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Draft Fan Control Using Fuzzy Logic in Thermal Power Plant

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Abstract: ***In a thermal power plant combustion process in the boilers plays a vital role and it has to be controlled effectively. At present, this is controlled using draft fans employed with DCS. This paper deals with the controlling process using Fuzzy logic. The goal of this task is to manage the Forced draft fan, Secondary air fan, Grid refining fan and induced draft fan in the boiler. Every one of these fans assumes a significant job in controlling the temperature of the boiler during the burning (combustion) procedure. Utilizing DCS to control the temperature is mind-boggling expense and furthermore it needs a different server, a processor and a workstation to complete the procedure. In the case of software based Fuzzy logic controller, the controlling process is the cheapest and the easiest method to maintain and control.***

Keywords: ***Boiler Furnace, FD Fan, Fuzzy Logic Controller, ID Fan, SA Fan***

I. INTRODUCTION

The forced draft fan [4] is utilized to keep up the climatic air inside the boiler for doing the combustion procedure. An induced draft fan is used to suck the flue gases generated in the boiler. It helps to maintain the required pressure. Thus the temperature inside the furnace is maintained by an induced draft fan [4] and a forced draft fan [4]. At the point when the humidity of the fuel is expanded, the temperature gets diminished [1]. In the mean-time it is necessary to increase the speed of rotation of the fan. A secondary air fan (SA fan) is used in the boiler to increase the speed. To reduce the unburned fuel in the boiler the Grid refining fan is used (GR Fan) [7].This paper clearly explains about the controlling of the speed of the draft fans used in the boiler in accordance with the presence of humidity level in the fuel and also the oxygen content in the boiler.

II. FURNACE IN THERMAL POWER PLANT

Furnace is the important part in the boiler. It produces required heat in order to produce steam inside the boiler. The fans involved in furnace operation are forced draft fan, induced fan, grid refining fan and secondary air fan. Heater temperature inside the boiler is kept up with assistance of a Forced Draft fan [FD] and an induced Draft fan [ID]. In furnace a travelling grate is present which is used to move the fuel inside the furnace. In furnace, a Grid Refining fan [GR] is used to recycle the unburned coal inside the boiler. The Secondary Air fan [SA] is used to provide additional air to the furnace for the combustion process. Ash is collected in the ash hopper and it is carried along with the fuel used in the furnace. Coal is used in order to produce required heat for the production of steam inside the boiler in the thermal power plant [2]. In the ash conveyor water is used to carry the ash.

III. FORCED DRAFT FAN

A FD fan is utilized to supply ignition air into the framework. The working range of this fan is usually above atmospheric pressure. The Forced draft fan is utilized to give important oxygen to the burning procedure. Control is accomplished by regulating the fan speed or damper operation [3]. The Fig 2 shows the location of the FD fan in the boiler. Care should be taken that the Forced draft furnace must be airtight in order to avoid the outflow of flue gases around the neighbouring area.

The FD fan is associated with the base of the heater.It makes the fuel combustion in an efficient manner. Either steam turbine or electric motor is used to drive the Forced Draft fan.

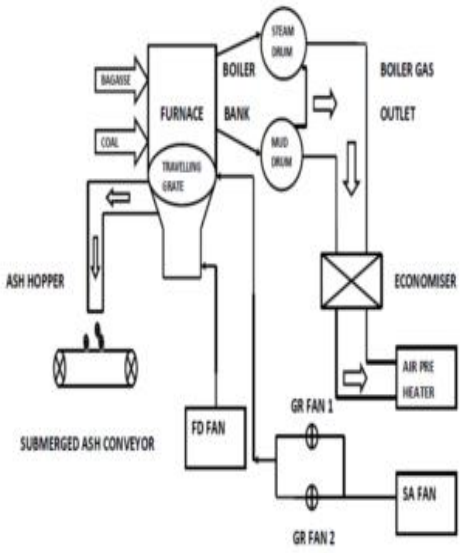

Fig. 1 Furnace Operation

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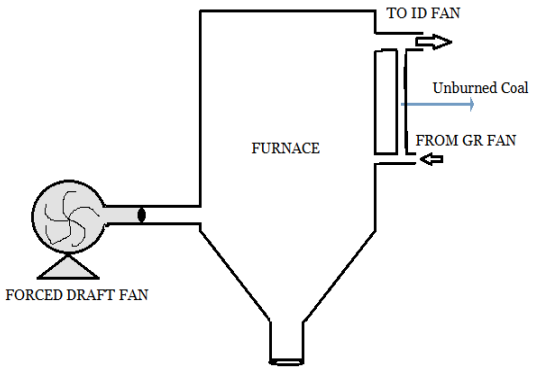

Fig. 2 Forced Draft Fan [4]

IV. INDUCED DRAFT FAN [4]

An ID fan goes about as a vacuum pump which is introduced among boiler and stack [4].The flue gases from the boiler are sent to the atmosphere through this fan. The system is controlled by regulating the speed of a fan. It is connected at the top of the boiler. The pressure present in the furnace is somewhat lower than the pressure in the atmosphere [5].In this type of fan a negative air pressure is maintained to avoid backfire. In order to prevent the air leakage in the boiler, the casing and the opening of the Boiler are sealed properly. The unlocked packaging may bring down the limit and proficiency of the fans.The Fig 3 shows that the location of ID fans in the boiler.

The boiler [4] packaging is basic to be manufacture sufficiently able to withstand the outside weight of the air.

V. SECONDARY AIR FAN AND GRID REFINING FAN

It is placed in the middle of the boiler. The grid refining fan is mainly used for the re-combustion of unburned fuel to the boiler which makes to reduce the wastage of coal from the boiler. Due to this there is less scarcity of coal and also it reduces the cost of coal. The GR fan gets its input air from the secondary air fan. So the outlet pressure from GR Fan is low when compared to Secondary Air Fan [6].

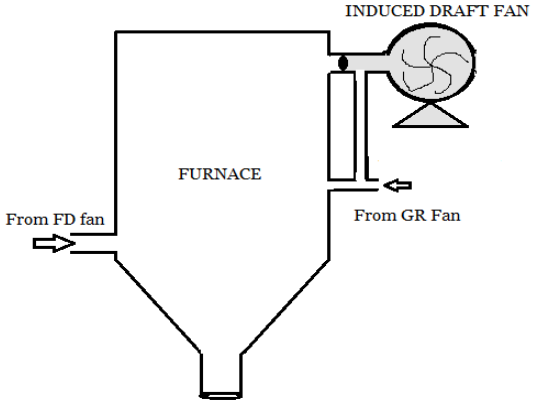

Fig. 3 Induced Draft Fan

The Fig 4 demonstrates the area of GR fan in the evaporator. It is put at the base of the heater. The optional air

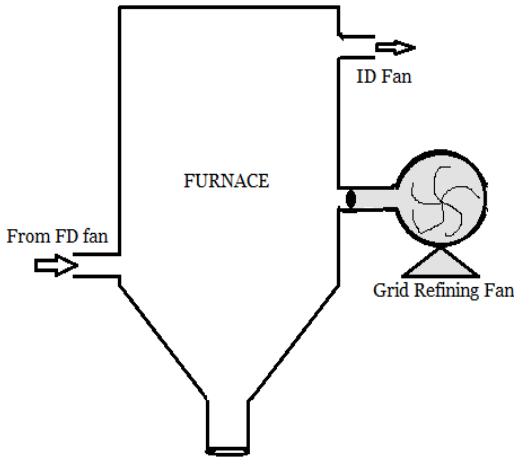

Fig. 4 Grid Refining Fan

fan is chiefly utilized for sending the additional air supply to the kettle. So the burning in the evaporator happens consistently without the loss of heater temperature. The wellspring of the SA Fan is from the yield of FD draft fan [6].So the outlet weight from the SA Fan is similarly low contrasted with the FD Fan

VI. FUNDAMENTAL BLOCK DIAGRAM OF FURNACE

The fig.5 demonstrates the interfacing of equipment with Mat lab programming. The communication cable is used as a interfacing cable between the hardware devices and the software. The humidity sensor output is as the input to the software and thus the fans will be controlled.

VII. PID CONTROLLER

In the industries, for controlling the process variables PID control is most widely used [7]. The change in the actual value and the measured value of the controlling variable is calculated as error value. The utilization of the controlled variable is to modify the procedure to limit the mistake. The PID controller calculation includes three separate consistent parameters, the corresponding, the basic and the subordinate qualities, meant as P, I and D [8].In PID control the relative control relies upon the present blunder, Integral control relies upon the amassing of past mistakes and Derivative control relies upon the expectation of future blunders, in view of current rate of progress.

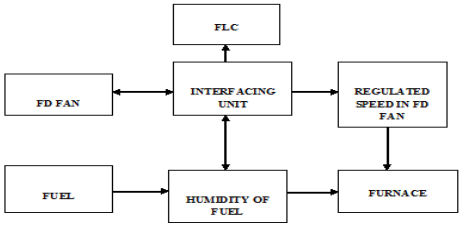

Fig. 5 Furnace Block Diagram

VIII. FUZZY LOGIC CONTROLLER

The Fuzzy Logic Controller[12] Algorithm can be well explained by the term Fuzzification, Defuzzification, Inference Engine, etc.The fuzzy logic system chosen for the draft fan controlling process has multiple input and single output. This system has n variables A_1,A_2,…A_n. The control action can be well explained by the "if-then" rules and the input variables are first transformed into their linguistic variables [9]. The process of converting the input variables into their respective linguistic variables through different membership functions is called fuzzification. It is the first process in the inference engine.

In the inference process, the output is determined by the linguistic values (fuzzified output).The process of converting the fuzzified output into a crisp value is called Defuzzification [10]. In this architecture all the rules are evaluated to produce the final fuzzy value which is converted into a crisp set by defuzzification process. The combination of fuzzy inputs and the generated outputs are done with product operation or sum operation respectively. In the Fuzzy Logic Controller the defuzzified value is used to control the required process. Some of the Defuzzification methods used are [12]:

- Centre of Sums Method(COS)
- Centre of Gravity(COG)
- Centre of Area (COA)
- Maxima Methods

In this paper we have used Centre of area method (COA). The triangular fuzzy sets are utilized for information sources (inputs) and yields (outputs). The entire fuzzy logic controller is dependent on the fuzzification, Defuzzifictaion and the knowledge base. The FLC is based on the following constraints.

Constraint 1: The triangular fuzzy sets are used in the fuzzification process.

Constraint 2: For each adjacent fuzzy set the width is extended to its peak value. The addition of the membership values over the gap between two adjacent sets will be one. Over the universe, the sum of all the membership functions at any time for a control variable will be one and it is called as fuzzy partition [11].

Constraint 3: The Centre of area method is used as the defuzzification method which is same as that of the method used to obtain the weighted average of all output values [12].

IX. SIMULATION RESULTS

This paper clearly explains about the operation of Induced draft fan [4], Forced draft fan [4], Secondary air fan and Grid refining fan. As indicated by the stickiness of fuel and oxygen content in the boiler the progression of air will be controlled. Here the information parameters are humidity, speed of the transport line and the oxygen content in the boiler. The yield parameters are speed of the incited draft fan, speed of the constrained draft fan and the speed of the auxiliary air fan. The fig 6 is a FIS manager, fig 7 is a contribution to the framework (Humidity input), fig 8 is the FD fan yield and Fig 9 is an ID fan yield in the Fuzzy rationale controller

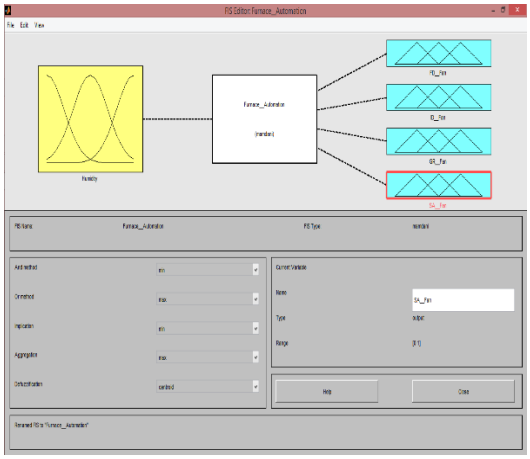

Fig. 6 FIS Editor Window

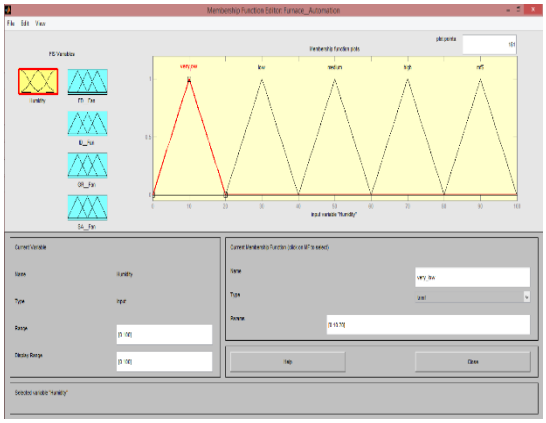

Fig.7 Input Humidity

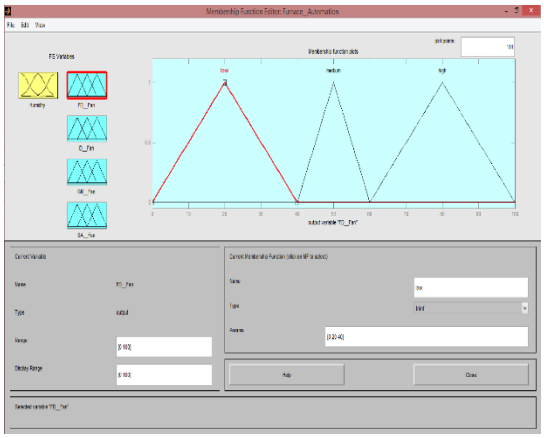

Fig. 8 FD fan output

As indicated by the humidity and speed of the transport line, the speed of the draft fans will be controlled. On the off chance that the humidity gets expanded the speed of the FD fan will be expanded. On the off chance that the speed of the FD fan gets expanded the weight in the heater will increments. So for lessening the pressure in the boiler the speed of the ID fan ought to be expanded.

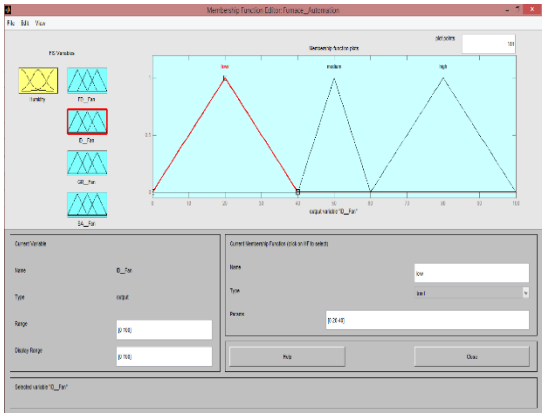

Fig. 9 FD fan output

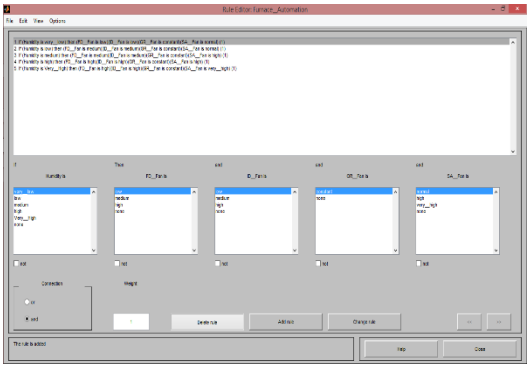

Fig. 10 If then Rule

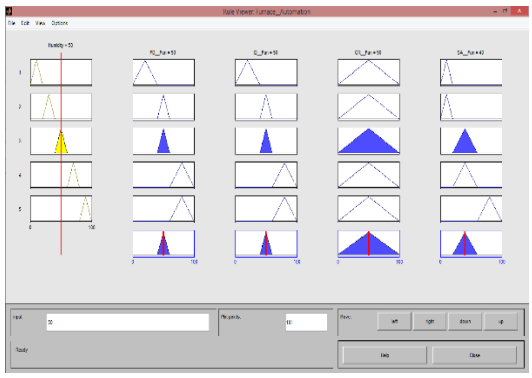

Fig. 11 Rule viewer output

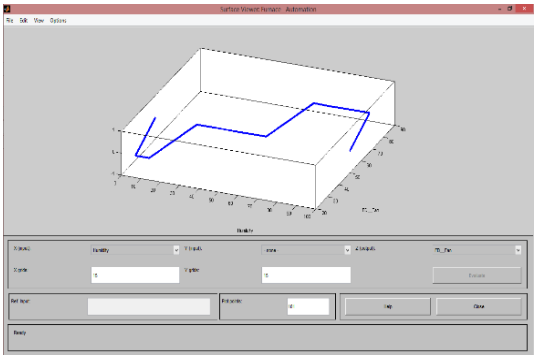

Fig. 12 Surface viewer output

The fig 10 demonstrates the guidelines given to the FLC and the fig 11 demonstrates the Rule viewer output and the fig 12 demonstrates the Surface viewer output.

X. CONCLUSION

It is clear that the FLC can be utilized to control the combustion procedure in thermal power plant.Thus the proposed method is proved to be efficient and cost effective. It is implemented in the Coal and Bagasse based Thermal power plant at EID Parry Sugar India Limited, Karur with the existing method of controlling the boiler using DCS system.

XI. FUTURE SCOPE

Fuzzy logic control is an efficient intelligent controlling method used for linear and non linear systems. So far the traditional controllers are used for controlling temperature in the boiler. The disadvantage is that it produces errors when there is a variation of load and nonlinearity in the system. But an intelligent control system can be easily implemented in boiler and other steam temperature control and water level control applications.

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