detail is given. The value of some of these techniques is not limited to their use in protein structure and this section will prove extremely useful to those interested in modifying highly intractable proteins, *e.g.* membrane constituents.

A very long article on the use of fluorescent measurements dominates the final section on the investigation of conformational changes. Variations in the fluorescence of proteins give useful information but the length of this article is quite out of scale with the space given to the other topics in this volume. There is an interesting article on the dialysis and diffusion properties of proteins together with others on acid-base titrations, susceptibility to proteolysis, reporter groups and general aspects of immunological techniques.

Inevitably in such a large compounded volume, one can find faults and unevenness in the treatment of the subject matter. Perhaps the most practical drawback to the book is the not very obvious crossreferencing between the various sections and also other volumes in this series containing relevant and related data. It is pointed out by the editor of this volume that the contents have been controlled to some extent by the presence of relevant material in other volumes, thus this volume in itself is not a comprehensive collection of appropriate techniques. However, with its companion volumes it is a very valuable compendium of information.

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Analytical Gel Permeation Chromatography, edited by JULIAN F. JOHNSON AND ROGER S. PORTER, Interscience Publishers, New York, 1968, 343 pp., price 135 sh.

Analytical Gel Permeation Chromatography is the twenty-first volume of polymer symposia published as Part C by the *Journal of Polymer Science*. As in previous issues, the volume is a collection of papers which were presented, upon invitation, at a polymer symposium devoted to a narrow field of current polymer research. The symposium in case is the first American Chemical Society sponsored symposium on Gel Permeation Chromatography (GPC), held in Chicago, Illinois, in September, 1967.

The collection of twenty-seven papers represents a significant fraction of the present and rapidly expanding world literature on GPC. It provides the reader with insight into a diverse research situation which reflects the rapid growth and wide acceptance that the relatively new technique has experienced.

It is in the nature of any compilation of research papers that the reader is offered little in the way of background, context towards related research and critique. Such a volume, moreover, lacks fluency in content and style. However, the situation here has been relieved through the inclusion of J. C. MOORE's personal as well as historical account of his GPC research and through an attempt to list the papers with the subject matter following the theoretical to practical trend. On the other hand, the

book makes immediately available today's important GPC research results and will, therefore, be of greatest value to the GPC expert.

Gel Permeation Chromatography is a separation and analytical characterization technique which has experienced spectacular growth within the last five years, particularly in its application to polymer characterization. The first paper gives the reason for this development. In it, J. C. MOORE recounts his early GPC research from his work on polystyrene gels to his association with Waters Associates, from which resulted the first commercial and most widely used chromatograph. It also explains why present GPC practice is so highly oriented towards polystyrene column packings and differential refractometer detectors.

The following ten papers deal with the mechanism and interpretation of the chromatographic process. The relationship between chromatographic zone spreading, separability and calculated polymer dispersity is covered. The term "resolution" is defined and formalized, and the extent of fractionation of different species is predicted. The effects of gel pore size and of solvent velocity on separation efficiency is discussed.

One outstanding advantage of GPC over other techniques is its ability to yield average molecular weights and molecular weight distributions from measurements on the chromatogram. A rigorous approach requires that correction for chromatographic zone spreading (axial dispersion) be included. Several computational methods have been advanced to do just that. PIERCE AND ARMONA's paper points out ways of overcoming the practical difficulties in applying the mathematically complex methods. PICKET *et al.* describe a chromatogram "reshaping" method which is based solely on the GPC behavior of narrow molecular weight fractions without making assumptions about the separation process or the specific chromatogram shapes of monodisperse species. From a separate evaluation of the four available correction methods, it was concluded that all methods have merit but that they, not surprisingly, fail in the high molecular weight region where concentration effects, residence time and species interaction constitute their severest test.

The search for alternate and improved column packings and column effluent detectors, as well as for separation scale-up, has been reported on in a number of papers. Two presentations alone evaluate the analytical GPC potential and physical characteristics of porous silica beads and porous glass packings. Flow-through infrared detectors are described which are found to be more sensitive to mass and less sensitive to temperature and pressure than the refractometer detector. Commercial GPC equipment is described which is capable of both analytical and preparative separations.

The growing interest in applying the technique to small-molecule separation is represented by an extensive study on polynuclear aromatic hydrocarbon materials. The application of GPC to the determination of molecular weight and molecular weight distribution of several polymers, including polypropylene, cellulose, carboxy-terminated polybutadiene, and to commercial formulations, such as oil extended elastomers and surface coating vehicles, is described. Three papers are concerned with the measurement of radiation crosslinking, unsaturation and branching in polyethylene. GPC was also found valuable in guiding polymer synthesis activities.

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