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Polymerization - Review on Some Important Investigations

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ABSTRACT

Polymer engineering is specialized field which is taught as an elective to chemical engineering students in many universities. Fundamentals of polymerization, types of polymerization and other important aspects of polymerization are being studied. The models for these reactions are widely discussed and investigated. The current review is an attempt to provide insight into selected research papers on polymer related investigation.
Keywords: Optimization, simulation, copolymer, thermodynamic modelling, degree of polymerization.

I. INTRODUCTION

Chemical engineering is much diversified field. The core chemical engineering subjects like process engineering, heat and mass transfer, reaction engineering, process control, fluid flow operations are basic building blocks of chemical engineering related operations and process. The chemical engineering needs basic knowledge of some mechanical engineering subjects like thermodynamics and heat transfer, thermal engineering. The utilities like refrigeration, cooling tower, refrigeration and boilers are required for the operation of plant. Optimization and simulation of these operations is integral part of research in the chemical engineering [1-6]. The allied branches like food technology, biotechnology utilizes some specific inputs from fundamental chemical engineering [7-9]. The boiler operation and optimization is one such widely discussed area [10-12]. Similarly advanced membrane separation is one allied field [12-16]. Environmental engineering utilizes biological principles as well as chemical and physical principles [17-20]. Reactor optimization, operation utilizes knowledge of chemistry, mathematics and thermodynamics.

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II. POLYMERIZATION- REVIEW ON IMPORTANT INVESTIGATIONS

Emulsion polymerization was discussed in detail by Asua[21]. He discussed various fundamental aspects of emulsion polymerization such as initiators, propagation rate constants of acrylic monomers, processes involved in the formation of branched and cross linked polymers, microstructure modification by post reaction operations, the formation of particle morphology, and reactive surfactants. He also discussed process development and modeling. In the competitive market, the profit margin is reducing and environmental regulations are also becoming stringer. The low cost manufacturing process is key to many of these problems. Emulsion polymerization ensures consistent, safe, and environmentally friendly production. According to him, knowledge-based strategies that use the polymer microstructure can ensure the solution to the economical aspect of the polymers.

Billiet et.al. investigated step growth polymerization [22]. According to them, from last many decades the

academic and industrial research is involved in finding attractive synthetic pathways to introduce large contents of different reactive functional groups in several polymer classes. Their studies indicated that (copper catalyzed azide–alkyne cycloaddition), CuAAC was a straightforward and versatile technique for industrially relevant polymers. Ayres et.al. investigated peptide–polymer vesicles [23]. Their research was mainly on the vesicles prepared by atom transfer radical polymerization.They used peptide-based initiator for the atom transfer radical polymerization of methyl methacrylate to yield a well-defined ABA triblock copolymer. Kagiya and Izu carried out investigation on the kinetics of polymerization [24].They classified the polymerization according to the relative magnitude of the rates of the elementary steps. Four main types of polymerization were stationary polymerization with slow initiation, non-stationary polymerization with slow initiation, stationary polymerization with rapid initiation, and non-stationary polymerization with rapid initiation. They also discussed various classifications of polymerization. According to the change in the number of moles of the propagating species with an increase in the reaction time, they were classified as stationary and nonstationary. They used the term chain polymerization for the reactions where the number-average degree of polymerization is independent of the reaction time. They termed successive polymerization as the reactions where the degree of polymerization changes with an increase in the reaction time.

Blank and Janiak carried out investigation on the vinyl/addition polymerization of norbornene[25].Their review paper provided full account of work describing the transition-metal catalyzed vinyl or addition polymerization to polynorbornene from 2001 to 2008. They found that most of the activity studies of the majority of complexes towards various ligand or substituent effects were empirical. The nature of the active species needs to be studied in depth to have understanding on the activation mechanism. Gerdolle et.al. carried out investigation on the polymerization shrinkage and the microleakage of direct resin-based restorative materials[26]. They observed that the microleakage was significantly lower at the enamel margins than at the cementum margins. They also found that best sealing ability, as well as the lowest polymerization shrinkage was exhibited by the ormocer and the packable resin composite.

Korolev and Mogilevich discussed kinetic features of three-dimensional free-radical polymerization(TFRP) [27].They identified main kinetic features of TFRP in a series of systematic studies. They found that Oligo(acrylates) were very convenient oligomers for experimental studies. They also observed that for various structures, processes of TFRP for polyunsaturated oligomers had similar pattern. Almeidaet.al. carried out investigation on kinetic and thermodynamic modeling for styrene polymerization reactors [28].They developed mathematical model for the free radical polymerization of styrene. The model was aimed at predicting the steady-state and dynamic behavior of a continuous process. Emphasis of their studies was on the kinetic and thermodynamic models. They used cubic equation of state for thermodynamic data and applied mixing rule for the low pressure vapor-liquid equilibrium of polymeric solutions. Hammond has discussed step growth polymerization in detail [29]. He discussed various aspects of step growth polymerization such as types of monomers, kinetics and equilibrium considerations, closed vs. open systems.

III. CONCLUSION

The investigation by Asua indicates that in the competitive market, the profit margin is reducing and environmental regulations are also becoming stringer. The low cost manufacturing process is key to many of these problems. According to Billiet from many decades the academic and industrial research is involved in finding attractive synthetic pathways to introduce large contents of different reactive functional groups in several polymer classes. In many review papers the fundamentals, types and kinetic aspects of polymerization have been discussed.

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