Byproduct Hydrogen Recycling Networks Design of Petrochemical Complex

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Abstract— In a petrochemical complex, large amount of hydrogen is produced as a by-product and used as a fuel in petrochemical and oil refinery plants. By recycling this byproduct hydrogen as a raw material, the value of hydrogen can be greatly improved. This study proposes a design methodology for byproduct hydrogen recycling network between plants in petrochemical complex by analyzing the hydrogen pinch, required cost and constraints.

INTRODUCTION

This study describes the application of mass integration principles to the problem of a petrochemical complex hydrogen management. Mass integration is a methodology that provides an understanding of the flow and allocation of hydrogen offgas within a process.

In general, hydrogen recycling network design determines the optimal routing and allocation between the sources and the sinks. Sometimes, sources can be intercepted and treated in order to change flowrates and purities. This study considers a specific type of process which is a petrochemical complex hydrogen network.

BACKGROUND

The superstructure shown in Figure 1 has been built to consider trade-offs. Hydrogen suppliers and hydrogen consumers are decomposed as the sources and the sinks. Hydrogen purification processes are installed between these sources and sinks. In order to integrate different purification processes, they are assumed to be able to feed each other. Currently, only the integration of PSA is considered because it is the most commonly used purification processes in petrochemical complex.

The superstructure contains all the possible network configurations with purification processes. The optimal design may need one purification unit(PSA or membrane) or no purification process at all. The possibility of streams fed to purification units is fully covered by the superstructure. The installation of new compressors and pipelines is also included in this superstructure.
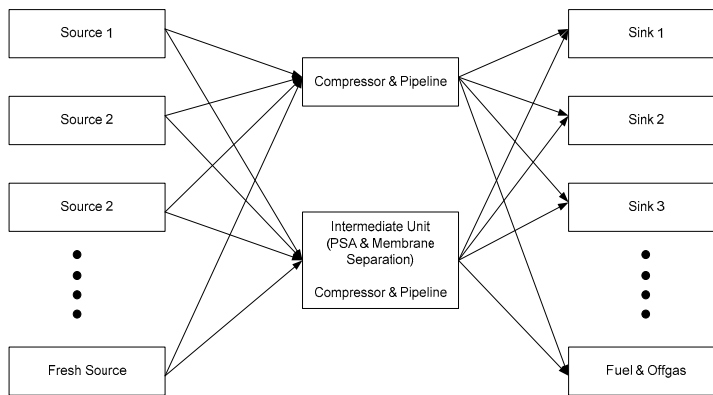

Fig. 1 Superstructure of hydrogen network

THEORY

The hydrogen recovery network of petrochemical complex is formulated as a mathematical model based on the assumption above. The objective is to maximize the profit of the hydrogen recovery, considering the fresh resource, interception device, and pipeline.

To investigate the distribution of profits between industries in Petrochemical complex, the optimization problem is reformulated based on the assumptions as follows.

1. The hydrogen from each company is reused by another company, or purified by separation units of hydrogen network or thrown away outside.

2. Each company uses 'high purity hydrogen' from other companies directly, or 'purified hydrogen' by separation units of hydrogen network, or purchased raw materials from outside.

3.Separation units of hydrogen network treat 'low purity hydrogen' from each company and transfer them to each company or fuel.

CONCLUSION

In this study, the economic effectiveness of hydrogen recovery network is represented by proposing a network optimization model. The method is based on setting up a superstructure that includes the feasible networks. The objective function consists of the average total cost saving in hydrogen network.. And this method can be applied to solve real scale problems.

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