Modelling of a biomass supercritical CO_2 extraction process in a packed bed column.

Simulator for academic learning purposes.

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ABSTRACT

In this work a comprehensive study on the modelling of a supercritical CO_2 extraction process in a packed bed column was conducted. The aim was to develop a user-friendly Excel interface able to adjust the extraction yields and to simulate the dynamic concentration profiles inside the column. This free software is a useful tool for learning purposes. The model comprises non-stationary mass balances for the recovered compounds in both phases (solid and supercritical CO_2). These mass balances generate a set of partial differential equations, solved by discretisation dividing the length of the column in several finite elements, where the orthogonal collocation method was individually applied. The resultant set of ordinary differential equations was solved using 8^{th} Runge-Kutta's method. The model was tested by reproducing the extraction of two biomass samples: sesame seeds and coffee beans. These samples were specifically selected to demonstrate the feasibility of reproducing processes when the mass transfer limitation is very different. Thus, for the sesame seeds case study, the extraction process was controlled by both the external mass transfer and oil solubility, since the seeds should be grinded. If the seed is not grinded enough, mass transfer control changes at the end of the extraction and as a consequence the process is limited by internal diffusion. On the contrary, for coffee grains, the internal diffusion is always the main mass transfer limitation as the whole grain is required. Regarding solubility, a Henry's linear relation between solid and liquid concentration was assumed. In addition, the internal solid and liquid profiles were calculated to make easier to follow the process and to analyse how they are modified depending on the mass transfer restriction.

Keywords: Supercritical extraction, CO_2, modelling, sesame seeds, coffee grains.

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