

Polystyrene particle synthesis using two-step acoustic emulsification method

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1. Introduction – Emulsions are used in many industrial fields, and it is important to control the droplet size, because the property of products is influenced by droplet diameter and size distribution. Acoustic emulsification is known to be useful in preparation of nanoemulsions [1]. Moreover, nanoemulsions with droplet diameters of around 100 nm can be prepared by sequential ultrasonic irradiation from low to high frequency [2]. However, the effects of ultrasound on preparation of nanoemulsion has not been investigated well. In this study, oil in water emulsion system is prepared using acoustic emulsification and mechanical emulsification methods. We also investigate sequential emulsification process. Finally, the two-step emulsification method was applied to preparation of polymer particles.

2. Experimental - In this study, oil in water systems of toluene-water emulsion is prepared using acoustic emulsification and mechanical emulsification methods. We also investigate two-step emulsification method. Especially, we focused on the relationship between droplet size of crude emulsion and ultrasonic frequency in the second step. Finally, the two-step emulsification method was applied to preparation of polymer particles of polystyrene.

3. Results and Discussion – At first, effects of emulsification method on size and stability of oil in water systems of toluene-water emulsion was investigated, and acoustic emulsification method was found to be more suitable than mechanical emulsification method using a homogenizer. Next, two-step emulsification method was applied to preparation of toluene-water emulsion. Crude emulsion was prepared in the first step, and this crude emulsion was irradiated with ultrasound in the second step for various frequencies. The droplet size of emulsion was influenced by relationships between droplet size of crude emulsion and ultrasonic frequency in the second step. When the droplet size of crude emulsion was larger than 40 μm , ultrasound with low frequency around 20 kHz in the second step was effective for decreasing droplet size. On the other hand, when the droplet size of crude emulsion was smaller than 5 μm , ultrasound with high frequency around 2 MHz in the second step was effective. Finally, the two-step emulsification method was applied to preparation of polymer particles. In this study, styrene monomer was used as an oil phase. Styrene monomer containing initiator in water emulsion was prepared using two-step emulsification method. After preparation of emulsion, this emulsion solution was heated, and polymerization reaction was progressed. The diameter of synthesized polystyrene particle and the diameter of droplet of emulsion using two-step emulsification method were almost same. Thus, two-step emulsification method is considered to be useful technique for preparation of nano polymer particles.

4. Conclusions - Ultrasound is more suitable for emulsification than homogenizer. In addition, dynamic process operational method is applied to preparation of emulsion. The droplet size of final emulsion is influenced by the relationships between droplet size of crude emulsion and ultrasonic frequency in the second stage. The synthesized particle diameter of polystyrene was almost same as the droplet size of emulsion. Therefore, a two-step emulsification method was useful for preparation of fine polymer particles around 100 nm.

5. References

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