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On Line Dirt Based Soot Blowing System using Fuzzy Logic for Utility Boilers

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Abstract: ***Soot is a byproduct of burning coal in thermal power plants. The soot accumulates in the boilers tubes. It gradually spoils the heating surface which reduces the heating efficiency. Hence it has to be cleaned. This process is called soot blowing. The existing soot blower control system in the old boiler is composed of relays, timers and contactors which are not efficient. In order to improve the efficiency, an intelligent system is proposed which estimates the dirt in the boiler tube periodically and initiates soot blowing process to improve the thermal efficiency. Simulation results demonstrate the superiority of the proposed scheme when compared to relay logics.***

Index Terms**: *A Boiler, Soot Blower, Intelligent Control.***

I. INTRODUCTION

In a thermal power plant combustion of boiler is with coal as fuel. Flue gas is utilized to heat the water tubes in the boiler. The flue gas is the product of combustion that has ash contents which stick to the water tubes. This is called "soot" which is a thin layer with high density ash content sticking on to the boiler water tube. This will affect the heat transfer. Due to this temperature of the surface area increases causes overheating of the tube. The strength of the water tube weakens and a small pinhole puncture will develop. This may lead to a forced shut down of the boiler thereby entire plant. Removing soot is carried periodically to clear the soot deposits is called soot blowing operation. Steam with high velocity is impinges on the tubes to remove the soot by a motor operated motor with forward and reverse direction. There will be many soot blowers distributed equally in the surface of the boiler. Soot removal will be carried out periodically for fixed period of time according to the surface area of the boiler. A cleaning cycle is a period will vary with size of boiler, and fuel used.

Singrauli Sadhana Singh et al , [1] presented an efficient system to reduce the loss and maximize the efficiency.

Acharya Chirag et al [2] addressed performance of the boiler by considering heat energy in an optimal way.

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Akash Singh et al [3] presented a solution to avoid unnecessary shutdown of the unit due to soot etc.

Manoj Kumar [4] proposed a fuzzy technique in critical areas of Soot Blowing optimization. Timer is used to control dirt on a predefined time period. Some instances, certain boiler stages are blown unnecessarily, resulting in efficiency loss. Therefore a fuzzy based system is proposed which shall indicate individual section cleanliness to determine correct soot blowing scheme. Practical soot blowing optimization improves boiler performance, reduces NOx emissions and minimizes disturbances caused by soot blower activation. Therefore a fuzzy based system is proposed to replace the existing conventional controllers.

T.K Sai et al [5] proposed an intelligent scheme by deciding the soot blowing operation as per the density of the dirt at a particular time.

Taneshwaren Sundaram et al [6] addressed with a intelligent system, which analysis the condition of the boiler soot to carry out the cleaning operation.

The existing soot blower control system in the old boiler is composed of relays, timers and contactors which are not efficient. In order to improve the efficiency, an intelligent system is proposed which estimates the dirt in the boiler tube on line and initiates soot blowing process to improve the thermal efficiency. Simulation results demonstrate the superiority of the proposed scheme when compared to relay logics.

II. EXISTING SYSTEM

A soot blower is a device for removing the soot that is deposited on the furnace tubes of a boiler during combustion and prevent plugging of gas passes and maintain boiler efficiency.Types of soot blowers are, Wall Blowers Long Retractable Soot Blower and Air Heater Blower. Relay system is used for sequential operation for a predetermined time.Relays are electromechanical devices shown in fig 1a&1b.that use an electromagnet to operate a pair of movable contacts from an open position to a closed position and also close position to a open positionSteam is normally used as a medium for blowing away the soot.Programmable Timer logic with relay system for soot removal is used to remove dirt in the boiler water tube and super-heater tubes. At scheduled period, the soot blower operation begins with pressurized steam. The schedule will be in sequence. First wall blower then long soot blower fitted for super heater area. Finally Air heater area will be carried out. For all areas, the operating time is fixed irrespective of the dirt.

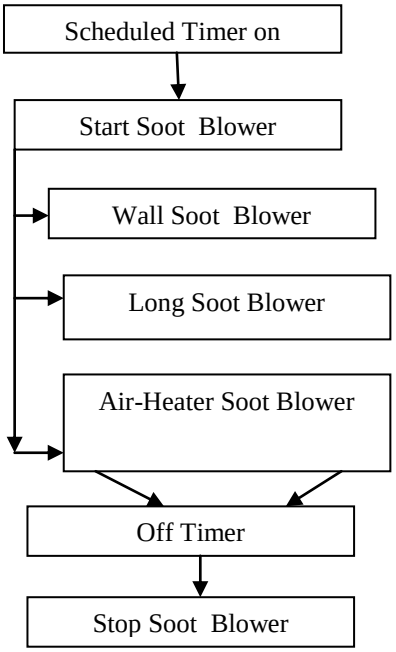

Fig.1a. Time based Soot-blowing

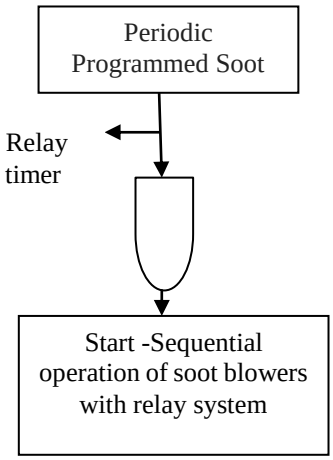

Fig.1b. General Timer and Relay based Soot Blowing system

Relay sequence with timer	
1.	soot blower pipeline clearance
2.	Open drain valve to remove water
3.	The drain valve is shut off
4.	Turn on the soot blower
5.	Timer on
6.	Timer Off &Steam supply off
7.	shut off the steam supply valve

Fig 2. Relay logic sequence Soot blowing operation is being

Soot blowing operation is being activated once in a day for a particular period of time as per the boiler capacity.

III. PROPOSED FUZZY SCHEME

The process designing the Fuzzy controller design are:(fig. 3.) Formulation of the inputs and outputs using linguistic variables
Membership functions to the variables
Forming a rule matrix
Decision formation
Generating a crisp control action (defuzzification)

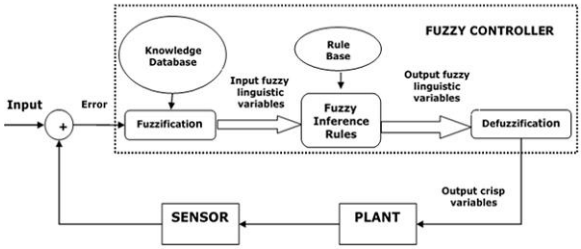

Fig 3. Fuzzy System Block Diagram

The input variables for the proposed fuzzy system are 1. Metal temperature of the super heater 2. Flow of water to control the steam temperature 3) Angular position of Burner 4) Load 5) Flue Gas Temperature 6)CO in flue gas,7) Air/Fuel ratio 8) Smoke density. Output variables: Wall soot Blower and Long soot Blower operation and on-off sequence.

A method of estimating dirt in furnace is estimated by using fuzzy rules (fig.4.). For example If the Load is low, Metal Temp is high, Water flow to temperature control is High, Flue Gas CO more,S moke Density more,Furnace tilt is down and economizer outlet temperature is High then start soot blowing. If already soot blower is running then continue for more duration.

The modular based hardware design consists of the following: 1) Signal conditioning and input module, 2) Microcontroller interface module, 3) Start-up/shutdown module, 4) Output module, 5) Display module, 6) Alarm module and 7) Protection module.

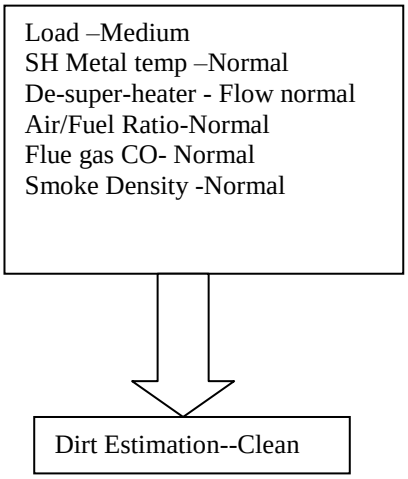

Fig.4. Fuzzy Rule for Dirt Estimation

Software includes of the following activities: diagnostic, formulation of input and output parameters, manipulation of information, declaration of the inputs to the variables, I/O signals, assignment of the output variables, assignments of results to the respective blowers, assignment of data for alarm and protection.

IV. CONCLUSION

A soot blower is a process for clearing the soot that is settled on the boiler water tubes from the product of combustion. This will improve the heat dissipation their by improving the efficiency of the steam generator. The performance of the proposed soot blowing system is more efficient than the conventional relay controller. The proposed soot blowing system is on line and based on dirt in water tubes in a boiler. It replaces time based relay system with on line dirt monitoring and control system.

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