Study and Performance Improvements of Cooling Tower by Using VFD

N.Viswanathan[1],
[1]Assistant professor,
Mechanical Department,
Nandha College of Technology, Erode,

S. Niranjan[2], T. Pradeepkumar[2], T. Sarathbabu[2], P. Tamilarasan[2]
[2]UG Student,
Mechanical Department,
Nandha College of Technology,
Erode, India,

Abstract*—— *In our country energy is the major resource. Most of the energy can be generated and developed from solar cells, bio gas, natural gas etc.., steam power plant continue to be competent because of usage of water as the main working fluid which is abundantly available and is also reusable. Under inadequate control, the cooling water system can present significant difficulty to the plant in loss of production capacity, increased energy and maintenance costs, and a reduction in service life. Although regular checks are made to determine water quality and compliance with prescribed operating conditions, these checks can be infrequent enough to allow problems in this system and present cooling methods are not adaptable for current seasonal condition. Our project is based on improving the performance of cooling water system in thermal power plant at 210MW. So we are mainly focusing on thermal power plant .In thermal power plant we have to maximize the turbine efficiency. So accommodate the power generation we have to maximize the condenser efficiency by the following methods. They are water purification in cooling water system, variable frequency drive (VFD) used in cooling tower. Using this method we have to maximize the condenser efficiency in order to automatically maximize the turbine efficiency for improving power generation.

KEYWORDS— ***VFD, Cooling water system, purifying water system.***

1.INTRODUCTION

A thermal power station is a power plant in which heat energy is converted to electric power. In most of the places in the world the turbine is steam-driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated; this is known as a Rankin cycle. The greatest variation in the design of thermal power stations is due to the different heat sources, fossil fuel dominates here, although nuclear heat energy and solar heat energy are also used. Some prefer to use the term energy center because such facilities convert forms of heat energy into electrical energy. Certain thermal power plants also are designed to produce heat energy for industrial purposes of district heating, or desalination of water, in addition to generating electrical power.

2. LITERATURE REVIEW

Chetan T. Patel, Dr.Bhavesh K. patel, Vijay K. Patel (2013) analyzed that boiler is a most useful device and it is necessary to optimized good boiler efficiency. Boiler efficiency can be measured by two method, direct method and indirect method. Both methods give a different result. Direct method did not include any losses for calculating boiler efficiency, while indirect method includes all the heat losses from a system to find boiler efficiency. As the heating value is high, efficiency is also increased with increased with the higher GCV coal. Compare with the different GCV of coal to find out the proper fuel selection of fuel. There are different parameters regarding to the boiler system which helps to improved boiler efficiency.

Dr. V.S.Deshpande(2014)examined thatBoiler tube failure is the prime reason of forced Outages at coal fired thermal power plants.With ever increasing demand for electricity, it is very necessary for the power plants to generate electricity without forced outages. This paper illustrates cause & effect analysis of boiler tube failures. The data pertaining to boiler tube failures for one of Thermal Power Plant in Maharashtra State of last ten years is referred. Out of total 144 failures, 43 failures are observed in Economizer zone. Economizer is the main part of the boiler in the furnace second pass. It is the medium for transportation of the feed water to boiler drum. It helps to increase the boiler efficiency. Economizer is placed in the flue gas path, to absorb the heat from the flue gas and increase the temperature of the feed water. Factors contributing for Economizer tube failure include stress rupture, fatigue, erosion, water side corrosion, fire side corrosion and lack of material quality. Out of these factors Erosion is the prime factor contributing for tube failure as referred from literature review. Erosion is a process in which material is removed from the surface layers of an object impacted by a stream of abrasive particles. Factor influencing the Erosion is the velocity of flue gas, the temperature of flue gas, the mineral content in coal, the arrangement of pressure parts and deviation from design condition. Amongst these factors velocity of flue gas ash particle has the predominant effect on erosion of economizer tubes. Boiler tube failures results in loss of 465 Million Of Units (MU's) in power generation.

Moreover the severe service condition in coal fired thermal power plants causes failures such as the effects of high temperature, erosion, stress, vibration and corrosion combined resulting in failure of the boiler tubes thus it is extremely important to determine and correct the root cause to get your boiler back on line and reduce or eliminate future forced outages.

A Ashok Kumar (2007) stated that Boilers in a Thermal power plant are to be operated efficiently to achieve higher plant efficiency in the present day market economy. Many of the boilers operating today are performing at efficiencies that are less than 60 percent. Hence there is huge potential for energy improvements and cost savings leading to higher profits. To achieve this objective, the performance of the boilers is to be assessed and based on which rectification measures are to be incorporated. Because of steep rise in fuel prices and other resources, the optimum use of the resources is very much essential. This can be done by estimating the heat losses occurring in boilers and thereafter finding suitable ways for reduction of losses and the same is dealt by the present paper.

S. Krishnanunni, Josephkunju Paul C, MathuPotti, Ernest Markose Mathew (2012)The efficiency of oil fired fire tube boiler was calculated by evaluating the heat losses. Investigation on the performance of the boiler was conducted by examining the heat losses, identifying the reasons for losses, measuring the individual loss and developing a strategy for loss reduction. The boiler efficiency was measured by indirect method. Heat losses in dry flue gas and due to unburned fuel were found to be the major problems. Since they were interrelated, installation of Zirconium oxygen sensor was recommended as a common remedy.

3. PROBLEM IDENTIFICATION

1) Loss of energy
2) Increased wear rate of bearing
3) Increased maintenance cost
4) Increased operating cost
5) Damaging of fan blades
6) High power consumption of motor
7) Water loss
8) This all heat losses are directly affects the cooling tower efficiency, so directly drop the net plant efficiency.

OBJECTIVES

9) To calculate the various losses in cooling tower
10) To install the variable frequency drive
11) To reduce the water loss
12) To reduce the wear rate of bearing
13) To increase the cooling tower efficiency as soon as increase the net efficiency of the plant

4. CALCULATION

Flow rate of inlet water = 228734 kg/hr. 63.53 kg/s
Inlet water temperature = 34.6°c

Outlet water temperature = 25.7°c

Air inlet temperature = 29.0°c

Air outlet temperature = 30.8°c

Dry bulb temperature = 29°c

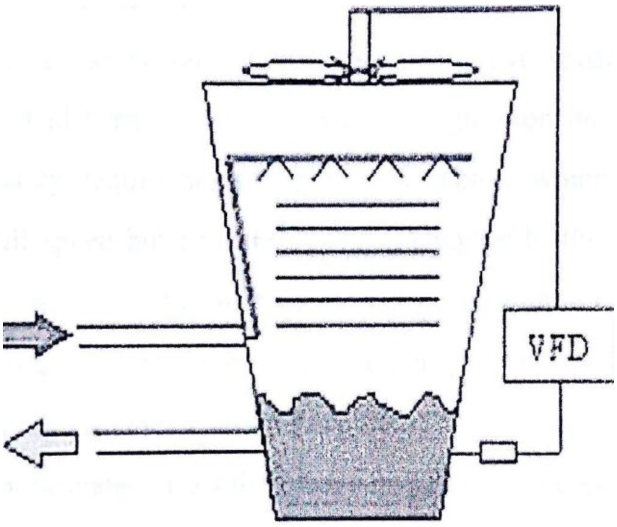
Wet bulb temperature = 24°c

Percentage humidity = 62.96%

1. Cooling range = hot water temperature - cold water temperature
= 34.6-25.7
= 8.9°c
2. Cooling approach = water outlet temperature-wet bulb temperature
= 25.7-24
= 1.7°c
3. Effectiveness% = range/ (range + approach)* 100
= 8.9/ (8.9+1) x100
= 89.97 %
4. Air mass flow/cell = flow x density of air = 2909.1 x 1.29 = 3752.74 kg/hr
5. Evaporation loss = 0.00085 x 1.8 x C.R x (T1 -T2)
= 0.00085 x 1.8 x 228734 x (33.6 - 25.7)
= 3114.67 kg/hr
6. Fraction of water evaporated = water evaporated/total water fed
= 3114.67/228734
= 0.0136
7. Drift loss = 0.2% of water supply = (0.2/100) x (20794 x 11) = 457.468 kg/hr
8. Make up water = evaporation loss / (coc-1) Coc = 1.45
= 3114.61/ (1.45-1) ----- 6921.35 kg/hr

5. VARIABLE FREQUENCY DRIVES

Variable Frequency Drives (VFDs) are the preferred method of capacity control for evaporative cooling equipment, including cooling towers, closed-circuit cooling towers, and evaporative condensers. Precisely matching fan motor speeds to the required heat rejection, VFDs can significantly reduce energy consumption and operating costs of the entire system while providing operational benefits to the power plant.



The principle of variable frequency drive is expressed. It is well-known that water-cooled systems offer significant energy advantages over air-cooled alternatives, due to increased moisture in the air that can absorb additional heat. Controlling a cooling tower fan motor with a VFD will reduce operating costs through reduced energy consumption when compared to

6. CONCLUSION

Energy conversion of thermal power plant is very important. For turbine efficiency. In our project we are mainly concentrating achieving maximize the condenser and turbine efficiency by using cooling tower modification. With increasing costs of water, efforts to increase Cycles of Concentration (COC), by Cooling Water Treatment would help to reduce make up water requirements significantly. In large industries, power plants, COC improvement is often considered as a key area for water conservation. Variable Frequency Drives (VFDs) are the preferred method of capacity control for evaporative cooling equipment, closed-circuit cooling towers. Controlling a cooling tower fan motor with a VFD will reduce operating costs through reduced energy consumption when compared to cycling fans on and ofLVFDs offer additional operating benefits, such as maintenance and sound reduction. By increasing the cooling tower performance and intern improvement in condenser vacuum. By applying the above said methods in the cooling water system condenser efficiency and turbine efficiency will be improved.

7. REFERENCES

[1] V.H.Aherene, Energy Efficiency in Thermal System. Vol. III. IECC Press. Delhi 2009
[2] M. Cehlar, V. Jakao, Z. Jurkasova, M. Paskova. "Technical and Economical Aspects of the Optimization of the cooling tower".ActaMetallurgica.Vol 18. 2012. No 2-3, page 133-142
[3] Rahul Dev Gupta, SudhirGhai, Ajai Jain. "Energy Efficiency Improvement Strategies for Industrial Boilers: A Case Study". Journal of Engineering and Technology.Vol 1.Issue 1. Jan-June 2011
[4] Kevin Carpenter, Chris Schmidt and Kelly Kissock. "Common Boiler Excess Air Tends and Strategies to Optimized Efficiency". ACEEE Sumer Study On Energy Efficiency In Buildings. 2008,3,page 52-63
[5] Jorge Barroso, Felix Barreras, HippolyteAmaveda, Antonio Lozano on the "Optimization of Boiler Efficiency Using Bagasse as Fuel". FUEL (82)2003.Elsevier Publication.Page 1451-1463.
[6] Payne, F. 1984.Efficient Boiler Operations Sourcebook. Atlanta, GA:Fairmont Press.
[7] Woodruff, E. and Lammers, H. 1935. Steam Plant Operation. New York, NY: McGraw-Hill Book Company, Inc.
[8] Manson, Inc. 1998. Energy Optimization Program (software). Overland Park, KS: Sega, Inc.
[9] ASME. 1964. Power test codes (PTC) 4.1: Steam generating units. New York, NY: American Society of Mechanical Engineers.
[10] Aschner, F. S. 1977. Planning fundamentals of thermal power plants. Jerusalem: Israel Universities Press.