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Supercritical carbon dioxide: a powerful and life-sustaining solvent

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Industries, through applied research, have been looking for new alternatives aligned with the green chemistry principles, and provide efficiency, lower cost and sustainability of products and processes, by reducing/ eliminating the use and generation of potentially hazardous substances. Thus, attention has been directed to processes involving fluids in the supercritical state, which are potential substitutes for traditional VOCs in a wide range of applications, with supercritical CO_2 being the most widely used. Carbon dioxide is a solvent that has several properties that make its use feasible, among them the high availability, the low cost and the fact that it is non-flammable, non-toxic and recyclable, in addition to its moderate supercritical constants. Due to the properties of mass transport, low viscosity and high diffusivity, the supercritical extraction using CO_2 as solvent is the most exploited technique, mainly to obtain bioactive compounds from biomass, reaching industrial implanted applications. As the solvent strength of the medium can be easily altered as a function of the thermodynamic parameters and the low temperatures preserve the obtained compounds, several types of biomass have been used to generate extracts with high added value (SILVA et al., 2016). The supercritical extraction of emulsions has been used as an innovative method for the encapsulation of hydrophilic or lipophilic active substances in micro/nanometric scale with controlled size and morphology, being an easily scalable process (PRIETO and CALVO, 2017). CO_2 has also been tested as a solvent in a wide range of industrially important chemical reactions, such as alkylation, hydroformylation and hydrogenation, with good performances regarding reactivity and selectivity, and facilitating separation and recovery processes of products and catalysts (WAI et al. 1998). Also, processes for the production and processing of polymers using sc-CO_2 include polymerization reactions, polymer composites production, polymer particle production and foaming, some of them even used in commercial applications (BOYERE et al., 2014). Coupling processes involving sc-CO_2 also has been investigated as a feasible possibility for generation of clean energy (ZHOU et al., 2017; KIM et al., 2016). Despite the associated advantages, the use of carbon dioxide in the most diverse processes must always be in line with the recovery/ reuse of this gas, aiming to minimize emissions to the atmosphere. The use of membranes with high permeability and selectivity to CO_2 compared to other gaseous compounds is an alternative to recover up to 90% of the CO_2 of a certain process, with purity of 88% (BRUNETTI et al., 2010), and can be coupled to a system based on supercritical carbon dioxide to make feasible its applicability. The large availability of CO_2 tends to allow the adaptation of a huge range of processes, providing objective benefits with the application of green chemistry principles.

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