

VOC Reduction by Dynamic condenser Design

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In most organic chemical reactions, which comprise the vast majority of reactions encountered in pharmaceutical plants, volatile organic compounds (VOCs) are used and sometimes generated by a reaction. Volatile organic compounds are defined as organic chemicals that have a high vapor pressure and easily form vapors at normal temperature and pressure. They include such chemicals as tetrahydrofuran, cyclohexane, benzene, and most aromatic hydrocarbons. VOCs are a major concern of the Environmental Protection Agency (EPA) and state air quality boards all over the United States. This study addresses the issue of reducing VOC emissions by considering the following:

- Design a condenser with a feedback control system to reduce VOC emissions.
- Determine the economic incentive of designing such a condenser by considering factors such as:
 - Savings on coolant and operating costs
 - Savings on VOC emission permit costs
 - Avoidance of plant shutdown due to regulations

These factors have been evaluated using a number of different methods, including developing dynamic models of a condenser, researching the fines for emissions, and developing a relationship between the economics and the design variables of this process.

Condenser Design

The unsteady-state condenser model was considered, based on the alpha-condenser model. Energy and mass balances were derived to solve for the temperature profiles and the amount of condensate. A program was developed to calculate the above and a commercial fluid dynamic simulator (FLUENT) was used to solve for flow field and temperature profiles along the heat exchanger in order to validate the results obtained from the computer program. The simulator was also used to test current exchanger calculations methods, such as the log-mean-temperature-difference, to justify the need for more accurate models.



Figure 1. Three-dimensional grid of the heat exchanger

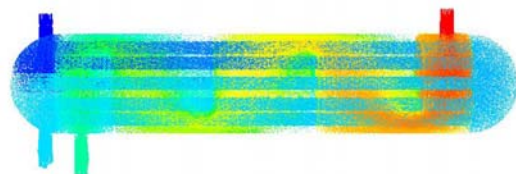


Figure 2. Flow field colored by temperature.