Chapter 6
Summary

Elutriation of ground ocimum seeds powder was found to be a complicate system. Its phenomena was characterized by the nature of the powder and fluidization behavior.

Study on physical properties of ocimum seeds powder revealed that it composed of 3 different species, i.e., fraction of seed coat (250-840 μm), fraction of swelling substance (44-250 μm) and fraction of seed core (<44 μm). This powder has an average particle diameter of about 150 μm with true density of 1,525 kg/m^3 and bulk density of 638 kg/m^3 (ε = 0.54). By its nature, ocimum seeds powder is a hygroscopic substance, and under normal conditions, it possesses the moisture content of 10-15 % by weight. It was found that the separation efficiency decreased as the moisture content of powder was increased. The moist powder after being dried to the moisture content of approximately 5-6 % can be well-classified by fluidization. Furthermore, trial of combined drying and separating operation of ambient moist powder was also successful. Although there are 3 species of particles in this system, density of each species which is a main parameter in this process is found to be indifferent with approximately an average value of 1,400 kg/m^3.

According to nature of powder, it may be classified into Geldart's group A powder (ρ_s-$\rho_g \approx$ 1400 kg/m^3, average particle size of 150 μm). Fluidized system of ocimum seeds powder was considered to be three-kind powder bed type with multimodal particles at high concentration of fine or elutriated particles.

Fluidization of this powder in batch process was characterized by slug flow type at the beginning of opration, then normal bubble bed was in place. Superficial gas velocity was the main factor which influence the rate characteristics, however, bed hydrodynamics were also involved in this system. Only particles which superficial velocity was in excess of their terminal velocities were elutriated. Rate of intermediate particles was strongly affected by initial bubbling owing to slug flow, which resulting in the sudden drop down of curve. Freeboard of over 1 m high seem to produce little effect on rate of intermediate particles, but the rate was increased when height was lower than TDH. Elutriation of extremely fine particles were not effected by freeboard height, it might only depend upon superficial gas velocity as previously reported.

Regression analysis for rate characteristic curve found that it was deviated from first order correlation and was better fitted with

$$\frac{X_i}{X_{io}} = A + Be^{\beta t}$$

especially for intermediate-size group. This deviation was rationalized to be the effects of bed hydrodynamics as well as interparticle interaction other than gas velocity. Nevertheless, elutriation of extremely fine particles still followed first order rate relation despite its observed constant was much lower than the estimated value.

The elutriation rate curves in this study could be used as a guidance in designing of batch processing ocimum seeds powder classification equipment. One essential factor abandoned in this experiment is the type of distributor or distribution plate. In fact, mechanism of classification starts up when bubbles burst at the bed surface and eject into the freeboard zone. At this point particles will actually transport with their initial velocity. It was found that the initial particle velocity varies between 0 to 8 times the bubbles velocity. This velocity might be

related to the type of distributor, apart from the nature of powder itself. If one could control the initial particle velocity into a narrow range, the separation capacity would be improved. Another points is that the unexpected slug flow was unfortunately encountered in this system so that the freeboard height used in this experiment may not sufficient. It is recommended that further study should be explored on the effects of both distributor type and height of freeboard over 1.5 m.

Fluidization has long been known as the particle classifier, yet its practical application is limited by economic reasons and shortage of knowledge about its nature especially in multi-species bed. In this case owing to its nature of swelling powder, other method seems unsuitable except fluidization. Even though elutriation mechanism is quite difficult to be defined, its construction and operation are proved to be easy and simple. In addition, this method is even more powerful when combined with drying process in case of material that required both processing effects. It has also been shown to be economically worth in terms of the energy consumption aspect. In general, its application is suitable for materials with the following properties;

- multi-species powder, particles to be removed should be small in size and have a low density
- one specie powder, difference in size is the key factor

Ocimum seed powder employed in this study is one of a potential example in particles classification of powders with specific nature utilizing fluidization technique. It may, therefore, be the method of choice in dealing and handling with powders of some unique characteristics.