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A fuzzy logic controller application for thermal power plants

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Abstract

This study presents a fuzzy logic based control technique to regulate the power and enthalpy outputs in a boiler of a 765 MW coal fired thermal power plant. An approximate mathematical model of the thermal power plant was developed by using real time data on Computer Aided Design and Control (CADACS) software. Conventional proportional, integral and derivative (PID), fuzzy logic (FL) and fuzzy gain scheduled proportional and integral (FGPI) controllers have been applied to the power plant model. The simulation results show that the FGPI controller developed in this study performs better than the rest of the controllers on the settling time and overshoot of power and enthalpy outputs.

Keywords: Thermal power plant; Modeling; PID controller; Fuzzy controller; FGPI controller

1. Introduction

Enhanced environmental awareness and the requirements for the most economical operation possible of power plants in the past decade have resulted, apart from the application of reduced pollutant emissions efforts, in the use of modern control concepts to improve the control quality.

The dynamic behaviour of many industrial plants heavily depends on disturbances and, particularly, on changes in the operating point. This is especially true for large coal fired power plants

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[2], which represent, from the control engineering point of view, a time variant and non-linear multivariable process with strong interactions. Therefore, they are very difficult to control [3]. The main inputs to a thermal power plant, as shown in Fig. 1, are the flow rates of fuel, feed water, injection water and air flows, while the main outputs from the system are represented by the electrical power, steam enthalpy after the evaporator, which, in turn, is a function of the temperature and pressure of the steam, and by the combustion gas composition. In many cases, it seems advantageous not to consider the total plant model but to reduce it to a number of significant input and output variables for a special partial problem. Mostly, the flow rates of fuel and water as inputs and the electrical power and steam enthalpy as outputs have more importance in the modeling of power plants [2].

All thermal power plants have been controlled by conventional controller techniques, especially conventional PID controllers because of their easy implementation and simple structure [4,5]. Because of changes to cover power demands, quality differences of the coal and contamination of the boiler heating surfaces, conventional three term PID control schemes will not attain a high degree of control performance. Since the dynamic behaviour, even for a reduced mathematical model of a power plant, is usually non-linear, time variant and governed by strong cross coupling of the input variables, special care has to be taken in the design of the corresponding controllers and their schemes [6].

On the other hand, the growing needs of complex large modern combinational power plants require optimal and flexible operation. Not only because of the effects discussed above but also taking into account the expected economical benefits, an improvement in once through boiler control is necessary. To utilize the heat energy released by burning coal with very little loss and also to meet the variations in energy output requirements, recently, modern adaptive control concepts have been applied to such power systems, either in simulations or real time [2,6–8]. These studies have shown that power and enthalpy outputs of adaptive controllers perform better than those of conventional controllers. Both to optimize and improve the outputs of the system and to take care of the above mentioned problems, decoupling networks and advanced control techniques, including fuzzy logic, have been used in such power plants [9]. Over recent decades, there have been many improvements in the design theory of fuzzy logic controllers, and they has been widely used in power plants.

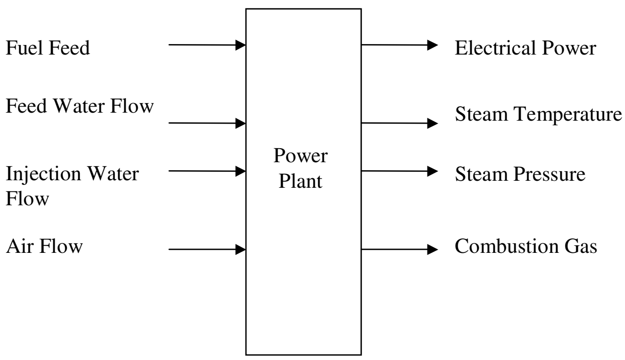

Fig. 1. Power plant as multivariable dynamic system.