Synthesis of Polymer Support by Suspension Polymerization - Effect of Initiator Amount on Polymer Properties

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Highlights

- Organic support has advantage of easy tailoring during synthesis
- Suspension polymerization is most widely used industrially for Polystyrene synthesis
- Monodispersity in the particle size and its distribution is most important in their synthesis
- Porous polymer with monodisperse particles has great advantages in catalytic applications

1. Introduction

Catalytic supports provide large surface area for dispersion of small amount of catalytically active agents. They are classified into two categories, organic (polymer resins) and inorganic (silica, alumina, zeolites, etc). Organic supports have low chemical and mechanical stability and lower surface area than inorganic supports still they are widely used in chemical reactions due to some promising features such as non-volatility, non-toxicity, recyclability, insolubility, easy separation of product, heat and solvent resistant. The major advantage of organic polymer as catalytic support is that its properties can be easily modified or altered during synthesis. The desired polymer support characteristics include good mechanical property and adequate thermal stability, readily accessible sites for anchoring potential active centers and limited solubility in reaction medium and these can be varied by changing different synthetic parameters e.g. initiator amount, crosslinker amount, type of porogen solvent, stirring speed and temperature. Various polymers are used as catalytic support for example polystyrene (PS), polymethylmethaacrylate (PMMA), polyvinyl alcohol (PVA), polyvinyl chloride (PVC), etc., among which polystyrene is most frequently used [1]. PS can be synthesized by the various techniques for example suspension, emulsion, dispersion, precipitation, seeded and microfluidic polymerization [2, 3]. Among all the existing techniques, suspension polymerization is the simplest and widely used in industry for the synthesis of porous polymer particles.

2. Methods

In the present work, PS polymer was synthesized by suspension polymerization. The aqueous phase was prepared by adding $CaCO_3$ and sodium sulfate in distilled water and organic phase was prepared by adding DVB, AIBN, styrene and toluene/n-hexane. Both phases were mixed and the reaction was carried out in a batch reactor at 60-90°C for 6-7 hr at 600 rpm followed by filtration and washing and subsequent drying at 60°C in oven [4]. PS beads were characterized by SEM, EDAX and CHNS which confirmed its formation, composition, surface morphology and topology.

3. Results and discussion

Three different samples were prepared by varying initiator amount i.e. (a) 0.5 wt %, (b) 1.5 wt % and (c) 2.0 wt% of monomer. Figure-1 shows the Scanning Electron Microscopy (SEM) and particle size distribution of these samples, which confirmed that 0.5 wt% contain monodisperse polymer particles and also there is no accumulation or elongation of the polymer particles, whereas 1.5 wt% and 2 wt% have polydispersity and accumulation of particles, which is usually not desired. Particle size analysis was done by sieving with different mesh sizes. The size range for these samples was 250-784 μm, 280-784 μm and 205-784 μm for 0.5 wt%, 1.5 wt% and 2 wt% respectively, while the size with respect to maximum weight fraction is 250 μm, 470 μm and 280 μm.

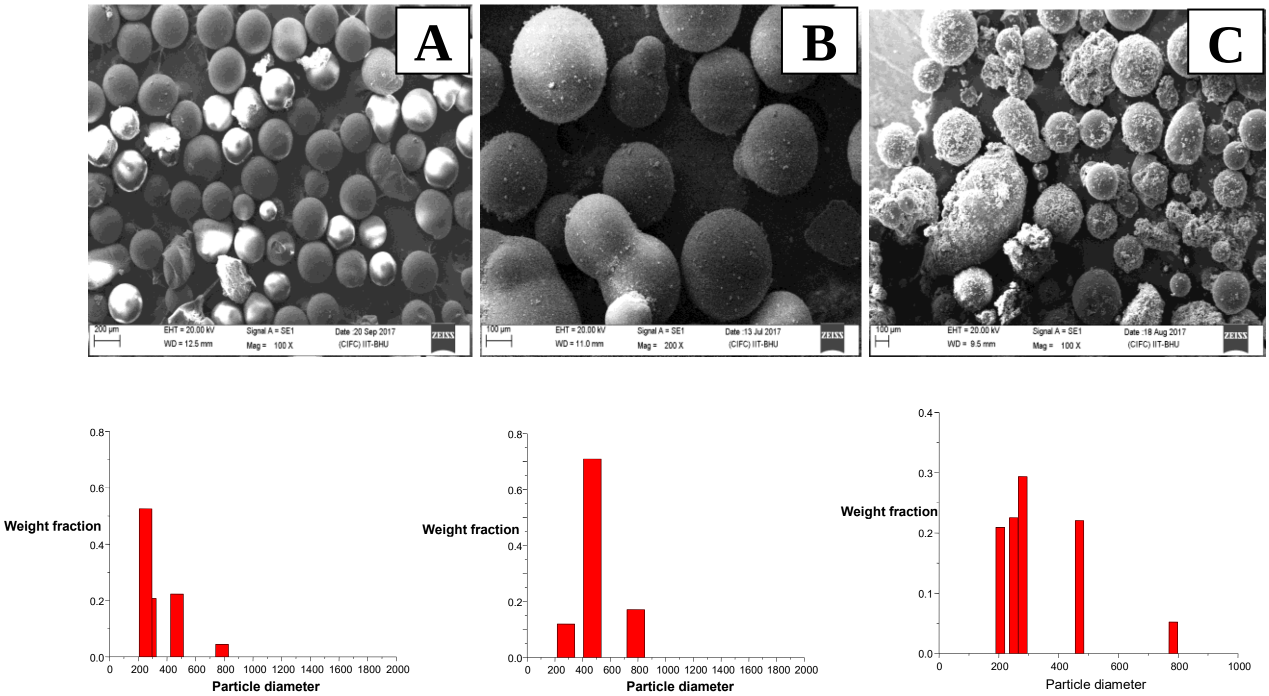

Figure 1. Scanning Electron Microscopy (SEM) of Polystyrene polymer prepared with initiator amount of (A) 0.5 wt%, (B) 1.5 wt% and (C) 2 wt% of monomer and correspondingly their particle size distribution

4. Conclusions

From the SEM and particle size analysis, it was concluded that first sample is more suitable for catalytic applications such as oxidation, hydrogenation and epoxidation reactions because it has uniform polymer particles with no accumulation and not very large particle size, which is desirable for a catalytic chemical reaction.

References

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Keywords

“Polystyrene”;”Suspension polymerization”; “Polydispersity”; “Oxidation”.