Membrane crystallization in an integrated process for CO_2 capture

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Abstract

Carbon dioxide (CO_2) capture and sequestration/reutilization has become one of the most urgent technological demands in order to reduce CO_2 emissions in a global context. Conventional technology is typically based on absorption using selective solvents, such as monoethanolamines, and a posterior desorption process using heat to release pure CO_2 and reuse the amines. However, this process presents strong limitations [1]: i) amine production is very energy intensive, which involves non-negligible CO_2 emissions; and ii) the desorption process requires energy, and again, we can expect CO_2 emissions associated to the production of the required energy. This means that even though CO_2 is capture in the site, it is also emitted somewhere else, decreasing significantly the overall CO_2 captured/CO_2 emitted. In this context, membrane technology appears as a promising technique to capture CO_2 and convert it into a valuable product.

In this work, a novel process based on a first step of absorption followed by a second step using membrane crystallization is presented [2]. A liquid phase containing a mass transfer promoter (i.e., enzymes or amino acids) is used to capture CO_2. After absorption, the (bi)carbonate solution is sent to the membrane crystallization unit so that the (bi)carbonate salts are produced. The mass transfer efficiency will be evaluated considering different membrane crystallization methods (i.e., osmotic membrane crystallization, direct contact membrane crystallization and vacuum membrane crystallization) and varying the operation conditions, such as feed velocity, temperature and vacuum. The effect of the presence of impurities will be also discussed. This process presents an alternative to conventional CO_2 absorption-sequestration methods in order to valorize the CO_2 while closing the carbon cycle.

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[1] P. Luis, Use of monoethanolamine (MEA) for CO_2 capture in a global scenario: Consequences and alternatives, Desalination, Volume 380, 2016, Pages 93-99.
[2] P. Luis, Continuous process and system for the production of sodium bicarbonate crystals. Patent filed on December 03, 2020 (EP 20 211 693).