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Optimal Planning of Sustainable Supply Chains for the Production of *Ambrox* based on *Ageratina jocotepecana* in Mexico

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7.1 Introduction

The perfume industry has shown great progress during the past years mainly due to the economic profit that this industry produces every year. The two main components of a perfume are fragrant oils and fixatives, the latter being the most expensive ingredient in a perfume (Fráter et al., 1998). Historically, the ambergris, which comes from some species of sperm whale, has been successfully used as natural fixative, being one of the most valuable raw materials bringing uniqueness to a perfume; however, the environmental implications (such as killing of endangered species such as the *Physeter macrocephalus*) of its use and high cost have promoted the development of synthetic alternatives to ambergris, which may be much more cheaply and reliably produced. Among all the synthetic substitutes, *Ambrox*® [(−)-8α-12-epoxy-13,14,15,16-tetranorlabdane] is the most widely used

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Optimal Planning of Distributed Systems of Refineries and Biorefineries Considering Pollution Trading with Forest Plantations

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Abstract

The production of fossil fuels to satisfy the energy demand has caused a drastic increment in the greenhouse gas emissions, which are associated directly with the global warming problem. Installing biorefineries is an interesting alternative to address this problem because biomass can capture CO_2 emissions during its growth. On the other hand, a new interesting approach to promote economic growth in low-income regions is through new eco-industries dedicated to cultivate trees and taking care of the forest. These forest plantations help to capture CO_2 emissions produced by petroleum refineries and biorefineries. Therefore, a system able to integrate production of fuels through refineries and biorefineries with the use of forest plantations to decrease the greenhouse gas emissions can be an attractive solution to significantly improve the environmental sustainability. However, the implementation of this project has to consider several factors, including the life time of the project, the availability of resources, the amount and type of products that should be produced, the allocation and capacity of the involved refineries, biorefineries and forest plantations, among others. For this reason, this paper presents an optimization model for the optimal planning of an integrated system for the production of fossil fuels and biofuels considering the interaction with eco-industries, which are able to capture emissions from biorefineries and refineries and receive an economic benefit. The proposed mathematical model takes into account the availability of biomass, the production of oil, a set of existing biorefineries and refineries as well as the possibility to install new facilities. The mathematical approach was applied to a nationwide case study from Mexico, considering the creation of new jobs, overall emissions and net profit as objectives. The results are shown through a Pareto curve, which is useful to make decisions about the planning of the interactions between these types of industries as well as determining the supply chain configuration in order to satisfy overall demand of products.

Keywords: Refineries, Biorefineries, Forest Plantations, Optimization, Multi-objective.

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Biofuels from Residues of the Tequila Industry of Mexico

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Abstract

One of the most important industries in Mexico is the one associated to the tequila production; where several agave residues are produced (agave is the plant used to make tequila), these residues are lignocellulosic matter that can be used to produce bioethanol. The agave residues are obtained in the harvesting sites located in several states of Mexico and from the tequila factories that are mainly located in two places in Mexico. Therefore, this paper presents an optimization framework for designing a supply chain for the bioethanol production from residues of agave bagasse obtained in the tequila processing in Mexico; where central and distributed bioethanol processing plants are considered. The bioethanol production process in the central and distributed plants is modeled according to conversion factors for the different processing steps obtained from experimental data. Results show that the bioethanol production from agave bagasse is a feasible way for obtaining biofuels. For the current situation, the results show that is possible to satisfy around 10 % of the total demand of bioethanol of Mexico. Finally, no numerical complications were observed during the application of the proposed approach, which is general and can be applied to different biomass types and biofuels.

Keywords: Agave, Tequila Industry, Bioethanol, Supply Chain, Optimization.

1. Introduction

The agave is a perennial arid plant that consists of thin sheets around a plant head, whose main elements are fibers, sugars, minerals and water. Juice with high concentration of fructose and other vitamin properties is naturally produced in the center of the plant head. This way, a large number of products can be obtained from agave as honey water, paper, textiles, liquors and tequila. During the processing of agave to yield tequila several lignocellulosic residues from the agave are produced; these residues correspond to the sheets that are obtained in the cultivation areas because these are not used for the tequila processing, and also there are other lignocellulosic residues obtained in the factories associated to the tequila processing from the plant heads after the fermentation process. It should be noted that the agave is mainly cultivated in the central-west part of Mexico (in the states of Jalisco, Guanajuato and Michoacán), and most of the factories associated to the tequila are located also in this region. These lignocellulosic residues can be used as raw material to produce several products, including bioethanol. In this way, Alex-Marvin et al. 2012 presented an optimization

Chapter 1

Optimal Planning for the Supply Chain of Shale Gas

Karla Arredondo-Ramírez, José María Ponce-Ortega and Mahmoud M. El-Halwagi

Abstract Shale gas has attracted the interest in the development and exploitation of unconventional gas resources. Substantial shale gas reserves are found in regions that lack the proper infrastructure needed for production and distribution. This chapter presents an optimization approach for the optimal planning of shale gas exploitation and infrastructure development in places that lack the infrastructure needed for production, treatment, and distribution. A multi-period optimization approach is presented to account for the variability in market. The different components of the infrastructure, the production schedules, and the time-value of money to maximize the net present value of the infrastructure are considered in the optimization model. The applicability of the proposed approach is shown through a case study from Mexico, where there are enormous reserves of shale gas without exploitation. The results show attractive economic results for the exploitation and distribution of gas to satisfy a certain demand.

1 Global perspective of shale gas production

It is projected that by 2035 the global energy consumption increases by 37% from today's levels with India and China accounting for half of the growth according to BP (2015). In order to give a broad view about hydrocarbon fuels, in 2014, 80.6 % of the total primary energy supply was based on fossil fuels such as oil, natural gas and coal. In 2014, the annual production of natural gas was 3,524 bcm (OECD/IEA, 2015).

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Chapter 4
Process Intensification in Heat and Mass Exchanger Networks

José María Ponce-Ortega

Abstract This chapter presents the use of process integration as a useful tool for intensifying processes. Particularly, mass and heat integration through the synthesis of mass and heat exchanger networks represent powerful tools that can be used for reducing the need of external agents such as fresh water and hot and cold utilities. Two optimization formulations are presented for mass and heat integration and the application to two case studies shows significant savings of external utilities.

4.1 Introduction

In recent years, when unified processes are required to be competitive in the global market, process intensification has become a very exciting topic [1]. In this way, process intensification has been defined by Ponce-Ortega et al. [2] as any activity that involves one of the following points:

(a) Smaller equipment for given throughput.
(b) Higher throughput for given equipment size or given process.
(c) Less holdup for equipment or less inventories for process of certain material for the same throughput.
(d) Less usage of utility material and feedstock for a given throughput and given equipment size.
(e) Higher performance for given unit size.

On the other hand, process integration has been recognized as a useful tool for intensifying processes; see, for example, Lutze et al. [3], El-Halwagi [4], and Gopalakrishnan et al. [5]. Particularly, energy and mass integration have been identified as powerful tools for improving processes. Energy integration allows reducing the energy consumption in industrial processes through intensifying the

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