. When Portland cement is mixed with a limited amount of water, a plastic, mud-like material called 'cement paste' results; it sets in a matter of hours, becoming reasonably firm, then continues to harden for a period of months, if not years. The hardened paste is the matrix into which the fine and coarse crushed rock or natural sand and gravel enter, thus forming the artificial rock called concrete. Stephen Brunauer, of the Portland Cement

Association, Illinois, discussed the role of tobermorite gel in concrete at a lecture to the Institute of Civil Engineers in London in July 1962 and a transcript appeared in *Structural Concrete* (1, 7; January/February, 1963); this has since been reprinted for the Cement and Concrete Association, London.

Brunauer's thesis is briefly as follows. Portland cement is a complex mixture of eight or more compounds of which the two most important are known to be tricalcium silicate (Ca_3SiO_5) and β -dicalcium silicate ($\beta\text{-Ca}_2\text{SiO}_4$), these two silicates constituting about 75 per cent of an

average Portland cement by weight. Reaction of either or both these silicates with water produces similar calcium silicate hydrates but with different amounts of calcium hydroxide. The calcium silicate hydrate is similar to the natural mineral known as tobermorite and is now designated as tobermorite gel, the most important constituent of hardened Portland cement paste, hence of concrete. "Tobermorite gel plays a vital role in determining the rheological or flow properties of fresh cement paste, which properties in turn determine the consistency and workability of fresh concrete. It plays a dominant role in the setting and hardening of the paste and in determining the strength and dimensional stability of hardened paste and concrete. For these reasons I have called tobermorite gel the 'heart of concrete'."

Examination of hardened tricalcium silicate paste after complete hydration suggests the following stoichiometry of the reaction: $2(3\text{CaO} \cdot \text{SiO}_2) + 6\text{H}_2\text{O} = 3\text{CaO} \cdot 2\text{SiO}_2 \cdot 3\text{H}_2\text{O} + 3\text{Ca}(\text{OH})_2$. Dicalcium silicate reacts with water much more slowly than tricalcium silicate and the examination of a mature, four-year-old dicalcium silicate paste can be represented by the equation: $2(2\text{CaO} \cdot \text{SiO}_2) + 4\text{H}_2\text{O} = 3 \cdot 3\text{CaO} \cdot 2\text{SiO}_2 \cdot 3\text{H}_2\text{O} + 0 \cdot 7\text{Ca}(\text{OH})_2$. Thus the lime/silica ratio in tricalcium silicate is 3, in dicalcium silicate it is 2. Tobermorite gel obtained from tricalcium silicate does not have the same composition exactly as that obtained from the dicalcium silicate, but otherwise the two gels are similar, having the same X-ray diffraction pattern, and when examined with the electron microscope the gel particles look the same. There is, however, in the specific surface area of each a marked difference. It is the nature of the surface and the extent of that surface which combine to determine the cementing power of tobermorite gel. H. B. MILNER

TOTAL TRAPPING OF CHROMATOGRAPHIC EFFLUENTS IN ARGON CARRIER GAS

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THE quantitative collection of fractions in preparative gas chromatography is difficult because of the tendency of the sample to condense into fog particles which are then swept by the carrier gas through the collecting trap¹. This difficulty is avoided if a method of trapping is used in which there is total condensation of the carrier gas together with the sample, followed by low-temperature evaporation of the condensed gas without loss of the frozen sample. Liquid nitrogen (b.p., -196°) is used as the coolant to condense argon (b.p., -186°). Since on liquefaction there is about a thousand-fold diminution of volume considerable amounts of carrier gas may be collected in a small simple trap.

If a closed vessel cooled in liquid nitrogen is connected to the exit of the chromatograph the condensed argon has such a low vapour pressure (c. 200 mm mercury at -196°) that a partial vacuum is applied to the detector and column outlet with a consequent disturbance of the operating parameters of the separation. Usually the exit of the chromatograph is at atmospheric pressure and this is achieved by venting the trap to the atmosphere. The reduced vapour pressure of argon on condensation then results in a back-flow of air into the trap, where it is also condensed. With the apparatus shown in Fig. 1 continuous back-flow rates of air between 200 and 400 ml./min were observed with argon in-flows ranging from 11 to 310 ml./min. To prevent contamination by atmospheric pollutants and to reduce the extra volume of liquid collected, it is preferable to allow pure nitrogen gas to be sucked back. This is most easily achieved by connecting the outlet of the trap to a length of glass tubing the end of which dips under the surface of liquid nitrogen. Back-flow rates of between 75 and 200 ml./min of nitrogen gas were observed with argon in-flows ranging from 11 to 600 ml./min. There must, of course, be an upper limit to the rate of flow of argon which can be completely condensed in a particular design of trap and this is solely determined by the rate of heat transfer to the coolant. That this is high is indicated by the fact that in every experiment where initially argon was passed through the 'Drechsel' tube trap at room temperature, the reversal of flow at the outlet of the trap occurred within 5–10 sec of immersion in liquid nitrogen.

Quantitative recovery of the frozen sample on evaporation of the liquid argon-nitrogen mixture is achieved if the input of heat is not so excessive as to cause explosive vaporization, and the ultimate temperature attained is

not so high that the sample has a considerable vapour pressure. The simplest procedure is to transfer quickly the trap, with its inlet now closed and the outlet vented to the atmosphere, to a 150×25 mm test-tube half-filled with liquid nitrogen. After standing for a few minutes the liquefied gases have evaporated and the trap will eventually attain room temperature. To limit this final temperature rise the test-tube may be immersed in a suitable cryogenic mixture (for example, melting pentane at -131°). For extremely volatile samples it is preferable

Fig. 1. 'Drechsel' tube used for total trapping. Not shown are the retaining spring and the silicone rubber tubing connexions sealed by Mohr's spring clips