Technical University of Denmark

A Systematic Methodology for the Assessment and Troubleshooting of Control Strategies and Operational Problems In Distillation Systems

Mauricio Iglesias, Miguel; Johansen, Kristoffer; Jørgensen, Sten Bay; Sin, Gürkan

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Mauricio Iglesias, M., Johansen, K., Jørgensen, S. B., & Sin, G. (2011). A Systematic Methodology for the Assessment and Troubleshooting of Control Strategies and Operational Problems In Distillation Systems. Abstract from 2011 AIChE Annual Meeting, Minneapolis, MN, United States.

A Systematic Methodology for the Assessment and Troubleshooting of Control Strategies and Operational Problems In Distillation Systems

Friday, October 21, 2011: 9:45 AM

101 B (Minneapolis Convention Center)

Miguel Mauricio-Iglesias[1], Kristoffer Johansen[2], Sten Bay Jørgensen[1] and Gürkan Sin[1], (1)CAPEC, Department of Chemical and Biochemical Engineering, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark, (2)NNE Pharmaplan, Søborg, Denmark

A systematic methodology for the assessment and troubleshooting of control strategies and operational problems in distillation systems

Miguel Mauricio-Iglesias[1], Kristoffer Johansen[2], Sten Bay Jørgensen[1], Gürkan Sin[1].

[1]CAPEC – Department of Chemical and Biochemical Engineering, Technical University of Denmark, 2800 Lyngby, Denmark;[2]NNE Pharmaplan, Vandtårnsvej 108-110, 2860 Søborg

In order to increase efficiency in resources and energy allocation and reduce capital costs, chemical processes tend to use more heat and mass integration, which increase interactions, and fewer surge vessels that could dampen disturbances. As a consequence, interactions between process units become more important, which has to be considered and managed properly in the design of the control layer for the process operation.

One particular area where process operation optimization and control challenges frequently are observed is separation systems. In particular for distillation processes, strategies for heat recovery have been extensively implemented in industrial processes during the last decades. Operation (including start-up and shut-down) and control of, heat-integrated systems become formidable challenges if not problematic since higher-order dynamics occur where different time-scale phenomena interact. Furthermore, if the dynamic state of the process does not lie close to the designed state, the amount of energy wasted increases, questioning the economics of the implementation of heat integration.

On the other hand, literature deals extensively with classic distillation columns whereas much less has been investigated on dynamics of heat integrated distillation systems and the significance of developing a proper plantwide control strategy to ensure optimal and stable operation. Classic control strategies may be unsuitable for such complex systems and, more importantly, the design and operating conditions of the process may lead to a hardly controllable process. The goal of this work is to present a systematic and process engineering oriented methodology for the assessment, troubleshooting and improvement of existing operation and control strategies for distillation systems. The operation and control strategy is assessed stepwise following a top-down and bottom-up approach (Skogestad 2003) according to the following steps:

(i) reviewing control objectives & strategy;

(ii) the model development & control degrees of freedom analysis strategy;

(iii) reviewing and generating pairing of control and manipulated variables and obtaining the subsequent fine-tuning parameters;

(iv) finally, evaluation of the new proposed strategy.

Particular attention was given to the analysis of existing operating conditions of the process and how their modification can lead to a more easily controllable system. To this end, the driving force concept -a powerful and relatively simple graphical method (Bek-Pedersen et al. 2010), is used that provides optimal operating set-points insensitive to disturbances and require minimum energy for the separation (Hamid et al. 2010).

The application of the methodology was highlighted using a real industrial case problem, for which a dynamic model for heat-integrated distillation systems is developed and used to analyze and solve operational and control problems for solvent recovery in a pharmaceutical industry.

The system studied in the industrial case is composed of two distillation columns in series (operated at 3.5 and 1.5 bar respectively) for recovery of ethanol (light key) from a liquid mixture, modeled as pseudo-binary (water is the heavy key). Heat recovery is carried out both backward (from the two bottoms flow to the feed) and forward (from the first condenser to the second reboiler). Finally, based on a numerical model of the system and using the methodology described above three solutions were generated for improving its control: i) a fine tuning of the existing control strategy, therefore suitable for immediate implementation; ii) a new control strategy considering improved pairings of variables in the existing plant; and iii) a new control structure, including sensors and actuators for long term modification of the system. Benefits of each alternative remedies have been evaluated and benchmarked against each other.

Bek-Pedersen E., Gani R., & Levaux O. (2000). *Computers and Chemical Engineering*, 24(2-7), 253-259.

Hamid M.K.A., Sin G., & Gani R. (2010). *Computers and Chemical Engineering*, 34(5), 683-699.

Skogestad S. (2002). *Computer Aided Chemical Engineering*, 10(C), 57-69.

Extended Abstract: File Not Uploaded

See more of this Session: Smart Plants Operation and Control
See more of this Group/Topical: Computing and Systems Technology Division