LETTER FROM TOKYO

Pushing radiation chemistry

The Japanese are striving to make irradiated plastics a commercial success

by Stuart Griffin

Japan's nuclear industry is still fledging. Nuclear power generation will reach 1.3 million kilowatts next year, and Japan only this year has made some progress in the process for making enriched uranium (SN: 7/12, p. 29). Nevertheless, Japan is moving forward and is even ahead of schedule.

One area of considerable progress is that of radioactive isotopes.

The focus for the Japanese isotope work is the 15-year-old Takasaki Radiation Chemistry Research Center of the Japan Atomic Energy Research Institute, 65 miles northeast of Tokyo.

One of the products of its five-year, industry-oriented research and development program, using cobalt 60, is a radiation-produced polyethylene that the Japanese say has exceptional properties. Polyethylene is the most widely used of plastic materials, and is normally produced by chemical and thermal reactions.

The Japanese bombarded ethylene gas with gamma rays to produce what they say is a new type of polyethylene. It is produced at normal temperature in ultrafine powder form. The plastic has two notable features: The products are purer, in that they are free of the catalysts used in conventional production methods, and the fine powder has greater absorbency.

The advantage of having it in powder form is that it can then be easily rotomolded into a container, an important application since polyethylene is the mainstay of the packaging industry. In rotomolding, the powder is heated in a metal tube, where is melts on the walls. The tube is removed after the polyethylene sets, leaving a container in the shape of the tube.

Because it is powdery it offers other possible advantages, such as easier handling and transportation as well as easier dyeing.

Polyethylene is also made in powder form in the United States. Union Carbide, a large supplier, has looked into the irradiation process, but, says Carbide's Dr. J. E. Potts, "We haven't found sufficient incentive to go into this radiation approach. We've done a little experimental work, but it doesn't make a different product."

Dr. Potts believes that because of the cost of isotopes and the safeguards that must be employed, the manufacturing expense will be greater. If the Japanese have not reduced costs, this could kill the process commercially.

Using conventional methods, the cost of polyethylene is very low, bouncing between 10 and 26 cents a pound; irradiation would have to compete with this figure.

The cause is helped somewhat, though, by a present increase in polyethylene demand and no corresponding increase in output capacity. The net result is an upswing in price expected in January.

"What is clear," notes the research center director, Dr. Shoichi Sawayanagi, "is that with the progress of atomic power generation in Japan and elsewhere, radiation resources will become quite cheap in the future and abundant stockpiles of spent nuclear fuels will serve as a treasurehouse of radioisotopes."

Dr. Potts also points to another problem with irradiation. Extremely pure polyethylene has its greatest use as an electrical insulator. But the irradiation process causes the formation of free radicals. These free radicals are very active and react with oxygen to form peroxides, which in turn destroy insulating properties.

One problem the Japanese appear to have solved is the difficulty of removing the polyethylene from the reactor, something which was plaguing the U.S. Atomic Energy Commission's Brookhaven Laboratory when it was working on polyethylene irradiation.

Another plastic being studied at the center is polyvinyl chloride, which is Japan's most widely used plastic resin. A problem with PVC is that it is weak. To improve its impact resistance, the Japanese have irradiated it with cobalt 60 in order to combine it with the rubbery butadiene (SN: 7/5, p. 10).

They have also gone into the textile area and applied irradiation to the grafting of styrene, a thermoplastic, to cellulose. In grafting, a polymer is grown on a pre-existing backbone. The result is a material with greater wear resistance and permanent press capability. Problems arose, however, in the consumer area. Although the product was technologically a success, it lacked appeal in radiation-sensitive Japan.

The reason for the emphasis on plastics and textiles is that these materials are large polymers, which are more sensitive to radiation than other substances. But future research and development will extend to other materials.

Undaunted, the Japanese intend to maintain their momentum in the field of polymer irradiation, says director Sawayanagi.