Development of Efficient Nano-particle Production Technology for Eco-Toiletry Goods

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1. Introduction

Recently, several attempts have been performed in order to reduce significantly GHG emissions by 2050. To qualify this target, it is crucial to reduce GHG in household section. In particular, it was reported that a shampoo emits the largest amount of GHG in toiletry goods including the time of use. To reduce the GHG emission, it is essential to design high functional goods as well as to produce it with high energy efficiency. Micro reaction technology is expected to satisfy the above two items by the attractive feature of rapid mixing. In this study, we tried to develop a new environmentally benign processing based on micro mixer for improving the functions of particles in a shampoo with high efficiency.

2. Experimental

Pearly sheen agents were produced by an emulsion crystallization method. The oil phase solution was prepared by mixing ethylene glycol distearate and polyethylene glycol monolauryl ether at equivalent ratio. Thus prepared oil phase solution was mixed with a 0.02 wt% aqueous solution of sodium dodecyl sulfate by the ratio of 1 to 9 using several types of micro mixers and a batch reactor. The emulsion formed by mixing was cooled to obtain the crystallized particles. The size of emulsion just after mixing was analyzed using a dynamic light scattering nanoparticle size analyzer (DLS). The size and shapes of crystals were measured by using an electron microscope (SEM) and DLS. We examined the effect of flow rate and structure of mixer channel on the crystalline structure was examined.

3. Result and Discussion

Figure 1 shows the SEM photomicrographs of the crystals produced by using the micro mixer and the batch reactor, respectively. The average size of crystals formed by use of the micro mixer was significantly smaller than that by the conventional batch method. The shape of the crystal formed by a micro mixing method is acicular; on the other hand, the particles formed by the batch reactor were aggregated and coarsened. This result clearly indicates that smaller and uniform emulsion can be produced by instant micro mixing and that the crystal particle can be independently grown without aggregating. At that time, the size and shape of crystals could be controlled by changing the flow rate and the channel structure of the micro mixer. In addition, the life time of suspension with fine particles was stable for a long term (Figure 2).

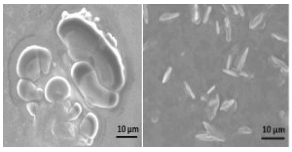

Fig. 1 SEM Image
(Left) Batch Reactor
(Right) Micro mixer

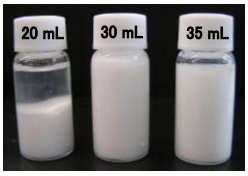

Fig.2 Effect of the flow rate on stability

4. Evaluation of Environmental Impact

We finally evaluated the product developed here by eco-efficiency index. The denominator of eco-efficiency index implying the environmental loading was the consumed energy of the all steps of the process. The numerator implying value of the product was adopted the specific surface of crystals. This micro chemical process could reduce 20 times the consumed energy of the conventional process, and the specific surface area of a new product was 2.4 times larger than that by conventional method. Based on these data, it was clarified that the micro chemical process gives us a methodology to reduce the environmental loading to one thirty-fourth.

5. Conclusion

We presented a new methodology to increase in the function of shampoo particles with save energy based on instant mixing by micro mixer. The product is sufficiently industrial level, and contributes eco-toiletry goods with low GHG emission.