Thermodynamic and mass transfer data for material processing using supercritical fluids

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Supercritical fluid-based technology has been largely proposed to produce materials with specific properties. One of the main industrial challenges is the adoption of sustainable technologies, development and scaling up of processes. Phase equilibria and reaction kinetics, verification of process steps and design of process sequences to produce a product from raw materials are the main hindrances concerning SCF applications. To select the most appropriate medium for a specific situation and its various applications, fundamentals of supercritical fluids, like thermodynamics of phase and chemical equilibria should be well considered for a particular system with SCF. Several methods have been well established to determine solubility, density, viscosity and interfacial tension for multi - compound systems at elevated pressures. Most of these methods require application of advanced equipment and may not be suitable for measurements in case of some aggressive substances, like corrosive gases. Therefore, there is a high potential in development of new, easier and quicker methods that offer the possibility to determine the fundamental data on thermodynamic properties.

For instance, carbon dioxide is quite soluble in many materials, such as polymers, thus it can be used as a solvent or plasticizer. Dissolved CO_2 causes a considerable reduction in the viscosity of the molten polymer, a very important property for applications like modification, formation of composites, blending, microcellular foaming, particle production and polymerization. Properties of obtained powder product like particle size, particle size distribution and morphology depend on phase equilibria and thermodynamic behaviour of the system, fluid dynamics, mass transfer and nucleation-growth kinetic. Detailed investigations on these data have to be carried out in order to fulfil consumer and economic requirements.

An overview of developed methods for determination of basic thermodynamic and mass transfer data and application of these data for design of different processes will be presented.