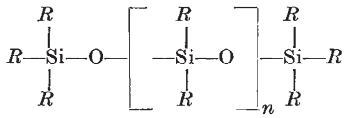
PRODUCTION OF SILICONES

NEW PLANT AT BARRY, GLAMORGAN

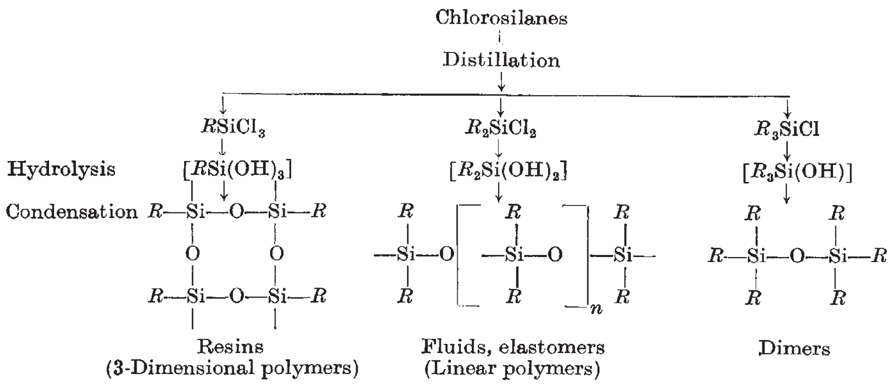
PROF. F. S. KIPPING, working in the University of Nottingham at the end of the nineteenth century and early years of the twentieth, carried out many experiments in the field of silicon chemistry. In the course of that research he often obtained polymeric silicon products, which he recognized as containing silicon–oxygen linkages. Such compounds are known as 'silicones', a term which refers to any organo-silicon compound based on a silicon–oxygen structure with hydrocarbon radicals attached to the silicon atoms ; for example :

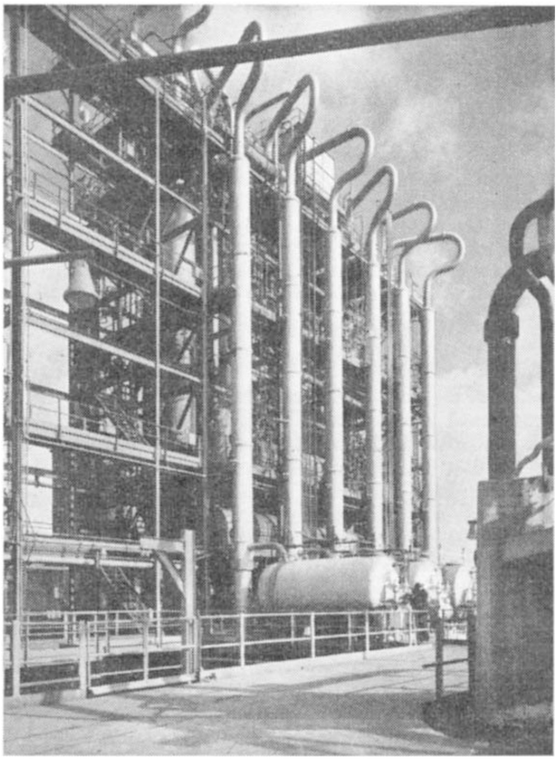


The group inside the brackets is called 'siloxane'. In the case of the polydimethylsiloxanes (that is, where R is a methyl group), n may vary from zero to several thousands.

The production of silicones in Great Britain is taking place at the Albright and Wilson, Ltd., Silicone Plant at Barry, Glamorgan. Here, on a large scale, with the rigorous exclusion of air and moisture, silicon is treated with methyl chloride at 275–375° C., using copper as a catalyst. The various chlorosilanes, $RSiCl_3$, R_2SiCl_2, R_3SiCl, which are so produced, for example, $Si + 2RCl \rightarrow R_2SiCl_2$, are fractionated into the pure components. This fractionation is difficult because the boiling points of the chlorosilanes are very close together, and fractioning equipment of great efficiency has to be used. The fractionating section is a vital part of the whole plant, and involves fractionating columns of great height and many stages, all controlled automatically. This fractionation gives the mono-, di- and tri-substituted chlorosilanes as pure components. Some of these chlorosilanes are further treated by a Grignard reaction, in order to prepare those types of chlorosilanes which are most needed.

Having obtained pure chlorosilanes, the next step is their hydrolysis by water. The products of hydrolysis condense, and by varying the initial proportions of the different chlorosilanes, a great variety of silicone products can be made ; for example :





Distillation unit showing still pots and batch columns

It can thus be seen that the characteristics of the products are dependent upon the type of chlorosilane or mixture of chlorosilanes used.

The process employed is very complicated, and requires to be carried through many stages with great care in order to produce pure materials in good yield. Since the chlorosilanes are corrosive and toxic, react spontaneously with water, and are highly inflammable, elaborate safety precautions are necessary, and the volatile solvents and intermediate products of the process are stored in buried tanks. The tanks—and indeed all parts of the system—are purged with inert gas to prevent the ingress of air or moisture and to reduce the risk of fire. Incoming solvents are transferred to the storage tanks from the tank cars, in which they are transported, by pumps. On the other hand, methyl chloride, which is also transported by road tanker, is transferred to storage tanks by utilizing its own vapour pressure. All people working in hazardous areas wear protective clothing, including glasses and helmets.

The silicone products so obtained are characterized by good resistance both to water and to extremes of temperature. These are extremely useful properties, and result in silicones being used for such varied purposes as paints for metal surfaces at high temperatures, water-repellent treatment for masonry, concrete, etc., heat-resistant electrical insulation, silicone finishes to fabrics to achieve water repellency and stain resistance, etc. The quality of the products is tested in a technical service laboratory, and the development of new products is also carried out there.

The knowledge and experience of the Dow Corning Corporation in the field of silicone science and technology has been freely available and has been drawn on liberally in the setting up of this plant at Barry.

BIOLOGICAL EVALUATION OF WATER AND EFFLUENTS

ON November 3 the Biological Methods Group of the Society for Analytical Chemistry held a symposium in London on "The Biological Evaluation of Water and Effluents". The large attendance and the spirited discussion of the papers gave a good indication of the large number of chemists and biologists now interested—either as consultants or as servants of public authorities or industrial firms—in the assessment and control of pollution.

Dr. B. A. Southgate (Water Pollution Research Laboratory, Stevenage), in introducing the subject, said that, in trying to evaluate the purity either of a surface water or a polluting discharge, chemical and biological methods are usually used in conjunction. Waters to be used as a source of domestic —or sometimes industrial—supply are usually examined bacteriologically ; with some surface waters the algal flora is examined frequently, and measures are taken to prevent its interfering with filtration and other methods of treatment of the water. There is a great lack of quantitative information on the distribution of different species of fish in rivers, particularly in rivers polluted by sewage and industrial effluents. Recent work has shown that large numbers of coarse fish enter a channel carrying an undiluted sewage effluent, in which conditions only rarely become lethal ; when lethal conditions do occur, it is due principally to depletion of oxygen in solution.

In regulating the discharge of effluents containing oxidizable matter to a stream, a method is urgently required whereby the effect of a given discharge on the oxygen tension in the stream can be predicted. Usually effluents are examined by the test for biochemical oxygen demand or, better, by measuring uptake of oxygen in a respirometer (of which a new modification of an instrument of the Warburg type was described), but it is by no means certain that the rate of oxidation—particularly of ammonia—measured in this way is the same as that which occurs in a stream. In the direct measurement of rate of oxidation in a river, it is necessary to be able to determine the rate of solution of oxygen from the air—known to vary widely with turbulence, surface agitation, and other factors. Dr. Southgate described an attempt to do this by following changes in the oxygen content of air trapped in a light plastic container, open at the bottom, and floating on the surface of the water. Rapid fluctuations may occur in the oxygen tension in polluted streams, and methods of recording the level of oxygenation, continuously or at short intervals, are required. A recently developed apparatus was described in which samples are taken at intervals of ten minutes, the oxygen content being determined automatically, essentially by the method of Winkler ; the values obtained are recorded on a chart.

The determination of the toxicity of effluents to fish was then dealt with by Mr. D. W. M. Herbert (Water Pollution Research Laboratory, Stevenage) ; the object of this work, he said, is to predict, from tests in the laboratory, what effect a given effluent would have on fish when discharged to a river. Laboratory tests under controlled conditions can usually be made only during a period of a few days, though some have been continued for as long as three months ; from tests of this kind, one has to try to predict what the effect of a small concentration of a poison, present continuously in a river, would be on a fishery. It is very probable that the toxicity of a river water, containing a fixed concentration of a poison, would in any event fluctuate widely, since the toxicity of most direct poisons which have been examined increases markedly as the oxygen tension of the water containing them is reduced below the air-saturation value. Fluctuations in temperature and *p*H value may also be important ; the toxicity of solutions of ammonia, for example, increases rapidly as the *p*H rises and ionization is suppressed.

Dr. J. E. Forrest (Queen Mary College, London) described the effects of polluting discharges on the flora and invertebrate fauna of streams, dividing effluents for this purpose into those containing direct poisons ; those, such as sewage effluents, not directly poisonous but containing organic matter ; and those which affect a river mainly by raising its temperature. Below a source of serious organic pollution there is a well-marked sequence of changes in the invertebrate fauna and, it was suggested, a study of the fauna in a river might give more reliable information about the state of pollution of the water than would be given by random chemical tests. The relative importance of the level of oxygenation of the water and of the nature of the bottom in influencing the distribution of invertebrates is not yet clear. Normally, of course, if mud and sludge are to be deposited in a river, this will happen in slow-flowing and relatively deep reaches where the oxygen tension of the water is likely to be low, as a result of uptake of oxygen at the mud–water interface, and of the relatively small rate of re-aeration of the water from the air under stagnant conditions. The importance of *Cladophora* (blanket weed) in modifying the character of a stream was stressed ; this alga may grow very vigorously in rivers polluted by nitrogenous organic matter.

In a paper on the determination of the safety of water, Dr. E. Windle Taylor (Metropolitan Water Board, London) described the development which has taken place, from about 1880 onwards, of bacteriological methods of examination. Recently, for research purposes, the probable error of bacterial counts, using liquid media, has been considerably reduced by using only two-fold dilutions and examining seven series, each of ten tubes, in each determination ; the modern view, however, is that in routine estimations to safeguard the purity of a domestic water supply it is better to increase the number of samples examined rather than to increase the number of tests carried out on each sample. He emphasized that a public water undertaking aims at distributing a safe, but not necessarily