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

high lead content of rocks and soils and the incidence of multiple sclerosis in 24 areas of England.

W. H. Allaway (U.S. Department of Agriculture) reported on a recent discovery that a deficiency of selenium (less than 0.1 part per million in the dry weight of forage) causes white muscle disease in lambs and calves. Areas of selenium deficiency and toxicity are being mapped by animal nutritionists. A possible connection with the incidence of muscular dystrophy in humans is being investigated by at least one government agency.

The deficiency problems in Florida that are related to the availability of iron, copper, molybdenum, and cobalt to plants and the effect of these elements on nitrate and potassium contents were described by H. C. Harris (agronomist, University of Florida). Such areas in Florida have been related to salt sickness in cattle and to anemia and bone deformation in children. This situation is being alleviated by adding minor elements to the soil.

Trace-element studies in New Zealand in areas of marked difference in the incidence of dental caries were described by F. L. Losee (U.S. Navy). Areas with soils that have a high *p*H and $CaCO_3$ content produce vegetables with more molybdenum and less manganese, and there is a lower incidence of dental caries. This work was corroborated by W. B. Healey (New Zealand) who described recent experiments in feeding molybdenum and manganese to twin lambs.

Hans T. Shacklette (U.S. Geological Survey) showed that the difference in iodine content in plants is an inherent characteristic of the taxonomic group. A given species thus has a characteristic range within which a secondary relation with the environment can occur. The iodine content ranged from 2.7 parts per million dry weight in deciduous trees to 1435 parts per million in brown algae. The iodine content of Spanish moss, an air plant (described by Shacklette), and the differences in humans (described by R. L. Voight, U.S. Public Health Service) indicate that both animals and plants absorb considerable amounts of iodine from the atmosphere.

Maps of the United States that showed areas of trace-element deficiency and excess and also of disease incidence pointed up the geographic, geologic, and soil relationships and suggested the need for compiling maps that would indicate the distribution of trace elements in ground water, geologic strata, soils, and plants.

J. E. Banta (U.S. Public Health Service) discussed the problems of an epidemiologist in correlating trace-element differences with evolutionary chronic diseases, in defining the population at risk, and in defining the particular geochemical unit related to the disease pattern. Me made a strong plea for cooperation between the geochemist, geologist, and epidemiologist.

Several participants proposed the establishment of a trace-element institute or repository for trace-element information accumulated by workers in many fields. This proposal was considered premature at this time. A tentative decision was made to continue the group under the auspices of the Geochemical Society and the Geological Society of America, but to meet with other health groups and scientific societies in alternate years. Those who are interested in receiving notices of publication of the papers or in participating in further group activity are invited to contact any member of the committee. Members of the committee include Helen L. Cannon, U.S. Geological Survey, Denver, Colorado; Homer K. Hall, U.S. Public Health Service, Columbia, Missouri; Harry V. Warren, University of British Columbia, Vancouver; Michael Fleischer, U.S. Geological Survey, Washington, D.C.; and John Fortescue, Canadian Geological Survey, Ottawa, Ontario.

HELEN L. CANNON
U.S. Geological Survey,
Denver, Colorado

Forthcoming Events

February

19–21. American **Educational Research** Assoc., Chicago, Ill. (J. R. Gerberich, 1201 16th St., NW, Washington, D.C.)

19–5. Pan American **Medical** Assoc., 39th congr., the Americas, during a cruise aboard the S.S. *Independence.* (J. J. Eller, 745 Fifth Ave., New York, N.Y.)

23–27. Technical Assoc. of the **Pulp and Paper** Industry, 49th annual, New York, N.Y. (TAPPI, 360 Lexington Ave., New York, N.Y. 10017)

23–28. **Otorhinolaryngology and Bronchoesophagology,** 9th Pan American congr., Bogota, Colombia. (C. M. Norris, 3401 N. Broad St., Philadelphia, Pa.)

24–25. Atmospheric Movements of **Radioactive Materials,** Geneva, Switzerland. (World Meteorological Organization, Geneva)

24–25. **Writing-Improvement** Programs for Engineers, seminar, New York, N.Y. (C. A. Meyer, RCA Commercial Engineering, Harrison, N.J.)