93 Advances in Polymer Science

Polymer Processing

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Editors

Editor's Foreword

Processing of polymers is one of the most important and rapidly progressing industries the theoretical basis of which is gaining respect. Plastic processing technology and the development of the relevant equipment can not be considered today merely as a set of empirical approaches employed to manufacture high-quality products. Such approaches would mean a "retreat" and a reduction of activities in this field to mediocrity and enclose the process within the framework of just an accumulation of skills and knowledge about "standard" cases of manufacturing experience.

The fact is that, in the long history of polymer processing, engineering and design has always been ahead of theory. The development of screwless (or disc-type) extruders, innovative for their time, on the basis of the earlier-discovered normal stress effect (which received the name of the Weissenberg effect) was, apparently, one of the few exclusions. However, this example has clearly demonstrated the potential and the role of theoretical research in the progress of technology.

The situation in the field of processing has been changing during recent years. A number of research projects have contributed to the development of theoretical premises not only for the intensification and optimization of the known processes but also for development of new technologies and products. This can be easily exemplified: successful studies of the orientation crystallization of polymers have provided a basis for the commercial production of superstrong materials (fibers, films, etc.); data on changes in the structure and mechanical properties of polymers under extrusion have been used to develop the technology and equipment for manufacturing of film threads and fibers (including the fibrillated ones); development of the composite shear theory and demonstration of the possibility of reducing the viscosity of melts and intensifying their flow when the polymer is in the combined-stress state occurring at low- and high-frequency oscillations (vibrations) of the molding tool have stimulated the search for designs of machinery with an increased molding rate attained on the basis of the above mentioned effect; development of mathematical models of many operations and processes, generally, has become an inallienable part of the automatization and computerization of the modern production lines; finally, the theory has provided a reliable basis for computer-aided engineering of the main working elements of extruders, casting machines, extrusion heads, and molding tools.

The list of similar achievements could easily be extended but even the above cited examples are sufficient to conclude that the further progress of polymer processing depends strongly on the successful development and improvement of the theoretical basis of technology. We hope that this publication will make a practical contribution to the elimination of the still-existing gap between "science" and "technology".

Certainly, it is impossible to review all the new developments in polymer processing in one book even if we limit ourselves to the short period of the last 5–10 years. This, however, had been planned neither by the publisher nor by by the editor. We have collected under one cover four reviews every one of which, we believe, illustrates different routes of the progress of scientific knowledge in the sphere of polymer processing and demonstrates various stages in the development of this knowledge and its practical application.

Thus the review on the problem of molten polymer extension (M. L. Fridman & V. D. Sevruk) describes not only achievements of the theory and experiments but also new approaches to estimation of the quality of thermoplastics on the basis of melt extension tests under constant-force conditions. During the next few years we may expect development of new instrumentation and standard procedures for testing raw materials used to manufacture films, fibres, etc. In other words, these data are available for practical application and it is high time we took advantage of them.

Another review on the problem of polymer molding under vibration effects is, in our view, fundamentally important. The idea of this publication is not only to analyze and generalize results of combined-shear studies but also to attract attention of experts to the two latest achievements: theoretical and experimental corroboration of the efficiency of physical effects upon molten polymers in molding processes, and discovery of a new phenomenon — acoustic cavitation of molten polymers — which had not been predicted by the cavitation theory for fluids with a viscosity that high. Practical applications of this effect in manufacturing technologies have still to be developed. However it is clear right now that it has a high potential, since the melt cavitation conditions permit us to adjust the melt's rheological properties, to attain "dosed" mechanical destruction, excite active radicals in the polymer, disperse fillers, make new mixtures and alloys of polymers. We believe that the effect of acoustic cavitation opens a possibility of creating a new branch of plastic processing. However its present status leaves room for improvement: the effect has been discovered and extensive scientific information is available, but it lacks the technology, or a number of technologies, which could be developed on that basis. We expect that these technologies will be characterized by low power consumption and high efficiency.

The situation is different in the case of processing of polymer materials at low pressure. Technology has been rapidly advancing in the sphere in recent years: centrifugal and rotary molding methods are widely used, the RIM-technology is generally accepted, polymer paste casting is used, etc. As regards the theory of the low pressure molding of polymer materials, it has not been completed so far and here we are facing again the situation when technology has leaped ahead of theory. We wished to demonstrate (M. L. Fridman, A. Z. Petrosyan, V. S. Levin, E. Yu. Bormashenko), using the example of a systematic review of the data on analysis and mathematical modelling of the casting of polymer pastes or plastisols, that science can provide a basis for automatization and optimization of the process, offer procedures for the analysis of optimum geometrical parameters of molding tools and temperature conditions of molding to be used by engineers and designers. An important point is that the developed approaches can be applied later to the analysis of the molding of low-viscous thermoplastics and other low-pressure processing technologies.

Finally, we suppose that the review on the aminoplastic granulation technology (V. I. Tunkel, M. L. Fridman) illustrates another level of the development of processing. The analysis makes it clear that the situation in this case is quite the opposite: a scientific basis of the granulation process is available but the optimum engineering solutions are still to be found. Therefore we have focused on the comparative analysis of machinery and equipment for the process. It should be noted that although aminoplastic nodulizing technology has been practically abandoned during recent years, the interest for this technology can be reanimated, apparently, due to the new engineering approaches.

Certainly, the above mentioned does not give a full answer to the question, why these four articles have been included into this collection. It is natural that they have been selected primarily with regard to the scientific and engineering interests of the editor (who is also one of the authors) and include works carried out during recent years together with junior colleagues.

In conclusion I wish to express my gratitude to Springer Verlag and, personally, to the Chemistry Editor Dr. R. Stumpe for granting us the opportunity to use a special issue of this much respected journal to disseminate our knowledge.

Moscow, October 1989 Professor M. Fridman

Table of Contents