CHAPTER II
LITERATURE REVIEW

This chapter is to present a review of this research of the previous works on the plantwide control.

2.1 Plantwide Control Structure Design

Douglas (1988) is considered a continuous process for producing benzene by hydrodealkylation of toluene (HDA process) to illustrate the procedure. The complete process is always considered at each decision level, but additional fine structure is added to the flow sheet as he proceeds to the later decision level. Each decision level terminates in an economic analysis. Experience indicates that less than one percent of the ideals for new designs are ever commercialized, and therefore it is highly desirable to discard poor projects quickly. Similarly, the later level decisions are guided by the economic analysis of the early level decisions.

Fisher *etal.* (1988) are presented a study of the interface between design and control including process controllability, process operability and selecting a set of controlled variables. At the normally there are not enough manipulative variables in the flow sheets to be able to satisfy all of the process constraints and to optimize all of the operating variables as disturbances enter the plant. In order to develop a systematic procedure for controllability analysis, Fisher et al. (1988) used the design decision hierarchy described by Douglas (1985) as the decomposition procedure and considered HAD process as a case study.

Terrill and Douglas (1988) have studied HDA process from a steady state point of view and determined that the process can be held very close to its optimum for a variety of expected load disturbances by using the following strategy:

(1) Fix the flow of recycle gas through the compressor at its maximum value

(2) Hold a constant heat input flow rate in the stabilizer

(3) Eliminate the reflux entirely in the recycle column

(4) Maintain a constant hydrogen-to-aromatic ratio in the reactor inlet by adjusting hydrogen fresh fed

(5) Hold the recycle toluene flow rate constant by adjusting fuel to the furnace

(6) Hold the temperature of the cooling water leaving the partial condenser constant.

Luyben (1988) is proposed the "eigenstructure" which refers to a control structure that is best at rejecting load disturbances, which is the most important job of a control system. Luyben also stated that variable interaction in a control system is not necessarily undesirable. What matters is how well the control system performs in the face of load disturbances. Thus, designing a control system with the purpose of minimizing interaction will not necessarily lead to the best control system. The each process has an intrinsically self-regulating control structure and that the first step of any control system design is to find this structure.

Downs and Vogel (1993) are described a model of an industrial chemical process for the purpose of developing, studying and evaluating process control technology. It's consisted of a reactor/separator/recycle arrangement involving two simultaneous gas-liquid exothermic reactions. This process was well suited for a wide variety of studies including both plantwide control and multivariable control problems.

Luyben (1994) is reported the snowball effect, the snowball effect a small change in load causing a very large change in the recycle flow rate. The most structures aresuggesting that how can the offered control structure prevent snowballing and why the conventional structure cause the snowball effect. The snowball effect could be removed by switching the conventional structures, fresh feed flowrate control and reactor level are controlled by manipulating reactor effluent flowrate, to reactor effluent flow control and reactor level are controlled by manipulating fresh feed flowrate. The flowrate of reactor is fixed effluent in one-recycle processes can prevent the snowballing.In two or more recycle streams processes can be prevented the snowball effect by fixing the flow rate of each recycle.

Luyben and Tyreus(1997) are presented a general heuristic design procedure. The nine steps are proposed procedure center around the fundamental principles of plantwide control: energy management, production rate, product quality, operational, environmental and safety constraints, liquid level and gas-pressure inventories, makeup of reactants, component balances and economic or process optimization. This procedure was illustrated with three industrial examples: the vinyl acetate monomer process, Eastman process, and HDA process. The procedure produced a workable plantwide control strategy for a given process designed.

The effects of material recycles are studied by many researchers. Basically increasing the material recycle flowrate increase the plant time constant and increase the steady-state gains, this is supported by Gilliland (1964), Denn (1982), and Kapoor and Marlin (1986).It was mentioned that the presence of material recycle makes a plant more sensitive to low-frequency disturbances.This is a direct result of the increase in the plant time constant (Denn,1982). Papadourakis (1985) demonstrated that the coupling of a series of units with a recycle stream places any time delays present in the individual units into the denominator of the plant transfer function.

Skogestad *et al.* (2000) isreviewed on the plantwide control with emphasis on the five tasks, selection of controlled variables, manipulated variables, measurements, control configuration, and controller type. There are two main parts of those tasks. First part is a top-down consideration which degrees of freedom are available to meet. The top-down analysis consists of the first and the second task, the selection of controlled variables, and the selection of manipulated variables. The three last tasks, the selection of measurements, control configuration, and controller type, are used for stabilizing the process, called a bottom-up design. For the first task, the steady-state economics is very useful. There is much-needed link between steady-state optimization and process control. The actual bottom-up design of the control system is done after the control problem has been defined.

Konda et al. (2005) is showed the plantwide control methodology with integrated framework of simulation and heuristics. An improved heuristic procedure is suggested by specifying the limitation related to the nine-step heuristic procedure of Luyben et al. More specific and generic guidelines are included. Beginners are supported to understand the alternatives at each stage and choose the better one based on the process knowledge and requirement. The improved heuristic methodology integrated with simulation as the heuristic procedure cannot always be trusted on plantwide controldecisions. The significance of this work is that the control system design cannot be performed just by heuristics without help of rigorous nonlinear simulation tools.

Konda*et al.* (2006) is used simulation-based heuristic approach for designing plantwide control structure. This work is proposed for obtaining both of economic and operational benefits. The approach consists of two stages. The first stage, Alternatives are systematically originated and ranked based on economics. Then, A few top-ranked alternatives are forwarded to the second stage for analysis on their dynamics to define the best process that is economical as well as easy to operate.

Douglas J. Cooper (2006) is presented a product impurity levels (measured either on-line or in the laboratory) are used by feedback controllers to adjust column operation to meet product specifications. In addition, tray temperatures are used to infer product compositions, where feasible. For columns that have slow-responding composition dynamics, analyzer delay is usually less of an issue.For certain columns, the bulk of the temperature change occurs in a few trays, resulting in a very steep temperature profile. If a single tray temperature is used to infer the product composition in such a case, feed composition changes can move the location of the steep temperature change away from the tray selected for control, leading to a situation in which the chosen tray temperature is insensitive to changes in product impurity levels. This problem can be handled by controlling the average of several tray temperatures that bracket the area where the steep temperature changes occur for feed composition changes.

In this manner, when feed changes cause the temperature profile in the column to move, at least one of the tray temperatures used in the average of the temperatures is located on the steep temperature front. The average of the tray temperatures should still be sensitive to product impurity changes over the full range of feed composition changes. *Single Composition Control:* Here the composition of one product is controlled while the composition of the other product is allowed to float. In the chemical industry over 90% of the columns are operated under single composition control compared to dual composition control, which controls both the overhead and the bottoms product compositions. The bottom product is controlled by single composition control. Because the boil up rate is faster acting and less sensitive to disturbances than either the bottoms product rate or the boil up ratio is used to control the bottom product composition with the reflux rate fixed, which allows the overhead composition to float. Single composition control is much easier to implement, tune and maintain than dual composition control. The choice between single and dual composition control is based on the tradeoff between the additional cost associated with dual composition control and the economic benefit of dual composition control.

Wongsri (2009) is developed the control structures for alkylation process. Then, plantwide control structures are designed for alkylation process using new design procedure of Wongsri (2009) and evaluate the dynamic performance of the designed control structures compare with base case control structure (Luyben, 2002) by two types of disturbances: material and thermal disturbances. The designed control structure has a good performance because it can handle disturbances entering the process and can maintain product quality as compared by integral absolute error (IAE) and total energy use low.

Vasudevan *et al.* (2009) is presented the comparison of the development of a plantwide control for the styrene monomer plant. In this paper, target is to apply and extend these is result in order to systematically design stable decentralized control structures for plants usingthe integrated framework (Konda et al., 2005). In order to measure its effectiveness, the result was compared to the heuristics procedure of Luyben and co-workers (Luyben et al., 1998) and the self-optimizing control procedure (Skogestad, 2004). An analysis of the effects indicated that while all the procedures give stable control structures, the integrated framework and self-optimizing control procedures give more robust control structures than heuristics procedure. The response is integrated framework of simulation and heuristics performs better in terms of control and management of production rate during the transient period, the self-optimization control procedure gives higher steady-state profit.

2.2 Heat Exchanger Network Design

Wongsri (1990) is studied a resilient HENs design, presented a simple but effective systematic synthesis procedure for the design of resilient HEN. His heuristic design procedure is used to design or synthesize HENs with pre-specified resiliency.

It used physical and heuristic knowledge in finding resilient HEN structures. The design must not only feature minimum cost, but must also be able cope with fluctuation or changers in operating condition. A resilient HEN synthesis procedure was developed based on the match pattern design and a physical understanding of the disturbances propagation concept. The disturbance load propagation technique was developed from the shift approach and was used in a systematic synthesis method. The design condition was selected to be the minimum heat load condition for easy accounting and interpretation. This is a condition where all process streams are at their minimum heat loads.