Optimal Design of Macroscopic Water and Energy Networks

Ramón González-Bravo, Fabricio Nápoles-Rivera and José María Ponce-Ortega

Abstract Water scarcity has led to an increase in the extraction of fresh water from aquifers, dams and lakes in certain regions where water availability is low. It has created serious problems in overexploitation of ground and surface water resources. This issue has been intensified due to population growth and increases in energy and water demands in the industry, agriculture, and households. In this chapter, a mathematical model for energy and water distribution networks in a macroscopic system is proposed. This model considers that the water and electricity demands can be satisfied by the existing power plants in the region and the installation of new power-desalination plants. Also, the model considers that the water demand can be satisfied by supplying water from dams, rivers, and aquifers. The model considers a macroscopic system that involves several cities in a water-stressed region. It accounts for variations in water demands throughout the year, for domestic, agricultural, and industrial users. The model considers both installation costs and operating costs of the new power-desalination plants, the installation of new storage tanks, pumping, and piping costs. The results show attractive solutions, where interesting economic profits can be obtained as well as the potential recharge of aquifers can be achieved.

List of Symbols

Indexes

g Location of agricultural users
i Existing aquifer
j Deep wells

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Chapter 15

SBA-16 MESOPOROUS SILICA AS CATALYTIC SUPPORT FOR HYDRODESULFURIZATION CATALYSTS

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ABSTRACT

SBA-16 is an interesting mesoporous silica material having nanopores and a large surface area, which is widely employed as catalysts supports, absorbents, drug delivery materials, etc. This material has attracted attention of catalytic researchers because of its 3D structure consisting of ordered and interconnected spherical mesopores which facilitates the transport of reactants and products without pore blockage. Since it has lack of functionality, heteroatoms have been incorporated by direct or post-synthesis methods in order to modify their functionality. The aim of this chapter is to show the state-of-the-art related to the SBA-16-based mesoporous systems as catalytic supports for hydrodesulfurization (HDS), to take stock of knowledge about current formulations and applications in this field.

Keywords: SBA-16, mesoporous, silica, catalytic support, hydrodesulfurization

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Optimal Reuse of Flowback Wastewater in Shale Gas Fracking Operations Considering Economic and Safety Aspects

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Abstract

This work presents a mathematical programing formulation for the optimal management of flowback water in shale gas wells considering economic and safety aspects. The proposed formulation accounts for the time-based generation of the flowback water, as well as the options for treatment, storage, reuse, and disposal. The economic objective function is aimed at determining the minimum cost for the fresh water, treatment, storage, disposals and transportation. The safety objective accounts for the risk associated to a failure in the treatment units and its consequence in human deaths. In this regard, the proposed method is able to consider different treatment units with different operating efficiency factors, costs and risks. To carry out the water integration, a recycle and reuse network is proposed. A given scheduling for the completion phases of the wells is required to implement the proposed method. Finally, an example problem is presented to show the applicability of the proposed method.

Keywords: Shale gas; Risk in hydraulic fracturing (fracking); Safety; Flowback water reuse.

1. Introduction

Recently, substantial reserves of shale gas have been discovered around the world. Hydraulic fracturing technologies have facilitated the production of shale gas trapped in tight formations. According to the Energy Information Administration (EIA), by the year 2035 shale gas is expected to provide about half of the total natural gas supply in U.S.A. (EIA, 2012) The EIA also estimated that U.S.A. has enough natural and shale gas to meet domestic electricity demands for 575 years at current electricity generation levels. Certainly, this information highlights the importance and the enormous potential of shale gas in the future. Even a recent study analyzed the impacts of shale gas in the chemical industry and in the natural gas market (Siirola 2012). However, a major challenge for the shale gas industry is associated to the water issues such as the supply of the water requirements for hydraulic fracturing process (this step demands huge amounts of water to be successfully implemented), the treatment for the flowback water

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Optimal planning of energy production involving carbon capture systems through a multi-stakeholder scheme

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Abstract

The global energy demand is mainly satisfied by fossil fuels; nevertheless, this is associated directly with the global warming problem. Some alternatives have been proposed to solve this problem such as the use of biofuels and the carbon capture approach. On the one hand, the biomass can capture the CO2 emissions during its growth; while the emissions generated during the production of fuels can be captured through industries based on forest plantations. For that reason, a system able to integrate the 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 the environmental sustainability issues. However, a holistic solution needs actions from many players as the government, society, biomass producer, etc. Therefore, this paper proposes a mathematical model for the optimal planning of an integrated system for the production of fuels and biofuels considering the interaction with eco-industries able to capture emissions from biorefineries and refineries and receive a monetary benefit. Furthermore, the present approach is formulated as a multi-stakeholder scheme in order to consider the benefits and affectations in each one of the entities of the involved supply chains, and determining how the interactions between the different stakeholders take place. This way, the present methodology takes into account the profit of biorefineries, refineries and forest plantations, as well as the emissions and generated jobs of each one of the entities. Additionally, it is considered the price of the petroleum and the possibility to use oil from external producers affecting directly the internal demand and consumption. Also, the methodology contemplates features such as the project life time, the availability of resources, the amount and type of products that should be produced and the allocation and capacity of the refineries, biorefineries and forest plantations The mathematical approach was applied to a nationwide case study for Mexico, considering the creation of new jobs, overall emissions and net profit as main objectives, nevertheless other features were evaluated as the competence of the biomass to food, the use of water and the employment in rural regions. The results are shown in several Pareto curves, which are useful to take decisions about the planning of the system and how the interactions between the stakeholders take place.

Keywords: Multi-stakeholder, Optimal planning, Carbon capturing.