Lagrangean-Based Techniques for the Supply Chain Management of Continuous Flexible Process Networks

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The supply chain optimization of continuous process networks is essential for most chemical companies. The increasing number of competitors and the fast growth of customer demands push the companies to search for better and more cost efficient ways of managing the processes in order to survive and remain competitive. The increase in customer demands leads to more processes that involve additional types of chemicals as well as multiple time periods, and ultimately more complicated and larger optimization problem. The underlying model is very difficult to solve, and sometimes not even solvable, due to the large computational effort and technological barriers. Hence, it requires the use of decomposition methods to break the problem down, so that it could be solved efficiently and effectively.

A comparison of decomposition techniques applied to a MINLP long-range production planning model of petroleum refineries is discussed in Neiro and Pinto (AIChE National Meeting [447f], 2003). The results showed significant improvement in computational efficiency for all the techniques, but none of them stands out better as compare with the others. A similar analysis of various decomposition techniques for linear models is necessary since linear models are more usual; more importantly these present convex properties in contrast to nonlinear models.

This work applies decomposition techniques to the continuous flexible process network model presented in Bok et al. (Ind. Eng. Chem. Res., 39, 1279, 2000). Lagrangean Decomposition is proposed to reduce solution time by decomposing temporally the model. Theoretical studies indicate that Lagrangean decomposition provides tighter bounds for the original problem but requires a specific structure, which matches the refinery production planning model. Different strategies are then proposed as alternatives for the application of the Lagrangean Decomposition that rely on variants of the sub-gradient optimization method (Maravelias and Grossmann: Ind. Eng. Chem. Res., 40, 6147-6164, 2001; Fumero: Comp. Oper. Res., 28, 33-52, 2001) and on the dual ascent method (Guignard and Opaswongkarn: Eur. J. Oper. Res., 46, 73-83, 1990).

Several schemes derived from the techniques are proposed and applied to the process network model. The results from full-scale method and the proposed decomposition schemes are presented and compared.