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# On the optimisation and control of Pressure Swing Distillation Unit

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Recycling of process solvents is receiving a good deal of attention lately as engineers and chemists strive to reduce long-term costs and minimize wastes. Distillation can be used for handling these recycle streams because it is a familiar and robust unit operation and because the required unit equipment may already exist on-site. The presence of azeotropes, however, may severely limit the use of standard distillation. This work deals with the modelling of a Pressure Swing Distillation (PSD) Unit for the recovery of ethyl-acetate from a mixture containing also ethanol, water and other organic compounds in small amounts, being these components responsible for the formation of pressure-sensitive azeotropes and of liquid-liquid splits; moreover in a PSD unit the sequence of the columns can be readily thermally integrated, thus allowing further savings.

A detailed model was used to simulate both the steady-state and the dynamic behaviour of the plant, showing that the modelling of the liquid-liquid and of the vapour-liquid equilibria is a crucial point to get reliable information about plant performances. Because of the variations that may occur in the feed concentration and flow rate a control system was designed to allow for a 90% of ethyl-acetate recovery with a 99.95 % purity; the aim of the control system should be also to optimise the operation, i.e. minimising energy consumption.

Model Predictive Control is the usual framework for optimising plant performances, but the number of the optimised variables may render the on-line optimisation particularly difficult, thus requiring the use of simplified model (even black-box model). Because of the complexity of the system, a detailed model should be used; this choice allows also to use the MPC algorithm on plants of different size or different operating conditions, without the need of re-evaluating the parameters of the (simplified or black-box) model. The main drawback of this choice, as stated before, is the complexity of the on-line optimisation; as a consequence steady-state optimisation was used to point out the influence on the objective function of the variables that can be manipulated, showing that the optimisation of one variable properly chosen may be enough, being poor the effect of the others on the plant optimisation. This strongly simplifies (and allows) the on-line application of a Model Predictive Control algorithm.