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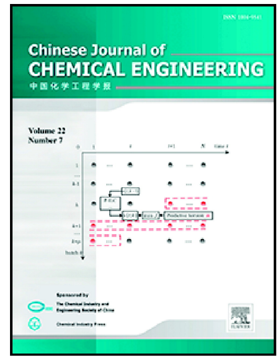

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Logarithm-transform piecewise linearization method for the optimization of fasoline blending processes

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Abstract

Gasoline blending is a key process in a petroleum refinery, as it can yield 60-70% of a typical refinery's total revenue. This process not only exhibits non-convex nonlinear blending behavior due to the complicated blend mechanism of various component feedstocks with different quality properties, but also involves global optimum searching among numerous blending recipes. Since blend products are required to meet a series of quality requirements and highly-sensitive to the proportion changes of blending feedstocks, global optimization methods for NLP problems are often difficult to be applied because of heavy computational burdens. Thus, piecewise linearization methods are naturally proposed to provide an approximate global optimum solution by adding binary variables into the models and converting the original NLP problems into MILP ones. In this paper, Logarithm-transform piecewise linearization (LTPL) method，an improved piecewise linearization, is proposed. In this method a logarithm transform is applied to convert multi-variable multi-degree constraints into a series of single-variable constraints. As a result, the number of 0-1 variables is greatly reduced. In the final part of this paper, an industrial case study is conducted to demonstrate the effectiveness of LTPL method. In principle, this method would be useful for blending problems with complicated empirical or theoretical models.

Keywords: piecewise linearization, blending, non-convex, global optimization

1. INTRODUCTION

The main objective of an oil refining process is to convert its input materials, e.g. a wide variety of crude oils, into consumer-demanded products such as jet fuels and diesel. Among these products, gasoline is considered to be one of the most important and valuable output products as it can yield 60-70% of a typical refinery's total revenue[1,2,3]. The economic efficiency and profitability are associated with higher-quality products (higher prices) and less-use or less-waste of input materials, which could be achieved by critical and accurate gasoline blending. As it shows in Figure 1[4], which is a flowsheet of a simplified refinery, in a gasoline-blending process, components oil (butanes, alkylate, reformate, etc.) from supply-tanks or produced by other units are mixed in blending tanks or on-line blenders to make the gasoline products meet a variety of quality-requirements.

Some of the most important gasoline quality specifications include research octane number (RON), motor octane number (MON), Reid vapor pressure (RVP), density, sulfur, aromatics (A), and olefins (O) content. The

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