Optimization of Steam Usage for a Chemical Process

Red Cedar Technology, Inc.

1. Introduction

When a predictive model of a chemical process exists, mathematical optimization procedures can be applied to identify the best combination of process parameters for meeting goals such as reducing cost, increasing yield or increasing purity. Here, the optimization software HEEDS is used with the Aspen Plus 2006 simulation tool to minimize the cost of producing Dichloro-Methane (DCM), a common chemical byproduct that can be used as a solvent and in production of certain food products, such as decaffeinating coffee [1].

The process for removing DCM from a mixed stream is shown in Figure 1. The process uses two flash towers. A feed containing a mixture of water and DCM is mixed with a stream of saturated steam in TOWER1. The bottom output stream is routed into TOWER2 where it is mixed with a second stream of saturated steam.

2. Optimization Problem Statement

The bottom output stream of TOWER2 (EFFLUENT) is required to have a concentration of not greater than 150 ppm (mass based) of remaining DCM. To reduce process cost, it is desired to minimize the amount of steam input. This can be stated as follows:

minimize: *Total_Steam*

subject to: *DCM_concentration* ≤ 150 ppm

by varying: 1,000 lb/hr ≤ *STEAM1* ≤ 20,000 lb/hr
1,000 lb/hr ≤ *STEAM2* ≤ 20,000 lb/hr

3. Baseline Design

The starting design for this problem had values of *STEAM1* and *STEAM2* of 18,000 lb/hr and 15,000 lb/hr, respectively. This design had a *Total_Steam* value of 33,000 lb/hr and a *DCM_concentration* value of 76.02 ppm. It is clear that since the concentration of DCM is close to half the allowable level, progress can be made to reduce the steam usage.

4. Problem Setup

Each design evaluation during the optimization study was performed using Aspen Plus 2006. HEEDS was used to automate the design evaluations and to search for an optimized solution. The hybrid and adaptive optimization algorithm SHERPA was used. The general procedure is shown in Figure 2.

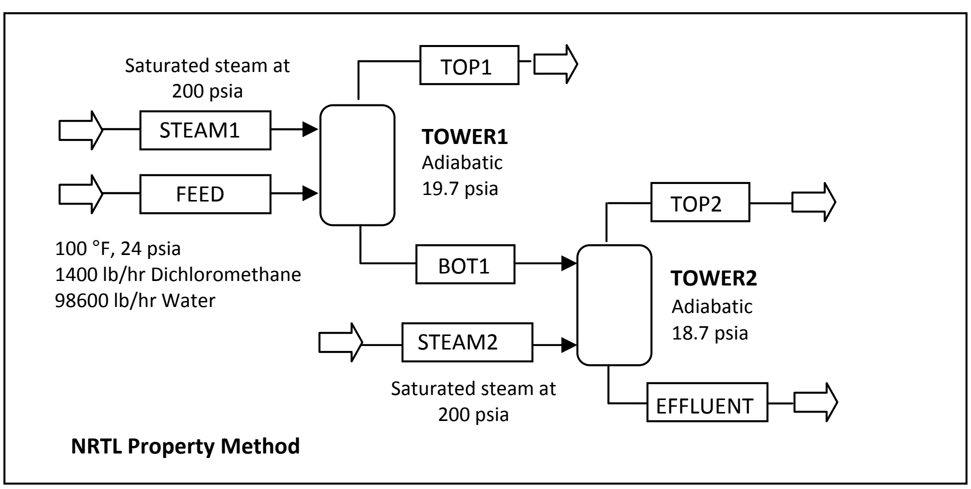

Figure 1. Process flow sheet with stream and process data [2].

5. Results

The best design found by HEEDS had a *Total_Steam* value of 28,200 lb/hr and *DCM_concentration* value of 149.4 ppm. These values corresponded to input steam values of 15,900 lb/hr and 12,300 lb/hr for *STEAM1* and *STEAM2*, respectively. This is a decrease of over 14% in total steam used, and a substantial cost reduction, compared to the baseline design.

6. Conclusions

HEEDS was successful in designing the process to use 14% less steam as compared to the baseline design, while meeting the constraint on the concentration of Dichloromethane in the effluent stream.

References

1. Office of Environmental Health Hazard Assessment (September 2000). "Dichloromethane". *Public Health Goals for Chemicals in Drinking Water*. California Environmental Protection Agency.

2. Abdel-Jabbar, Nabil, Jordan University of Science and Technology – ChE 590A Course Website (http://www.just.edu.jo/~chemeng/nabil/cad/che590-cad.htm)

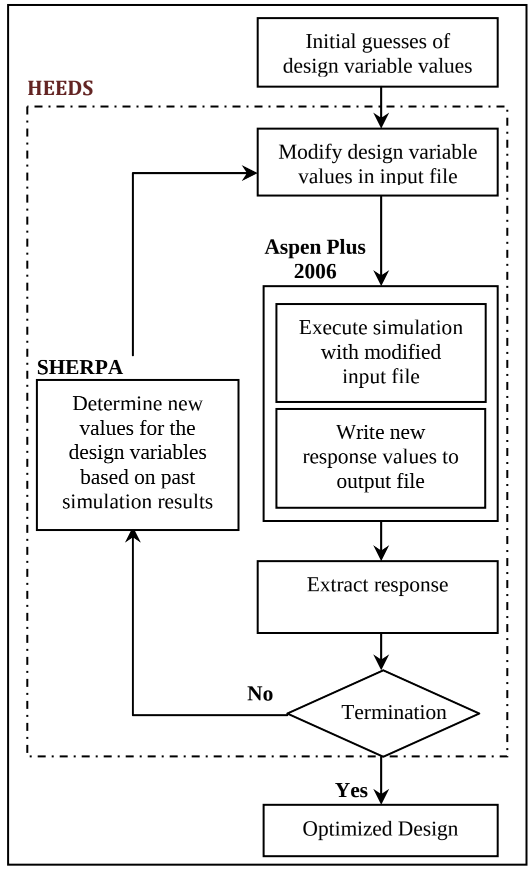

Figure 2. Flowchart for optimization procedure using HEEDS and Aspen Plus 2006.

4572 South Hagadorn Rd., Suite 3A ▲ East Lansing, MI 48823 ▲ TEL 517.664.1137 ▲ FAX 517.664.1175 ▲ www.redcedartech.com