Sustainable production of bio-butanol from wheat straw

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ABSTRACT

The usage of second-generation biomass is gaining more interest because it provides the opportunity to sustainably produce an important fuel using a bioprocess. Butanol is an important fuel because of its similar properties to gasoline and its higher energy density than ethanol. (Ranjan & Moholkar, 2012) The step towards bio-based processes and bio-based fuels is both important and advantageous due to the reduction in CO_2 emissions and other greenhouse gasses that are emitted primarily from the combustion of fossil fuel.

Using a systematic, hierarchal, 12 task approach for performing sustainable process design, a production process for bio-butanol utilizing wheat straw as raw material was designed and evaluated for producing 4,300 metric tons of bio-butanol (purity of 99.5 wt%) annually with a yield of 0.11 kg product per kilo of raw material. The reaction path considered for the production is the ABE fermentation with *C. beijerinckii* (Ezeji, Qureshi, & Blaschek, 2007). Two commercially by-products, acetone and ethanol, are produced during the fermentation reaction. These by-products are of importance because they can be sold as a chemical solvent and as a biofuel respectively (Ranjan & Moholkar, 2012). The fermenter outlet consists of a multi-component mixture of butanol, acetone, ethanol, water and minor amounts of acids. First, acetone and ethanol are separated from the mixture using distillation; acetone is then further purified. Second, butanol is separated from the broth and purified using azeotropic distillation. This design is used as the base case design that is evaluated for further improvement.

Using an economic analysis, targets are identified for process improvement related to heat integration and process optimization in order to reduce the process operating costs. The improvements up to this point are economic-based.

To achieve a more sustainable design, a LCA analysis (Kalakul, Malakul, Siemanond, & Gani, 2014) is performed to identify further improvement targets related to sustainability. These targets are met through the elimination and/or minimization of limitations in the process, identified from the sustainability analysis. The final design is a more sustainable, economic viable design. In this poster, the design method will be presented and the output from each step related to the production of bio-butanol will be given.

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