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Systematic procedure and framework for synthesis and evaluation of bioethanol production processes from lignocellulosic biomass

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Abstract

Bioethanol from lignocellulosic feedstock rises as a promising alternative to replace liquid fossil fuels in the energy market for the next years. However, the variety of available biomass combined with the necessity of possible pretreatments and their particular features make it difficult to clearly identify the favorable process routes. In this study a systematic approach consisting of seven steps was proposed to obtain possible and feasible alternatives for the conversion of lignocellulosic biomass into bioethanol. The method was exemplified with the aid of a general case study, from the biomass selection to possible by-products generation. The case study resulted in a corn stover based process to produce bioethanol through ammonia fiber explosion pretreatment. Following the systematic approach different alternatives were proposed to finally obtain the optimal flowsheet with a minimum ethanol selling price of 0.43$/kg of ethanol, 35.4% lower than the initial process.

Keywords: Bioethanol, Lignocellulosic Biomass, Process Synthesis, Process integration, Systematic procedure

1. Introduction

The biomass produced each year could generate about 161 EJ (10^{18} J) of energy considering a “food first” approach (Haberl et al., 2011). This value corresponds to 28.6% of our present energy intake and, currently, the renewable bioenergy share is merely 0.89% (Schiffer, 2016). This space for improvement can help reduce the greenhouse gas emissions and limit the global warming. Devoid