CHAPTER II

LITERATURE SURVEY

For the past few decades, many dynamic simulations were developed and studied. Many different models applied for distillation units have been described in research, as shown below.

In 1997, Bock *et al.* developed the design and control of a reaction distillation column, including the recovery system. To develop a control structure, the reaction column's steady-state and dynamic sensitivity of possible disturbances and manipulated variables were analyzed. It was shown that there is no direct relationship between temperature and purity. An efficient control structure was presented for this strongly non-linear coupled system. The purities of the product streams could be guaranteed by controlling the purity at the bottom of the column with the reboilers heat input and keeping the temperature at the top of the plate column constant with a heat supply at the top of the column.

Gross *et al.* (1998) studied the controllability of an industrial heat-integrated distillation process. They used steady-state and dynamic controllability measures for investigating three different control schemes. The rigorous process model includes the important interactions of liquid inventories between each other and with the heat transfer rate.

In 1998, Mizsey *et al.* studied the process control for energy integrated distillation schemes. Two energy integrated distillation schemes for the separation of three different ternary mixtures of four typical feed compositions have been rigorously investigated and compared to the best conventional two-column distillation scheme. The two energy integrated schemes are the heat integrated two column system and the fully thermally coupled distillation column (FTCDC) The heat integrate scheme proved to be economically always better than FTCDC.

Other models were developed by Chang *et al.* (1998). They improved the rigorous industrial dynamic simulation of a crude distillation unit considering valve tray rating parameters. A rigorous dynamic simulation was performed to find the optimal operating conditions of a crude distillation unit. They used a general-purpose dynamic simulator. The valve tray rating parameters describe the fluid behavior in the column such as downcomer load and jet flooding.

Two years later, Kano *et al.* (2000) developed an inferential control system of distillation compositions using dynamic partial least squares regression. They constructed the model on the basis of simulated time series data. The use of past measurements was effective for improving the accuracy of the estimation. The result showed that the cascade control system, based on the proposed dynamic Partial Least Squares (PLS) model, works much better than the usual tray temperature control system.

In 2000, Kurooka *et al.* considered a nonlinear control system for a heterogeneous azeotropic distillation column that separates a three component mixture of water, n-butyl-acetate, and acetic acid. For some disturbances, the outputs in the control system showed small fluctuations, and were quickly settled at the setpoints, compared with a multiple-loop control system.

In the same year, Shin *et al.* (2000) observed a nonlinear profile using tray temperatures instead of tray compositions. Composition measurement has been one of the major difficulties associated with the composition control distillation columns because the on-line analyzers still suffer from large measurement delays, high investment/maintenance costs and low reliability. A new nonlinear profile position observer which used tray temperatures could control high-purity distillation columns.

In 2001, Serra *et al.* analyzed of different control possibilities for divided wall column (DWC) by using feedback diagonal and dynamic matrix control. For setpoint tracking, the DMC presents smaller deviations but longer response time. For disturbance rejection, PI presents smaller overshoots and better response time. DMC has a very slow convergence in the particular direction corresponding to an increase of reflux and boil up, and a decrease of the side stream flowrate. In general, DMC has been found to be quite limited for the control of the DWC.

In 2002, Huang and Riggs compared PI (proportional-plus-integral) and model predictive control (MPC) for the control of a gas recovery unit. This study used a computer simulation for a gas recovery unit (GRU). The MPC controller gave significant economic benefit compared to the conventional PID controllers with constraint overrides for adjusting multiple manipulated variables simultaneously to maintain operation on a constraint.

In 2003, multi-model predictive control of an industrial C3/C4 splitter was constructed by Porfirio *et al.*. It applied a linear predictive controller to an industrial distillation column (nonlinear). The new controller included six linear models obtained at different operating points in the operating window of the system. The MMPC (Multi Model Predictive Control) presented a performance significantly better than the conventional controller and could be operated at quite different operating conditions.

Next, Osorio *et al.* (2004) made rigorous dynamic modeling and simulation of wine distillations. The model that was developed described wine distillation as a multi-component reactive batch distillation process. The simulation approach transforms the system of DAE (Differential-algebraic equations) into a set of ordinary differential equations. This new simulation strategy for wine distillation was 40% faster than the rigorous solution of the DAE system.

In 2005, Volk *et al.* developed an optimized multivariable predictive control of an industrial distillation column considering hard and soft constraints. By using feed-forward disturbance control for compensation of the feed flow fluctuations, a multivariable predictive controller was developed. The operation and behavior of the heating of the column became smoother, and saved heating power because pressure was minimized.

In 2005, Jana *et al.* developed a discrete-time multivariable globally linearized control (GLC) algorithm, which provided low computational requirements with constraint handling ability. The reduced-order estimator provided better setpoint tracking as well as disturbance rejection performance compared to the open-loop estimator under parametric uncertainty. Moreover, the reduced-order process-model-based optimizer ensured improved servo and regulatory behaviors more than the full-order process-model-based optimizer in the presence of uncertain parameters.

In the same year, Bezzo *et al.* (2005) used model predictive control (MPC) to control the middle-vessel continuous distillation column (MVCC). The result of employing MPC was to allow using a smaller middle vessel, with no major loss of control performance on the product compositions.