Simulation Analysis of an Industrial Heterogeneous Azeotropic Distillation Column for Control, using operating paths.

Marion ALLIET GAUBERT[1], Vincent GERBAUD[1], Xavier JOULIA[1], Pierre SERE PEYRIGAIN[2] and Michel PONS[3]
1- Laboratoire de Génie Chimique (LGC, UMR-CNRS 5503)
INPT - ENSIGC - Chemin de la Loge
F-31078 TOULOUSE Cedex 04 – FRANCE
2- ProSim S.A.
Route d'Espagne
F-3100 TOULOUSE - FRANCE
3- Elf-Atochem - Centre de Recherche et de Développement de l'Est
BP 31005
F-57501 SAINT-AVOLD Cedex - FRANCE

Abstract
The separation of components constituting an azeotropic mixture cannot be performed with a classical distillation column. One answer to this problem consists in using heterogeneous azeotropic distillation. A separation agent forming an heterogeneous azeotrope with one of the components is added to help to pass through the azeotrope barrier and facilitate the solvent reprocessing, often through the use of a decanter. A complete study of an industrial heterogeneous azeotropic distillation is presented. This process concerns an organic acid dehydration using an entrainer. Furthermore a fourth component, a by-product is considered. The study follows a systematic procedure. It includes a validation of the model through a pilot process study, with experimental campaigns, simulation of the pilot and a comparison between experimental and simulation results. The pilot column shows an interesting behavior since it switches from a low temperature profile to a high one for a small variation of boiler heating. Then a simulation of the industrial process has been made with plate by plate MESH (Material balance, Equilibrium, Summation of fractions and Heat balance) equations. The use of an operating path tool (Alliet-Gaubert et al., 1999) us allows to resolve the convergence difficulties encountered previously. Simulation results are compared with a test run and the matching is good. Furthermore, the operating path shows a process unusual behavior: the temperature of the sensible plate forms a peak according to heat power variation. The sharp variation of the temperature profile of the column and especially the peak of the sensible plate may explicate why it is difficult to control the process on the industrial set point that lie close to the maximum of the peak.

Scope
This study concerns a running industrial process with a two columns sequence (azeotropic column and solvent recovery column). Four of the main components are considered.
A systematic study procedure which includes a model testing on a pilot column and a case study on the industrial process provides a better understanding of the process operation. Simulation results are very close to the experimental data. The simulation operating path results show an unusual process behavior and give a valuable explanation of control difficulties that initiated this study.

Conclusions and significance
This study confirms (as shown by Kowach and Seider, 1987 and Pham et al., 1989) the relationship between impurities in the bottom stream and column temperature profile. It shows as well the connection between a high water fraction and
a low temperature in the column. Results display an unusual peak form response of the sensible plate temperature according to heat power variation. The control difficulties observed on the industrial unit may be caused by the location of the reference temperature close to the maximum of this peak. This study shows as well the operating path tool interest and the necessity of a systematic study to tackle the operation of real industrial processes.