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Studies and Research on Operation, Modeling and Simulation of Boilers: A Review

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ABSTRACT

Energy saving is very important for economical and cost effective operation of the facility. In boilers, steam is produced for various process, utility and instrumental applications. It is very important to operate the boiler with proper operating conditions. The parameters like level of feed water, steam temperature and flow of steam need to be optimized. Various studies are carried out on optimization of these parameters by using various software tools. Experimental data can be used to develop models. The present review aims at summarizing the research and studies carried out on various aspects of boilers such as operation, modeling, simulation and optimization.
Keywords: Efficiency, Power, Savings, Heat Recovery, Input, Output

I. INTRODUCTION

Energy and environment are two increasingly important areas in the modern economical and environmental scenario. Saving energy means less requirement, leading to less production and hence less harm to environment. Energy requirement can be minimized by pinch technology[1] Also use of nonconventional energy sources is being explored[2,3,4] The energy sources are depleting and studies are now concentrated on non-conventional energy resources[5,6].The boilers consume considerable amount of energy for their operation. The boiler operation and its efficiency is very important research area. The boiler efficiency can be maximized by optimizing operating parameters such as water input, air input and temperature. Proper control and instrumentation techniques can avoid excess use of power. The present review summarizes research and studies on boiler operation, simulation, modeling and optimization.

II. STUDIES AND RESEARCH ON BOILERS

Panxiang carried out investigation on boiler combustion process based on the improved RBF neural network [7]. They set the model to single input and single output system as the research object.Then they used the particle swarm optimization algorithm to optimize neural network. They observed that combustion efficiency of the entire system reached 94%.They concluded that the accuracy of the system model was significantly better than ordinary neural network. Waste heat recovery from an air conditioning unit was used as a source for performance improvement of a boiler by Jain et.al.[8].According to them it is high time that we concentrate on waste heat recovery by making significant and concrete efforts. The main objective of their research was to study and analyze the feasibility of retrofitting the waste heat recovery system for hot water generation. Karuppiah et.al. Investigated an embedded based power plant boiler automation using GSM [9].They proposed a system with one water tank and number of boilers. The valves were controlled by temperature sensors located at each boiler. The water level in main tank was controlled by water level indicator. A GSM mobile system with a PIC microcontroller, GSM modem, sensors and different interfacing circuits was used for the operation.

Chakraborty et.al. Carried out investigation on three-elements boiler drum level control for power plants [10]. According to them, the amount of water entering the

boiler drum must be balanced with the amounts of steam leaving and therefore it is extremely important to have the knowledge of the operating principles, installation requirements, strength and weaknesses of drum water level control system. Mohod et.al. Carried out energy analysis of baby boiler for steaming of raw cashew nut seeds [11].They observed the variation in steam pressure, temperature and operating time with respect to fuel. They observed that the thermal efficiency of boiler using electricity as a fuel was higher (69.31%) as compared to 4.66% (Wood) and 4.47% (Cashew nut shell). They concluded that the improvement in the biomass combustion efficiency for steam generation could results in less fuel consumption and shorter period.

Sunudas and Prince carried out work related to optimization of boiler blowdown and blowdown heat recovery in textile sector [12].They found that 1.5% of coal of total coal consumption was wasted in an industry by improper blowdwon. By installing the heat recovery system, they were able to recover nearly an 85% of total wasted fuel. Krishnan and Prathyusha utilized soft computing techniques to optimization of main boiler parameters[13].They optimized the main control parameters of process industries such as level of feed water, steam temperature and flow of steam by using ANFIS with PID controller. An ANFIS system is an adaptive network in which each node performs a particular function with respect to the incoming signals. Parameters are updated according to the given training data and a gradient-descent learning procedure. They used MATLAB software for optimization.

Babu and Das carried out studies on the implementation of condition based maintenance on boiler feed pump critical Machine used in the thermal plant, by adopting vibration spectrum analysis which is a predictive maintenance technology[14].They observed that due to looseness problem in the main pump bed bolts, the large increase in vibration frequency was observed. In order to reduce the problem, they tightned the main pump bed bolts and checked the impeller casing of the shelter of the main pump for looseness and adjusted it. Kumar et.al. Investigated boiler efficiency through incorporation of additional bank of tubes in the economiser for supercritical steam power cycles in order to economize the operation [15].They observed that the major efficiency loss of a boiler was caused by the hot stack gases discharging to the atmosphere. Installing an economizer on the boiler was most effective way to optimize the boiler operation. According to them, 2 to 4 percent increase in the efficiency can be achieved by using an economizer.

Hamid et.al. carried out an investigation on automatic detection and analysis of boiler tube leakage system[16]. According to their studies, approximately 60% of boiler outage was due to tube leakages.They used acoustic signal processing methods to detect leaks in pressurized systems of utility and industrial power plants.They obtained specificity of 94% and sensitivity of 92%. Sorensen et.al. studied optimization of boiler heating surfaces and evaporator circuits[17].They developed a model for optimizing the dynamic performance of boiler.They also included a function for the value of the dynamic performance. Lahane and Khandekar carried out an investigation on mathematical modeling of boiler and heat exchanger pilot plant by system identification procedure[18].They first acquired data from boiler and heat exchanger set-up and then used it for mathematical modeling. They observed that with slight delay and overshoots, the controller follows the model with less oscillations and the respons e is very fast.Turzynski carried out an investigation aimed at presentation of the results of experimental research conducted on helical coil biomass boiler with oil as a heating fluid[19]. For studying the characteristics of the device in terms of power, efficiency and oil parameters for moderate/high excess air numbers and fuel flow rates, they used experimental data.They observed that the maximum efficiency of the boiler unit was 83%. It occured for low air excess numb ers and oil flow rates. Also they found that the air flow gives a significantly wider power control range (up to 5 kW).

III. CONCLUSION

The boiler operation can be optimized by using proper operating conditions. The experimental data can be used for simulation of operating conditions. The studies carried out suggests that the optimization of water flow, temperature and air flow rate can lead to efficient and economical operation. Also it is very important to have proper measuring and control system for accurey control of the operating parameters.

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