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Chemicals in 1984

The ascendancy of giant molecules

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I SHALL attempt here to examine the likely industrial developments in giant synthetic molecules during the next twenty years. By then, their importance will be far greater than it is even today. The field of macromolecular chemistry embraces natural substances in everyday use (such as proteins, carbohydrates, natural rubber, wood, fibres such as cotton, wool and silk) and several natural products that are very important from both the biological and industrial points of view (notably nucleic acids and enzymes).

It is only in the last few decades that, thanks to the progress of chemistry, it has become possible to produce, by synthesis, macromolecular substances that can compete with, and sometimes even show better properties than natural substances.

The recent discovery of the "stereospecific" polymerisation processes has enlarged the possibilities in synthesising macromolecular products (plastics, synthetic fibres and synthetic rubbers). These processes enable us to link small molecules together in a manner that yields giant molecular structures having a high chemical and steric (three-dimensional) regularity, with a pre-determined type of symmetry and hence pre-determined properties.

By such means we can synthesise products having the same constitution as the natural polymers and also make similar products that do not exist in nature.

The production of synthetic macromolecular products has increased enormously in the past ten years: indeed, no other branch of the chemical industry has made such a big leap.

While it may be possible to foresee the progress of other branches of industry in the next twenty years by extrapolating from the statistics of previous decades, where macromolecules are concerned we cannot do so because the big advances are so recent. Neverthless, we can make predictions about the main fields.

Plastics.—The world production of each of the most important synthetic polymers known at present—notably polyethylene, polypropylene, polyvinylchloride, styrene polymer and copolymer, phenolics and polyesters—can be expected to reach several million tons per year. The quantities of articles made of plastics will greatly exceed those made of light metals. The possibilities are numberless; I can only give some examples of the widening use of plastics.

In the packaging industry, the plastics will surpass all other materials. Plastics with high melting points (polypropylene, for example) will allow the production of sterilised packages; thus metal cans will be largely replaced by opaque or transparent boxes made of plastics.

A great part of the building materials for houses (especially for prefabricated houses) will consist of plastics: for instance, more or less transparent plastics covers will substitute for tiles. Partition walls will be made of expanded plastics, exploiting their lightness and their heat and sound insulation. Furniture will be mostly made of plastics, rather than of the more expensive wood and metals.

The use of plastics in this field is presently limited by the capacity of the moulding machines; in particular, injection-moulding machines can handle no more than 15 kg in a single shot. But, within twenty years, it will be certainly possible to produce articles of several tens of kg, either by new types of moulding machines or by quite different processes.

Most, if not all, of the water pipes in houses will be made of plastics, being lighter and more readily shaped for particular needs. Similarly, in agricultu light plastics pipes, fitting more eas the irregularities of the terrain, w be used instead of metal ones for irri tion. Artificial ponds will be creat on sand and on permeable soils, by t laying down of weldable plastics filr

As for greenhouses, plastics will place metals and wood for the fram as well as glass for the transpare parts. As a result of low cost, gre houses will be more widely used th today. Films of plastics will be us to protect several crops (from stra berries to grapes) for the sake quicker ripening. In the case of vin they will reduce or eliminate the ne for the present expensive chemi treatments.

Textiles—Highly crystalline and v light fibres can now be obtained fr stereoregular hydrocarbon macromc cules. For instance, polypropylene high steric purity is made from propy ene produced from petroleum at v low cost; with this polymer one manufacture textile fibres that are v light (density 0.90-0.92) and have r chanical and thermal properties bet than those of many other filame Large-scale production of these pc propylene fibres will bring the pr down to a level defying all competiti even from cotton.

When used for clothes, polyprop ene yields for a given weight a grea volume of fabric—12.5 per cent m than for nylon, 50 per cent more t for PVC and 70 per cent more than cotton. Thus it is extremely conveni to use and demand for it will incre enormously in the next twenty ye probably surpassing that for any ot type of fibre.

Synthetic rubbers—At present, s thetic rubbers represent about half total amount of rubbers used, and th share of the world market will gr to at least 70-80 per cent. In fact, far as we can tell, the increased mand for rubber will be almost entir for the synthetic products. Wit twenty years, the production of s thetic rubber will exceed 10 mill tons per year, while that of natu rubber will remain almost constant.

26th WEEK OF THE 1984 SERIES

In this series the contributors have been asked to forecast conditions in 1984 on the basis of known possibilities and trends. It is recognised that a certain amount of guesswork is unavoidable and that unforeseeable discoveries and inventions could, in some cases, radically alter the picture.

Series continues until 9 August

Stereospecific polymerisation processes have yielded products having the same chemical and steric constitution as natural rubber (*cis*-1,4 polyisoprene), and gutta percha (*trans*-1,4 polyisoprene), and having properties practically identical with those of the corresponding natural products, as well as new types of synthetic rubbers (for example, *cis*-1,4 polybutadiene, having a high steric purity) made from less expensive starting materials. Moreover the new processes give rubbers (ethylene-propylene copolymers and terpolymers) that are made from low-cost raw materials and have good elastic and dynamic properties—as well as a higher resistance to ageing than natural rubber because they are chemically more "saturated" (less reactive).

Food production.—The increased production of synthetic macromolecular products from coal and petroleum means that much of the land now used for the production of cotton, wood, natural rubber, etc. can be turned over to the growing of food. By this indirect means, macromolecular chemistry will help to feed the growing population of the world.

The problem of synthetic food is a new research topic in which investigations will be as important as for the other macromolecular substances I have discussed. However, the production of synthetic food raises remarkable difficulties. At first, we can expect only pure materials (for example, vitamins and some carbohydrates) to be produced by synthesis; meanwhile we must hope that the natural products will be produced in great amounts.

Plenitude from petroleum

by Professor H. W. Slotboom

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WILL there be enough oil in 1984 for us to talk usefully about the prospects for its products? Experts in the oil industry say yes; they are confident that the present reserves of crude oil, plus additional sources which are likely to be discovered as a result of current exploration, are adequate to allow consumption to grow, even at the present rate, until 1984 and even beyond.

Today, more than 90 per cent of the crude oil produced is processed into products which provide roughly half of the world's total energy. The rest—less than 10 per cent—is converted into a wide range of other products. They include lubricating oils, paraffin wax and asphaltic bitumen, as well as "petrochemicals".

Nearly 20 million tons of organic chemicals from petroleum will be made in the free world during 1964 and it does not seem over-optimistic to forecast a quantity of 100 million tons by 1984. This increase will be stimulated by lower manufacturing costs, thanks to scientific advances in the design and operation of new processing units. Oil and chemicals manufacturing plants in 1984 will have larger units and fully-integrated control systems, with computers to make the decisions for economic operation.

In the energy field during the next twenty years the overall position of petroleum will not be affected other than marginally, although the fuel pa tern is likely to change. The use nuclear reactors in electric power st tions and in ships may check t growth rate in the use of heavy fu and cheaper electricity may well cau the growth curve for domestic petr eum fuel for central heating to flatt out; but on the other hand there likely to be steady growth in the utilis tion of petroleum in metallurgy, par cularly for reducing iron ore.

Petroleum fuels for motor ca heavy vehicles and aeroplanes will n be affected by the above trends. T new type of fuel which is being d veloped for supersonic jet aircraft w be hydrocarbon-based; so undoubted will be the fuel for any of the ne devices for the generation of aut motive power which may emerge fro current research and development ac vities. An example is the fuel cell.

The combination of piston engir hydrocarbon fuel and petroleum lub cant still holds a great deal of potenti for further improvements in efficien and convenience. As a welcome o shoot of such improvements we m expect the world to be a quieter a cleaner place in 1984.

The utilisation of petroleum-bas products outside the energy field go back to the beginnings of the oil indu try. The manufacture and use special hydrocarbon solvents, asphalt bitumen as a cheap plastic material f road-making and for hydraulic and i dustrial applications, and paraffin w for waterproofing packing paper, ha gone through a long period of co tinuous technological developme which will continue.

The marriage between the oil a chemical technologies, of which petr chemicals are the offspring, promis to be still more fruitful in the ne twenty years.

Conventional oil products, such fuels, are tending to become more a more "chemical", as the result of i