

ABSTRACT

Typical industrial chemical plants are tightly integrated processes which exhibit nonlinear behavior and complex dynamic properties. They usually have two or more controlled variables requiring two or more manipulated variables. Those processes with more than one controlled variable and more than one manipulated variable are known as Multi Input Multi Output (MIMO) process. The MIMO system can be decoupled into SISO systems. If a MIMO system is considered as a decoupled SISO system, no interaction will exist among the SISO subsystems. Each input variable has to control only one output variable. The essence of decoupling is to cancel the interaction existing process, allowing independent control of the loops. A multivariable system experiences interactions and responds poorly. The objective in decoupling is to compensate the effect of interactions brought about by cross coupling of the process variables and cause the input output relationship to be linear. For decoupling a linear interacting system, RGA and RNGA methods are applied. Implementation of these algorithm results in the system to be decoupled. Compared to RGA, RNGA method shows better results. But for a nonlinear highly interacting system, this method does not provide satisfactory results. This algorithm works well for linear systems only. So the algorithms like Kravaris, Generic model control, and Hirschorn's algorithm are considered. The objectives of this study are to analyze the nature of interaction and understand the concepts of three Decoupling and

Linearization algorithms namely (i) Kravaris algorithm (ii) Generic Model Control algorithm and (iii) Hirschorn's algorithm. PI, PI-SPW and FLC controllers are also included along with the linearization algorithms to enhance the performance of the system. MPC controller is also with Hirschorn's algorithm to achieve best results. Optimization algorithm like Genetic Algorithm is implemented to obtain a suitable controller. The controllers for a multivariable process could be a multivariable controller or a multiloop controller.

Initially Relative Gain Array (RGA) and Relative Normalized Gain Array (RNGA) techniques are applied for linear MIMO state space system like polymerization reactor. Interaction could be eliminated but applications of these techniques are limited to linear systems only. Liquid Level-Temperature cascaded and Liquid Level-pH cascaded processes are the multivariable processes which are used for implementing the decoupling algorithms.

Three decoupling and linearization algorithms are applied to two types of nonlinear systems such as Level-Temperature and Level-pH cascaded processes. By applying the control laws, MIMO systems are obtained in decoupled form. Hirschorn's algorithm with controllers provides the best result for Decoupling and Linearization process.

Kalman estimation technique is a method to get the estimated output where state feedback is necessary or where certain states are not measurable. Estimation makes the controller design easy as the estimate of the

future value of an output is available for effective control of the manipulated variable. Level-Temperature process is linearized with Hirschorn's control law and then estimation and observation techniques are implemented for the same system.

State observer is a system that approximates a real system in order to provide an estimate of its internal state, given measurements of the input and output of the real system without the use of actual sensors. Soft sensor techniques like Luenberger observer, Kalman observer, and Unknown Input Output observer are also applied to the liquid Level-Temperature cascaded process after linearizing it using Hirschorn's control law. Unknown Input Output observer gives better results than Kalman and Luenberger observer.

The performance of the controllers are evaluated and compared. The results are presented considering the Settling Time (T_s), Integral Square Error (ISE) as performance indices. It can be observed from the results that the system linearized with Hirschorn's algorithm and controlled by MPC controller performs relatively better than the other controllers.