

Kinetic Of Butyl Acrylate-Styrene By Emulsion Copolymerization, Part II: Effect Of The Reaction Temperature And Initiator.

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1. Abstract

The influence of various parameters on the emulsion copolymerization kinetics of butyl acrylate (BuA) with styrene (Sty) mainly reaction temperature and initiator concentration has been studied.

The emulsion copolymerization was crosslinking with acrylamide and metacrylic acid, and were stabilized with a constant mixing of anionic and nonionic surfactants (1:1). For all systems, conversion increases when increase the initiator concentration, due to the radicals flux increase in the reaction systems. A higher rate of polymerizations in the system was observed when the reaction temperature was increase. The resulting latex is a complex mixture of macromolecules that were characterized.

2. Introduction

Polymer latex produced by emulsion polymerization of acrylates such as methyl methacrylate (MMA) and n-butyl acrylate (BuA) is used for paints and waterproofing. Anionic emulsifier such as sodium dodecyl sulfate (SDS) is widely used in industrial emulsion polymerization. However, polymer latex produced by emulsion polymerization with anionic emulsifier is not stable enough against addition of pigments. To increase colloidal stability of the latex, a mixture of nonionic emulsifiers, which stabilize particles by thermodynamically favored steric repulsion, and anionic emulsifiers, which stabilize particles with electrostatic repulsion, is often used in emulsion polymerization. The number of kinetic studies on emulsion polymerization using mixed anionic and nonionic emulsifiers is not so many. Chern et al. [1] and Lin et al. [2] studied the effect of a mixed emulsifiers system with a nonionic emulsifier NP-40 and the anionic emulsifier SDS on particle formation in the emulsion polymerization of styrene at 80°C. Suzuki et al. [3] studied the effect of a mixed emulsifiers system with NP-40 and SDS on particle formation in the emulsion polymerization of MMA at 50°C. In this study, we examined the effect of the rate polymerization increasing the concentration of the initiator potassium persulfate, KPS, and the reaction temperature with keeping the concentration of the mixing emulsifiers constant.

3. Experimental section

3.1 Materials

Water tridistilled grade deionizer was used in all experiments. The antifoaming, Foamaster, anionic emulsifier, Disponil AES 25M with 30% surfactant active, the nonionic emulsifier Disponil NP 30/70 with an average of 30 oxy-ethylene units and 70% surfactant active, all of COGNIS Company was used without further purification. The potassium persulfate, $K_2S_2O_8$ (KPS, from Fluka), the sodium bicarbonate from Aldrich, the Acrylamide from Aldrich and the m-Acrylic Acid (MAA) industrial grade were used as received. Monomers like butyl acrylate, BuA, and Styrene, Sty, industrial grade, were distilled under vacuum (75mmHg) before used. The BuA was washed with NaOH 2N 3 times and dried with $CaCO_3$ by 24h stored at 4°C previous distillation.

3.2 Emulsion copolymerization procedure and characterization

Emulsion polymerization was carried out at 70 and 80°C in a cylindrical glass vessel at 400 RPM. The recipes employed were: water, Sty, BuA, Acrylamide and MAA, using KPS (0.5, 1.0 and 1.5%), and the mixing ratio emulsifiers of AES 25M and NP 30/70 4% (1:1), all percentages in weight. At every certain reaction time, samples were withdrawn from the reactor for measurements of monomer conversion and FT-IR characterizations. Monomer conversion was measured gravimetrically. FT-IR characterizations were measured with a FT-IR Spectrometer Spectrum One from Perkin Elmer Company.

4. Results and discussion

Analysis of samples withdrawn at regular intervals allows the study of copolymers at various conversions shows that the monomers homopolymerize at similar rates. However, in copolymerization, BuA is always the more rapidly consumed. The resulting latex is a complex mixture of macromolecules, this were characterized by FT-IR. The emulsion copolymerization of Sty and BuA crosslinking with Acrylamide and MAA were conducted with various concentrations of KPS. For all systems, conversion increases when increase the KPS concentration, due increase the radicals flux in the systems of reaction, Figure 1.

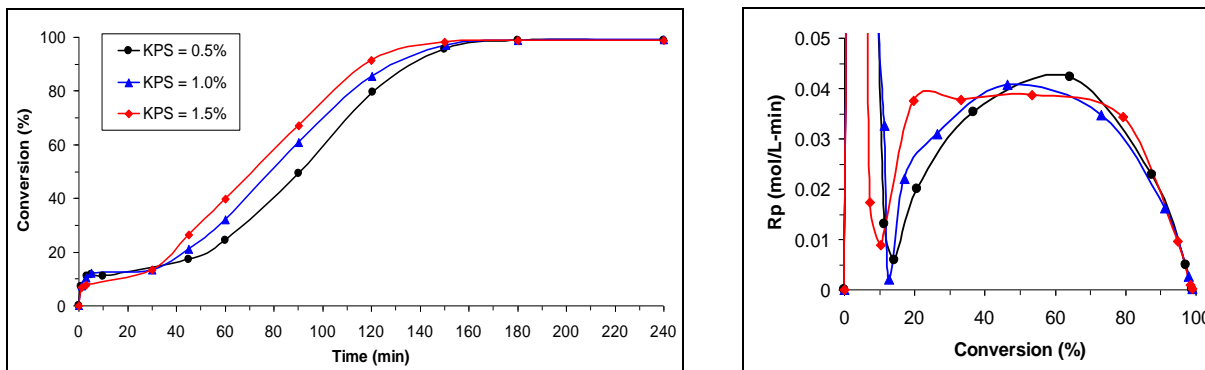


Figure 1. The emulsion copolymerization of Sty and BuA crosslinking with Acrylamide and MAA were conducted with various concentrations of KPS

The emulsion copolymerization of Sty and BuA were polymerized with different reaction temperature, Figure 2, using 1% of KPS as initiator. For all systems, conversion increases when increase the reaction temperature.

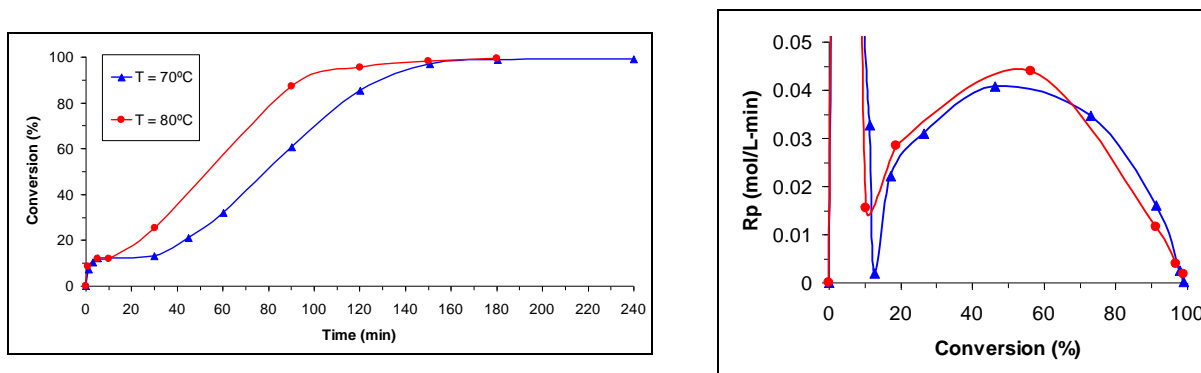


Figure 2. The emulsion copolymerization of Sty and BuA crosslinking with Acrylamide and MAA were conducted with different reaction temperature using 1% of KPS.

The emulsion copolymerization of Sty and BuA crosslinking with Acrylamide and MAA were characterized by FT-IR, Figure 3, we find bands by the Sty: 3060, 3027, 757, 698 cm^{-1} , and bands by BuA: 2956, 2930, 2872, 1726, 1245, 1156 cm^{-1} . In the Figure 3 show the copolymer have good properties to humidity.

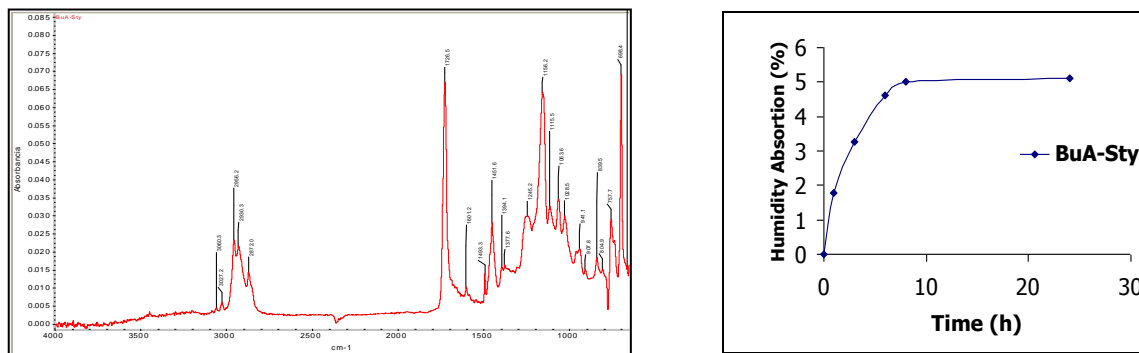


Figure 3. Spectrum FT-IR of copolymerization of BuA-Sty by emulsions polymerization with 1% of KPS at 80°C, and result of humidity absorption (%).

5. Conclusions

The increases of KPS as initiator increase the radicals flux in the systems of reaction and rise high conversation and rate of polymerization. When we increase the reaction temperature in the system increase the rate of polymerization, and we find good properties to humidity.

6. References

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- [3] Suzuki K, Wakatuki Y, Shirasaki S, Fujita K, Kato S, Nomura M. Polymer 2005; 46:5890.