Meetings

Polymers: Thermal Stability

The increasingly important area of polymer stability research was discussed and reviewed at a symposium on thermal stability of polymers, held at the Battelle Memorial Institute in Columbus, Ohio, on 5–6 December. Mechanisms of thermal degradation and stabilization of polymers were the two main topics of discussion.

The lectures by N. Grassie (University of Glasgow), H. H. G. Jellinek (University of Windsor, Windsor, Ontario), J. H. Golden (Ministry of Aviation, England), and E. Steininger (Battelle Memorial Institute, Frankfurt, Germany) gave special significance to the international aspects of the event. These men have contributed greatly to the understanding of the true universality of thinking on the fundamental aspects of the thermal stability of polymers. Of the many excellent papers and discussions, only a partial account can be given.

In his paper on the thermal and photochemical degradation of polymethacrylates, Grassie showed that poly (alkyl) methacrylates generally give almost quantitative yields of monomer under ultraviolet irradiation, but only polymethyl methacrylate does so thermally. On the other hand, poly (tert-butyl methacrylate) thermally degrades quantitatively to isobutene and polymethacrylic acid; the latter product subsequently breaks down further. This reaction can be explained mechanistically in terms of a competition between depolymerization, as in the case of polymethyl methacrylate, and ester decomposition, as in poly (tert-butyl methacrylate).

The reaction kinetics of the thermal degradation of polymethyl methacrylate in a closed system were described by J. E. Clark and H. H. G. Jellinek. Two main degradation reactions are operative. The energies of activation for these reactions do not vary with polymer chain length in accordance with what is to be expected from the usually assumed depolymerization mechanisms. The termination reactions are controlled by diffusion.

In his work on phenol, furan, and urea-based condensation polymers which are degraded in an air environment, R. T. Conley says oxidation occurs primarily through activated methylene linkages common to condensation polymers. Data on activated methylene oxidation indicate that phenolics might be useful for oxidative stabilization of vinyl polymers. The results also show the course of char formation which is important in thermal protection systems based on ablation, and indicate that curing of phenolic resins by vacuum at high temperatures yields new phenolic polymers which resist oxidation.

Investigations of the thermal stability of blends of polyvinyl chloride and chlorinated amorphous polypropylene lead G. A. Grode, W. R. Dunnavant, R. W. Pfeil, and J. W. Brasch to conclude that the chlorinated amorphous materials exert a thermal stabilizing influence on polyvinyl chloride. In addition, the chlorinated product is much more resistant to oxidative degradation than is the nonchlorinated polypropylene.

Polymers reported on by C. S. Overberger, S. Ozaki, and H. Mukamal were shown to have a ladder structure to at least approximately 90 percent. The polymers prepared from polyvinyl isocyanate or *N*-vinyl-1-nylon are not outstanding in respect to thermal properties and begin to degrade, as judged by weight loss, at about 350°C.

Carborane polymers prepared by J. Green, M. M. Fein, F. J. Loprest, A. Lum, and N. Mayes showed thermal stabilities up to 400° to 500°C. The carborane polyesters and polyacrylates were generally no more stable than the organic analogues. Carborane-siloxane polymers, however, exhibited thermal stabilities in excess of 400°C and are fusible and soluble in organic solvents and thus are useful polymers.

E. Steininger and M. Sander have investigated the thermal stability of many polymers containing phosphorus linked to carbon. The polymers have high contents of aromatic groups and lack beta-hydrogen atoms; both are factors that contribute to thermal stability. They concluded that purely aromatic phosphine oxides carrying phenyl or methyl radicals as side chains and phenyl groups as bridge members would be the most stable polyphosphine oxides.

R. G. Heiligmann and P. B. Stickney were general cochairmen of the symposium. The dinner speaker at a banquet held on the first day of the symposium was Dr. Wallace R. Brode, who spoke on "Ceilings on the supply of scientists and engineers." The chairmen of the four sessions, V. T. Stannett (Camille Dreyfus Laboratories), E. L. Kropa (Battelle Memorial Institute), F. H. Winslow (Bell Telephone Laboratories), and I. J. Goldfarb (Wright-Patterson Air Force Base), were most effective, and much of the success of the symposium was due to their guidance.

P. B. STICKNEY

Battelle Memorial Institute,
Columbus, Ohio, 43201

Geology and Trace Elements: Relation to Nutrition

The interdisciplinary aspects of the relation of geology and trace-element distribution to nutritional problems were discussed in a symposium at the annual meeting of the Geological Society of America in New York City on 17 November 1963. The symposium was attended by 300 scientists from such varied fields as geology, agronomy, zoology, botany, nutrition, and animal and human medicine.

Harry V. Warren (geologist, University of British Columbia) stressed that those who suggest the possibility of human health being linked to geology must steer a treacherous course between overenthusiasm, misleading optimism, or distorted presentation and the equally disastrous overcaution that prevents cooperation between scientists of different disciplines on whose combined knowledge success depends. As people live longer, there is a corresponding increase in degenerative diseases, some of which may be caused or enhanced by imbalances of one or more trace elements in the environment. As an example, Warren described a tie that has been found between the