Modelling of Molecular Distillation for Tryglyceride-Fatty Acid Separation

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Molecular distillation, one of physical separation of free fatty acids (FFA) from triglycerides has gained much attention in edible oil industry. Both experimental and simulation approaches were done using falling film molecular distillation for the separation. A binary mixture of oleic acid up to 10wt%, as FFA with refined soybean oil as triglycerides were used. Effects of temperature from 110 to 160°C and FFA concentration on molecular distillation process were investigated. Feeding rate was 0.30 kg/h and pressure was maintained at 0.1 Pa. Evaporator length and surface areas were 0.16 m and 0.018 m^2, respectively. FFA removal behavior was characterized from the mass analysis and chemical analysis of FFA. Higher temperature caused more removal of FFA. FFA removal ratio depended on temperature, but did not depend on FFA content. In order to characterize the molecular distillation process, mathematical model was introduced based on mass conservation and transport phenomena, and differential equation was obtained. If the FFA content is enough small, analytical solution of the differential equation was obtained as simple governing equation for molecular distillation. This simple governing equation had experimental parameters of temperature and FFA content, equipment parameters such as length of evaporator and diameter of evaporator, and process parameter of molecular distillation coefficient, h*. The coefficient, h* could be obtained by one set of experiment. After getting the value of h*, simulations under all other experimental conditions were carried out. Good agreement was obtained in the all the data between experiments and simulation. This means that proposed governing equation can be applied to separation of triglycerides and fatty acid mixture at any conditions of temperature and FFA content up to 10%, in which prediction and optimization can be done for scaling up and industrialization. The proposed model was developed for FFA removal from vegetable oil, but it could be also effective for other systems such as tocopherol recovery from vegetable oils, and squalene recovery from olive oil and so on.