CHEMISTRY

Versatile Plastics for Future

More rugged and versatile chemicals, rubbers and plastics result from stereo-chemistry which involves rearranging and linking molecules into chains.

By PETER CARTER

RESEARCH CHEMISTS are talking more about "stereo," but they are not concerned with phonographs or phonograph records.

The subject of their conversations is stereo-chemical research, the source of a more rugged and more versatile breed of plastics, rubbers and chemicals.

From stereo-chemistry may come lighter, stronger components for missiles and space vehicles and automobile bodies that are more rugged pound for pound than those in current use.

It is also viewed as the source of plastics that will have as great an impact on the construction industry as man-made fibers have had on the textile industry during the last 20 years. Homes constructed with plastic girders, walls and plumbing are a possibility of the future.

Plastics that owe their origin to stereo-chemical research already are competing in the market place with products made from conventional wood, steel and ceramic materials. The hundreds of products range from dishes for the home to hawsers for large ocean-going vessels.

As scientists look into the future, they see the list of end products continuing to grow. On an experimental basis, housings for washing machines and refrigerators have been molded from the new plastics.

Through stero-chemistry, plastics and some other synthetics, including synthetic rubber, can be tailor-made to meet the requirements of a particular application. This valuable new tool can be used to build in desirable product qualities, such as clarity, resistance to high temperatures, toughness and rigidity.

Millions of dollars each year are being spent for exploratory and applied research that will blaze new frontiers in stereo-chemistry. Much of the research work has to do with catalysts, substances which help promote chemical reactions.

For example, specialists in stereo-chemistry at Esso Research and Engineering Company have analyzed and tested more than 500 different catalyst combinations. They expect to try out hundreds more during the next few years.

Many other companies in the fields of chemicals, rubber and petroleum are active in stereo-chemical research. A representative cross-section of leading names would include Du Pont, Hercules Powder, Montecatini, Firestone and Phillips Petroleum.

Stereo-chemistry is part of a broad area of technology that deals with the arrangement in space of the various atoms in molecules. It is possible, for example, to link small molecules in a chain to make a giant molecule. This process is called polymerization and the end products are known as polymers. The plastics polyethylene and polypropylene are examples of polymers. They are made from the gases ethylene and propylene which are among the products of petroleum refining operations.

In a stereo-chemical reaction, the new giant molecular chain builds up with regularity and precision. Each link or repeating unit of the chain has the same composition and three-dimensional structure. Such polymers are called stereo-specific, hence the name stereo-chemistry.

One of the keys achieving this precise molecular order is a family of catalysts containing certain metallic compounds, usually titanium and aluminum. Great impetus was given to stereo-chemical research in 1954 when the work of Dr. Carl Zeigler of Germany in polymerizing ethylene with metallic type catalysts became known. During the past five years, many advances have been made in this country and abroad.

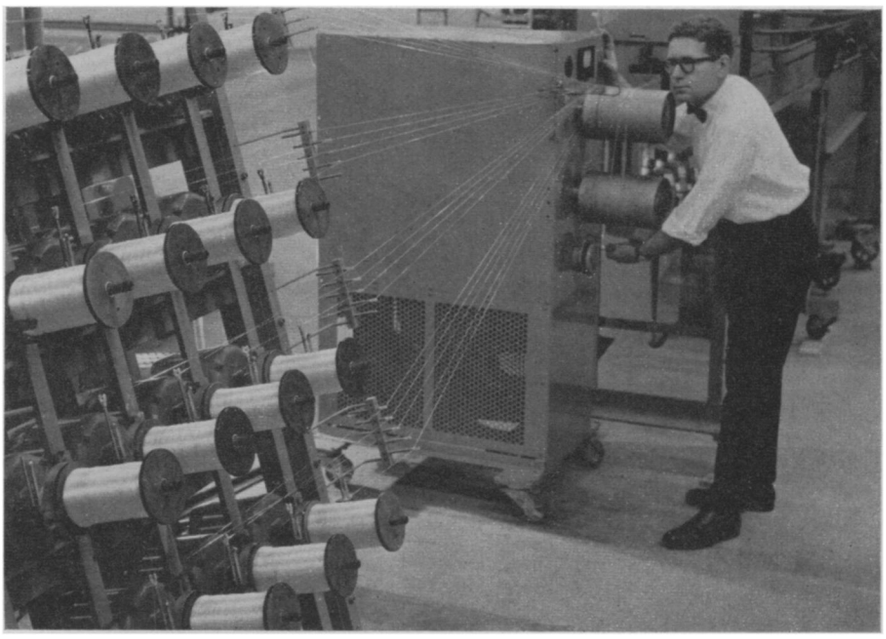
The qualities of a giant polymer can vary widely depending on its molecular structure. For example, polypropylene turns out to be formless, flexible and of limited usefulness if its molecular structure is allowed to build up in a random, unordered way. However, it becomes a tough, rigid and crystalline plastic if the polymer build-up is specific, well-ordered and carefully controlled.

Similarly, seven different types of polymers can be made from butadiene, another hydrocarbon gas, simply changing the type of catalyst complex used. The different polymers range from hard resins to liquid chemicals.

Much evidence has been gathered to explain how a catalyst gets its job done in a stereo-chemical reaction. One theory holds that the catalyst acts as guide and shaper for the smaller molecules. The new giant molecular chain grows from the surface of the catalyst in a manner that is comparable in principle to cake icing extruding from a pastry tube in a constantly recurring, specific pattern.

But the chemical researchers are far from satisfied with the amount of knowledge so far accumulated in this field. They would like to know a great deal more about the "hows" and "whys" of stereo-chemical reactions so that even tighter control can be gained over molecular structures.

The proving of a stereo-chemical reaction



PLASTIC STRANDS PROCESSED—Thin strands of polypropylene are examined at the Esso Research Center in Linden, N. J. The strands are extruded and then passed through an oven where they are heated and stretched. This tends to line up molecules and increase strength and toughness of the material. Strands such as these can be used as fibers in a number of useful products, including ropes, webbing for lawn furniture and automobile seat covers. Research in stereo-chemistry has enabled the development of a polypropylene plastic that combines the advantages of high strength, high rigidity, lightness, resilience and hardness.

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in the laboratory is only the beginning of the research and development story. A thousand engineering headaches must still be encountered in coming up with a full-scale commercial process that will be economical and efficient.

Are proper molecular weights being obtained? Can the correct polymerization rate be maintained? Is there a fouling problem in the reactor? Are traces of catalyst finding their way into the product?

These and many other questions must be answered. Often a catalyst that worked well in the laboratory will have to be thoroughly revised before it will work well on an around-the-clock basis in a big petrochemical plant.

However, problems—from basic reseach to engineering headaches involved in designing a continuous process—are being solved, and technical men are confident that important progress will continue to be made in stereo-chemistry.

As one Esso Research chemist put it: "The more research we do, the more convinced we become that the horizons are virtually limitless."

The examples given in the following list of major plastic types are illustrative of the principal kinds of materials included in each type. The examples are not comprehensive. In some cases, a complete list would involve hundreds of different types of materials.

Cellulose Plastics: cellulose acetate, nitro cellulose.

Formaldehyde-Containing Resins: phenolics, urea, melamine, polyformaldehyde.

Polyester Resins: Dacron and numerous compounds for laminate use.

Polyolefins: Polyethylene, polypropylene, polystyrene.

Vinyl Resins: polyvinyl chlorides, polyvinyl acetate, polyvinyl alcohol, acrylic polymers.

Polyamides: Nylon 66, Nylon 6.

Science News Letter, December 12, 1959

Questions

ASTRONOMY—What is the significance of finding water vapor in the atmosphere of Venus? p. 395.

GEOPHYSICS—What is the extent of the inner radiation belt surrounding the earth? p. 399.

MEDICINE—How many persons die annually from lockjaw compared with the polio fatalities? p. 400.

PHYSICS—What is the lifetime for hypernuclei? p. 394.

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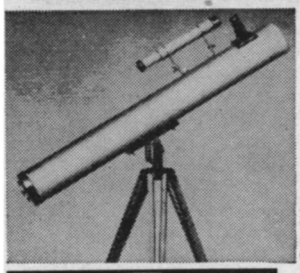

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