Blow down Losses Control in Thermal Power Plants Using Neural Network

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ABSTRACT:

This paper considers an approach to design a controller used for blow down optimization in the losses reduction process of a power plant boiler. The optimization of the BD will maintation TDS level and reduce the indirect heat losses.. Efficiency of any Boiler depends upon minimization of various indirect losses of the boiler so that amount of energy input in the boiler by burning the fuel can be maximum utilized for generation of steam and cost of steam can be minimized ultimately. The proposed back prapogation technique can prove to be a very effective tool for evaluating and maintain boiler efficiency and indirect losses. This neural network technology offers an best method for desigining a neuro control based on back propagation. The advantages of using a neural network to represent a system are it's ability to perform a nonlinear mapping between inputs and outputs and the necessity of requiring minimal prior knowledge of the system.

Key Word: Artificial neural network, Boiler efficiency, indirect losses, blowdown losses.

INTRODUCTION:

As steam is generated, water is evaporated in its pure form leaving practically all of the dissolved minerals behind . Steam is essentially distilled water. Thus the remaining boiler water contains the minerals which are left behind by the evaporating steam. As these minerals concentrate in the boiler, they too begin to cause problems and must be removed. Problems noted are the carry over of boiler water into the steam causing wet steam which has a lower overall BTU content and thus requires the generation of even more steam to provide the desired heating. This results in the loss of additional fuel. The additional water in the steam must be removed by the steam traps which can be seriously over worked and damaged, thus shortening their life. Finally it is possible for the wet steam to leave behind mineral deposits that insulate the steam side of heat exchangers preventing efficient heat transfer. To avoid unnecessary losses of heat, blow down should be kept as low as possible and part of this loss can be recovered by heat exchanger monitoring and the useful heat being used to preheat feed water heat.

Table1: Model Report Format for Boiler Efficiency and Indirect Lossess System

CODE: AL1 **DATE**: 19/12/12 12:00 AM
FUEL: OIL

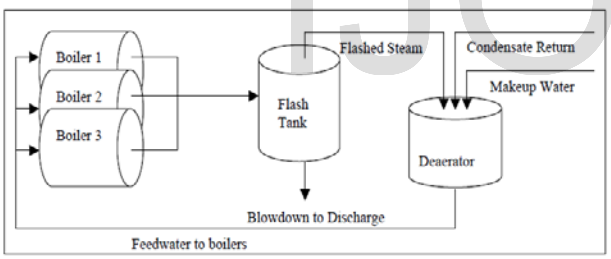
BOILER EFFICIENCY	**69.35**
INDIRECT LOSSES	**30.65**
(I) DRY FLUE GAS LOSS	7.42
(II) FUEL MOISTURE LOSS	6.31
(III) BLOW DOWN LOSSES	**14.77**
(IV) INCOMPLETE COMBUSTION LOSS	0.00
(V) AIR MOISTURE LOSS	0.00
(VI) RADIATION & CONVECTION LOSS	2.15

COURTESY:- THERMAX BOILER,J.K.PAPER,RAYAGADA

NEED OF WORK

In addition to proper blowdown practices, including the use of automatic blowdown control, reducing cost and heat loss associated with boiler blowdown can also be achieved through recovering the heat/energy in the blowdown. The blowdown water has the same temperature and pressure as the boiler water. Before this high-energy waste is discharged, the resident heat in blowdown can be recovered with a flash tank, a heat exchanger, or the combination of the two. Any boiler with continuous surface water blowdown exceeding 5 percent of the steam generation rate is a good candidate for blowdown waste heat recovery.

The flash tank system shown in the figure below can be used when expense and complexity must be reduced to a minimum. In this system, the blowdowns from the boilers are sent through a flash tank, where they are converted into low-pressure steam. This low-pressure steam is most typically used in deaerators or makeup water heaters.



Schematics of a Flash Tank System

fig.(1)

The system shown below consists of a flash tank and a heat exchanger. The temperature of the blowdown leaving the flash tank is usually still above 220°F. The heat of this flash blowdown can be used to heat makeup water by sending it through the heat exchanger, while cooling the blowdown at the same time. Heating boiler makeup water saves on fuel costs. An additional advantage of cooling blowdown is in helping to comply with local codes regulating the discharge of high temperature liquids into the sewer system.

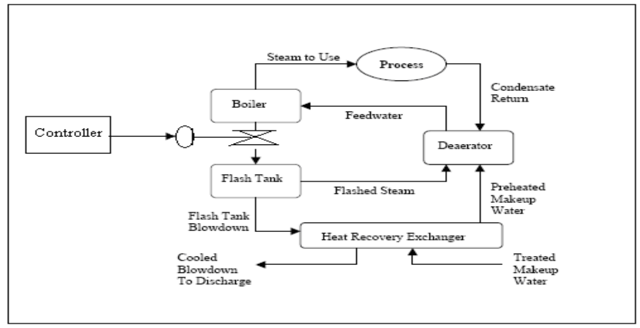
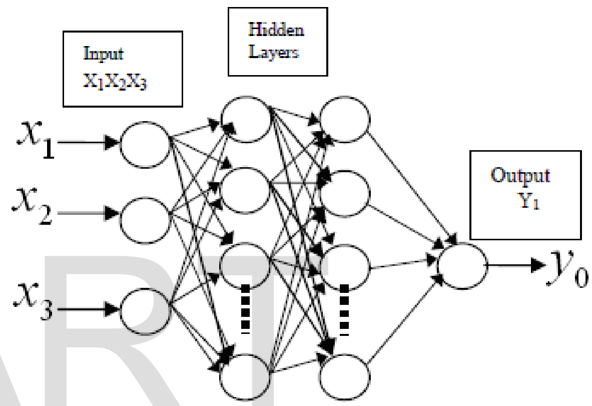


Fig.2 Conventional method of contorl

Proposed Neural Network Model



ANN architecture for the feed control station

Fig.3

There are many ANN architectures for which the choice depends on the type of problem and may require experimentation of different algorithms. One of the most popular architecture is a multilayer perceptron with the back propagation (BP) algorithm. BPNN (Back propagation neural network) is applied for the prediction of TDS in flash tank It is proved that a four-layer (with two hidden layers) perceptron can be used to approximate any continuous function with the desired accuracy. BP has been used successfully for pattern classification, though its original development placed more stress on control applications. A controller is usually connected serially to the controlled plant under consideration. For a multilayer perceptron, the weights of the network need to be updated using the network's output error. For an ANN-controller, the output is the control command to the system. However, when the

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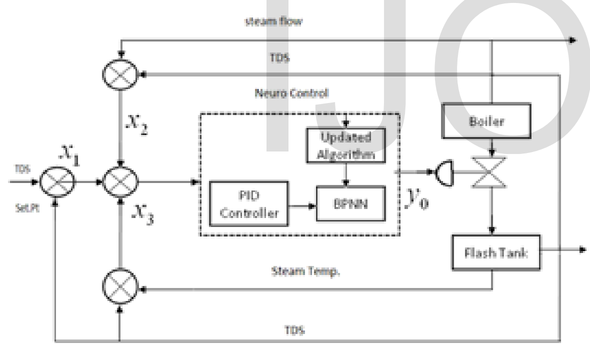
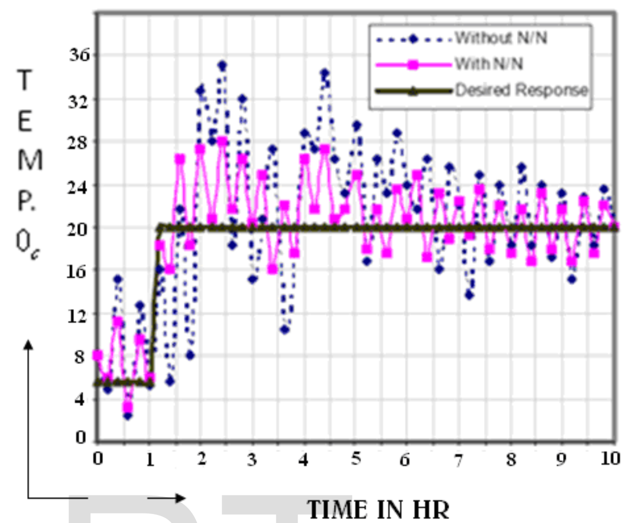
ANN is serially connected to a controlled plant, the network's output error is unknown, since the desired control action is unknown. This implies that BP cannot be applied to control problems directly. Thus, one of the key problems in designing a neural network controller is to develop an efficient training algorithm. Fig. 4 shows the ANN architecture for the TDS control station of the power plant. This is used to control the blow down of the of the Boiler. In this model, there are three inputs: TDS level, temperature of steam on flash tank, steam flow and one output are opening of the pneumatic valve in the blow down control system. The valve regulates the excess water in the blow down system and feed water line. Trials are performed using two hidden layers with the number of neurons one hundred in each of hidden layer, three neurons in the input layer and one in the output layer. Training the ANN is an important step for developing a useful network.



Blow down lossess control with BPNN
Fig.4

RESULTS AND DISCUSSION

The blowdown losses of the Boiler is one of the most sensitive parameter involved in all Thermal Power Plants. This parameter is directly related to the control of the steam and water temp at blow down . and the control of the TDS. A careful study was done on the existing PI controller system in the Power plant and compared with the designed ANN model. The unstable condition of boiler is considered to observe the effect of neural network to blowdown losses . The results obtained with the proposed neural network of the boiler plant shows that back propagation can converge the neural network to improve performance. fig. 5. shows comparison of neural network results with desired blowdown control and percentage of deviation of blow down without neural network. It has been clearly proved that the ANN model is more accurate and efficient making the system robust and reliable as compared to the former.



Blowdown temp control with BPNN
Fig.5

The results of ANN are very sensitive to number of neurons.Increasing the number of neurons in hidden layer will decrease the number of calculation steps with subsequent decrease in summed squared error. The proposed ANN controller can replace a conventional controller, and is shown to overcome most of the problems mentioned above. A training algorithm is derived based on BP, enabling the neural network to be trained with systemoutput errors, rather than the network-output errors. In the BP algorithm, weights need to be modified by using the network-output error that is not known when a multilayer perceptron is applied directly to the controlled plant. Therefore, the proposed algorithm enhances the NN's ability to handle control applications. The only a priori knowledge about the controlled plant is the direction of its response, which is usually easy to determine. The proposed ANN controller has been applied to the blow down control in a thermal power plant and extensive simulations conducted show promising results. As per Fig.6 we determine that the maximum effective operating range is between 4500 μmhos and 5000 μmhos, then we can set the controller to control blowdown at that range (as shown below). Below 4500 μmhos we are wasting water, chemical, and fuel. While above 5000 μmhos we are risking the generation of wet steam.

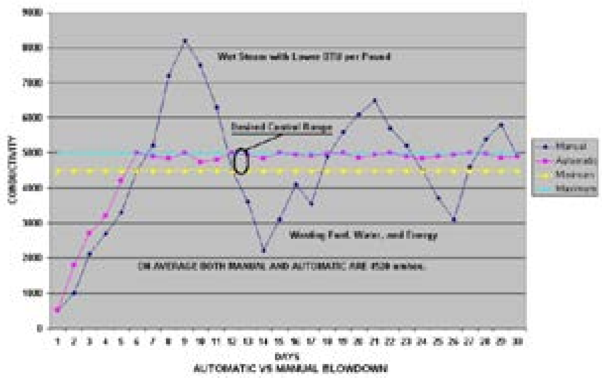


Fig.6

CONCLUSIONS

The proposed back propagation neural network proves to be an efficient modeling system for calculation and optimization of the Blow down. It significantly reduces the frequency of deviations and the degree of deviation of the TDS that can reduce indirect losses .the tripping of the boiler during load fluctuations. Focusing on process control systems, a new direct adaptive controller using neural networks has been designed and tested for the Blow down control in a thermal power plant. For such a control system, the negative effects of a long system response delay and nonlinear elements are the main obstacles in designing a high performance controller and fine-tuning its parameters. Good performance, a simple structure and algorithm, and the potential for fault tolerance make the proposed ANN controller attractive for process-control applications by proper use of this ANN technique it is possible to increase boiler efficiency and also consistency of boiler efficiency can also be maintained. This may serve as an important tool for the management to exercise effective energy conservation and cost control measures. In order to compete with international products, there is no other alternative but to go for automation in near future. This approach may act as a precursor to that.

An approach to design a ANM controller used for the blow down control optimization in the process of a power plant boiler has been presented. The optimization of the BDC will reduce the in direct losses and improve the efficiency in the boiler system.

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