ABSTRACT

Modeling and control of Fluid Catalytic Cracking Unit is a challenging problem since it is a highly nonlinear and interacting process. Model of FCCU that describes the dynamic behavior of reactor and regenerator has been developed by considering energy and material balance equations. A perceptive study has been carried out to determine the interaction between two controlled variables and two manipulated variables and the elements of Relative Gain Array (RGA). RGA analysis suggests that the temperature at the reactor and regenerator could be controlled by manipulating the regenerated catalyst flow rate and air flow rate respectively. Decouplers have been designed to reduce interactions. Conventional PID controllers have been used to achieve control of FCCU using MATLAB and the PID control parameters are tuned using real coded genetic algorithm.

Further, it is known that the conventional PID is a linear controller and it is efficient only for a limited operating range in nonlinear process. To overcome the disadvantages of linear PID controller, a GA based nonlinear PID controller (NPID) is designed. The main algorithm of the NPID controller is based on a nonlinear function of error as inherent part of the controller. The proposed approach has superior features, including easy implementation, stable convergence characteristic, and good computational efficiency. Simulation results are presented to show that the GA based NPID controller is capable of providing an improved closed loop performance over conventional controller parameter.

To date, Type-1 Fuzzy Logic Controllers (FLCs) have been applied with great success to many different real-world applications. The traditional Type-1FLC which uses crisp Type-1 fuzzy sets cannot handle high
levels of uncertainties appropriately. Nevertheless, it has been shown that Type-2 FLC using Type-2 fuzzy sets can handle such uncertainties better and thus produce a better performance. As such, Type-2 FLCs are considered to have the potential to overcome the limitations of Type-1 FLCs and produce a new generation of fuzzy controllers with improved performance for many applications which require handling high level Fuzzy logic control technique in the field of intelligent control has been used, since it does not require perfect model of the process and handles uncertainty very well. In this work, centralized mamdani type Type-1 FLC and Type-2 FLC have been designed for FCCU to control the reactor and regenerator temperature. The closed loop simulation studies for servo and servo with regulatory performance have been carried out for the two controllers and the performances have been analyzed. The closed loop performance indices such as ISE, IAE and ITAE of Type-2FLC are better than Type-1 FLC. Since the performance of fuzzy controller is poor than conventional controller, the most widely used of modern advanced control technique in the industries, linear Model Predictive Controller (MPC) is designed using mcode program.

From the simulation results it is observed that MPC controller is capable of providing an improved closed loop performance over Fuzzy Controller. The linear MPC is efficient only for a limited operating range when it is applied to a nonlinear process. The proposed Multi-Model Predictive Control (MMPC) scheme incorporates multiple MPC’s with switching mechanism which predicts the future plant (FCCU) outputs, based on the past and current values and on the proposed optimal future control actions for different operating region. Simulation results are presented to show that the MMPC control scheme is capable of providing an improved closed loop performance over RGA tuned PID and NPID, FUZZZY and linear MPC. MMPC control scheme has proved their excellence in giving
better results by improving the steady state characteristics and performance indices.

The performance of model based control technique is heavily depend on the availability an accurate model process model and also tuning of model based controller is non-trivial task, Active Disturbance Rejection Controller (ADRC) is developed for FCCU process. ADRC results in extremely simple controller design but achieves high performance in tracking and disturbance rejection than above mentioned controllers.