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A manufacturing supply chain optimization model for distilling process ☆

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Abstract

In this paper, the model of an integrated manufacturing supply chain where multiple products are manufactured across multiple manufacturing plants with distilling process is considered. This kind of supply chain often arises in such manufacturing scenarios where the products are distilled from one raw material. To solve the problem, we reformulate it as a minimum cost flow problem plus several bounded variables. Based on this reformulation, we show that the basis of the reformulated problem is closely related with the minimum cost flow problem and design a kind of network simplex method to get the integrated optimal solution of the problem. The efficiency of the method is also tested by our numerical experiments.

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1. Introduction

A supply chain is an integrated network of suppliers, manufacturing plants and distributing channels which are organized to acquire raw materials, to convert those raw materials to final products, and then to distribute those products to customers. In the supply chain, there are several organizations which are responsible for purchasing and manufacturing the raw materials, and distributing the final production, respectively. Although these organizations are owned by a single firm, they always operate independently and sometimes they may conflict. That is, there may not be a single and integrated plan for the firm. Based on this observation, we attempt to present an integrated model of production–distribution system with distilling process in this paper.

To our knowledge, a large number of manufacturing models have been proposed for the design and planning supply chain network, see [1–4] and the papers cited therein. In [5], Cohen and Lee developed a comprehensive modelling framework which links material management activities throughout the material production–distribution supply chain, in which the framework consists of four stochastic sub-models and the optimal solution for each sub-model is solved individually under certain assumptions. However, it would be hard to find an optimal solution if all sub-models are integrated. Later, Cohen et al. [6] considered the operation of a network of supplier, producers and markets, which includes material requirement balance constraints. Cohen and Lee [7] presented a simplified version of the model in [5].

Recently, more complicated manufacturing network is considered, such as the synthesis of different materials to one product and/or the distilling of one material to many different products. To model this manufacturing scenarios, Fang and Qi [9] described a generalized network model which consists of the operation of a network of suppliers, producers and customers. In this model, the producer has two production modes: distillation and combination. By using a simplified version of the model which is called distribution network, the authors of [9] proposed a network simplex method to solve the problem.

In this paper, we consider a manufacturing supply chain model with distilling process. The model consists of several sub-networks which deal with the raw material and productions separately. Motivated by the work of Ahuja et al. [10] and Calvete [11], we will give a new method to solve the model so that the optimal solution of integrated all sub-networks can be found efficiently. Using a similar technique, we reformulate the model as a minimum