ABSTRACT

Heat exchanger system is extensively found to be applicable in chemical plants because it can sustain ample range of temperature and pressure. The foremost intention of a heat exchanger system is to transfer heat from a hot fluid to that of a cooler one. To uphold the temperature of the steam (heated or cooled) in a heat exchanger at specified preset value with limited deviations is one of the largely and frequently met control problems in industry. For this purpose, the flow rate regulators are typically used, which control the flow of the fluid at the rate that guarantee specified temperature value of heated or cooled stream at the exit of the heat exchanger. As a result, the temperature control of outlet fluid is of prime importance. In any of the control applications, controller design is the most significant action to be carefully carried out. The controller can be conventional or an intelligent one. The conventional controller does not own the human intelligence whereas in the intelligent controller, human intelligence is entrenched with the help of certain soft computing algorithms. The intended controllers will adjust the temperature of the outgoing fluid to a preferred set point in the shortest probable time, irrespective of the load and process disturbances, equipment saturation and nonlinearity.

To control the temperature of outlet fluid of the heat exchanger system, a conventional P, PI and PID controller could be widely employed. Due to nonlinearity, heat exchanger system is generally hard to model and
control using available conventional methods. As a consequence, intelligent controllers are effectual for nonlinear processes. Control policies such as PID controllers, decentralized controllers, optimal controllers and adaptive controllers are implemented for temperature control of heat exchanger. Due to non-linear characteristics, it is tricky to search out satisfactory outcome by using the normal PID controller. Therefore, it is attractive to augment the capability of the controllers to suit the requirements of recent applications.

The most important cause to build up enhanced methods to design PID controllers is for significant impact on performance upgrading. The basic and essential performance indices that are adopted for problem formulation are settling time, overshoot and oscillations. The prime design objective is to attain high-quality load disturbance response by optimally picking the PID controller parameters. Traditionally, the control parameters have been acquired by trial and error approach, which consumes extra amount of time in optimizing variety of gains. To lessen the complexity in tuning the PID parameters, evolutionary computation practices can be used to crack a broad series of practical problems including optimization and design of PID gains. Intelligent computing techniques like Fuzzy, Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) and Evolutionary Algorithms (EA) have been greatly employed to efficiently attain the searching of global optimum solutions.

In this study, efficient optimization algorithms have been proposed to tune the optimal gains of the PID controllers employed in heat exchanger
systems. The principal aspire of the controller is to uphold the outlet temperature of heat exchanger at an optimal value under shifting operating and load conditions. The operating points and system parameters are gently varied to test the robustness of the heat exchanger system and effectiveness of the proposed controller.

From the simulation results, it is evidently found that the EA based controllers can produce relatively enhanced results with faster convergence rate and with higher precision. As evident from the graphs and empirical results, the suggested algorithm was seen to perform healthy under various disturbances. The simulation results are found to be acceptable in terms of settling time, overshoot and oscillations in comparison with the conventional fixed gain controllers. The combined and synergic use of information yields a promising tool in solving heat exchanger temperature control problems that requires optimization of several diverse parameters. With the application of hybrid EA based controllers, the computational time is greatly trimmed down because of faster convergence of particles towards an optimal solution.