Simulation of a biorefinery process as learning tool in chemical engineering degree

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Abstract

Currently, the search for alternative biomass to be used as renewable sources for energy production is one of the most important challenges to achieve a sustainable growth based on a bioeconomy strategy (Mendes et al., 2009). In this context, lignocellulosic waste are a renewable, clean, inexpensive and with high availability for the manufacture of biofuels. In this sense, the main objective of this study was the simulation and design of engineering processes that allows the valorization of lignocellulosic waste and the obtaining of biofuels as alternative to fossil fuels. This goal implies the practical application of the theoretical knowledge acquired by the student during the chemical engineering degree. Specifically, the students designed and simulated a biorefinery process that consisted of a Kraft pulping process as starting point of two main lines of production: (1) Process I: production of bioethanol and (2) Process II: direct and indirect production of dimethylether (DME), both from lignocellulosic biomass (Fig.1). Two commercial simulation packages, ASPEN HYSYS® and UNISIM were used to simulate the production of dimethylether and bioethanol, respectively.

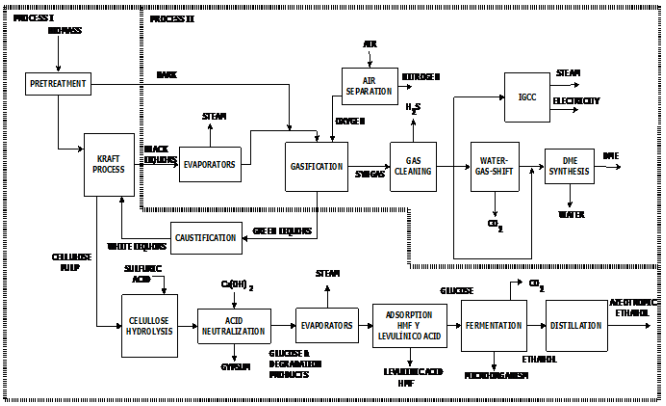

Fig. 1. Simplified block diagram for dimethylether (Process I) and bioethanol (Process II) production.

The first step was determining a strategic situation for the installation of the biorefinery. The central area of Andalusia (between the municipalities of Lucena and Antequera) was considered the most adequate area to develop the installation of the biorefinery plant after evaluating the biomass available inside of 100 kms of distance around this place. Specifically, different biomass mixtures were considered in order to ensure the viability of a constant inlet flow of biomass in the biorefinery. In function of this inlet flow of biomass, the installations were designed and dimensioned in each stage of the process. The student carried out a wide revision of state of the art to decide the most adequate processes among different alternatives to obtain dimethylether and bioethanol. The different stages selected as the most adequate in each line of the process can be observed in Fig.1. Moreover, the students evaluated the different alternatives for the valorisation and optimization of the by-products generated in each stage of the process in order to minimize the consuming of chemical compounds and energy requirements. Therefore, the students learnt to develop a real engineering process more sustainable and friendly with the environment.

To sum up, the used of programs to simulate the transformation of lignocellulosic biomass in biofuels, such as, bioethanol or dimethylether, which is a process with several social, environmental and economic advantages, was an interesting learning tool for students of chemical engineering degree.

Keywords

Bioethanol, design, dimethylether, Kraft pulping process, simulations.

References

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