Analysis and Improving Performance of The Cooling Tower

S.Gnanasekar [1], M.Vigneshwaran[2], H. Umar Farook[3], D.Vengadeswaran[4]
[1,] Assistant Professor Dept of Mechanical Engineering
[2, 3, 4] Dept of Mechanical Engineering
[1, 2] CK College of Engineering and Technology

Abstract- *Energy demand of India has been steadily increasing in every year. The majority of the electricity supplied all over India is from thermal power plant. So we are mainly focusing on thermal power plant. In thermal power plant we have to maximize the turbine efficiency. So in order to accommodate the power generation we have to maximize the condenser efficiency by the following methods like i) Water purification in cooling water system, ii) Variable Frequency Drive used in cooling tower and iii) Coating of materials for friction less flow. Using the above methods we have to maximize the condenser efficiency in order to automatically maximize the turbine efficiency for improving power generation.*

Keywords- condenser, efficiency, friction less flow , turbine, variable frequency drive, water purification.

I. INTRODUCTION

In our project we are mainly concentrating to maximize the condenser and turbine efficiency bymodifying cooling tower. Controlling a cooling tower fan motor with a VFD will reduce operating costs through reduced energy consumption when compared to cycling fans on and off. The primary purpose of controlling a motor with a VFD is to save energy and operating costs. VFDs reduces energy use by reducing the fan speed to match the rejected heat load requirements. For example, VFDs can reduce fan energy consumption by about 80% when operating at half speed. Sound reduction during startup and operation also benefits the environment when the equipment lies in the vicinities of residences and office buildings. In addition to energy and sound benefits, VFDs also provide maintenance benefits over standard motor starters.

II. PRINCIPLE BEHIND OUR PROJECT

In our project we have focused on the condenser efficiency by bringing a positive change alter considering various parameter and analysis. The water purification is the most prominent type to increase the efficiency. Variable frequency drive is altered by pony motor thereby decreasing the power consumption. When a water flow through the pipe is laminar and continuous friction is reduces greatly which results in loss of energy. Thus these methods are employed in our project to increase the efficiency.

III. VARIABLE FREQUENCY DRIVES

Energy codes, such as ASHRAE 90.1 and California Title 24, mandate that heat rejection equipment have the ability to adjust fan speeds to 2/3 of design speed for 7.5HP motors and larger.

MOTOR ARRANGEMENT

As VFD pricing has become more competitive, two-speed motors are used less than they had been in the past. However, pony-motor configurations are still utilized for motor redundancy. This configuration includes a main motor for full capacity requirements and a pony motor, which is typically designed for 2/3 full speed but consumes only 1/3 power of the main motor. For example, a cooling tower with a 30 HP main motor may have a 10 HP pony motor.

When two motors are used for redundancy, the main motor is typically controlled by an across-the-line starter while the pony motor is controlled by a VFD. This configuration reduces the total equipment first cost due to a VFD that is sized for approximately 1/3 full power. For 85% of the operating time, systems often require no more than 70% full capacity from the cooling tower. A VFD on the pony motor controls the fan speed from approximately 10% to 70% full capacity, and the main motor will be available for full capacity or in the case of pony motor failure. If a specific load profile shows a significant number of operating hours in the 70-100% capacity range, it may be more cost effective to place a VFD on the main motor.

OPERATION

A motor-driven system is controlled by the frequency of the supply voltage and rotates on a fixed speed. An alternating current that is applied produces a magnetic field that rotates at synchronous speed. The only way to alternate synchronous speed is through VFD, which converts the power in three stages. In the rectifier stage, the power is converted to higher adjustable DC voltage. In the inverter stage, the power transistors in the rectified DC are switched ON and OFF.A VFD modulates the cooling tower fan motor speed based on an analog input signal from a temperature sensing device or a BMS. A 4-20mA signal has become a preferred control signal, because amperage is less susceptible to signal loss and electrical noise than voltage.

The BMS can control the VFD through an analog signal that runs directly into a drive input or via a communications interface. Common communication protocols include BAC net, Modbus, and Lon works. The communication protocol card with the VFD should match that of the BMS; consult with a controls contractor to determine the most suitable protocol for specific applications.

The internal VFD software can be configured to control the motor based on the leaving water or fluid temperature from a temperature sensor. The software's Proportional Integral Derivative (PID) algorithm will control the motor speed appropriately once the user scales the current signal over a temperature range. If a temperature sensor is used for condenser loop control, it should be installed in the geaving water temperature or fluid piping close to the cooling tower for an accurate reads.

For multiple fan applications, it is recommended that all cooling tower fans should be operated simultaneously at the same speeds when driven by VFDs. As described in the energy analysis section of this report, marginal increases in fan speed require exponential increases in power consumption. It is more energy efficient to run two fans at 50% speed than to operate one fan at full speed, and simultaneous cooling tower cell operation maximizes the total heat transfer surface available.

For multiple fan applications, it is recommended that all cooling tower fans should be operated simultaneously at the same speeds when driven by VFDs. The marginal increases in fan speed require exponential increases in power consumption. It is more energy efficient to run two fans at 50% speed than to operate one fan at full speed, and simultaneous cooling tower cell operation maximizes the total heat transfer surface available.

Operators must also ensure that the motors are not driven below minimum speed, per the cooling tower manufacturer's requirements. Belt drive fans can typically operate at as low as 10% of full speed, which will permit an adequate amount of motor cooling. Standard gear drive systems should operate at no less than 25% of full speed operation due to lubrication requirements. If an external oil pump is installed in the gearbox for constant lubrication, the minimum speed is once again restricted by the motor cooling limitation, or 10% of full speed operation.

Variable torque VFDs must be used when controlling fans. A constant torque VFD may damage a gear driveshaft, as the VFD attempts to maintain a constant torque regardless of the magnitude of the load.

Engineers and owners must ensure that the following three requirements are met when controlling multiple motors with a single VFD:

1) The VFD should be sized to supply the total amperage of all motors and must not be designed by merely summing the horsepower of each motor.
2) Line-side wiring and short-circuit protection must be rated for maximum VFD amperage draw regardless of the total motor draw on the load side.
3) Each motor on the load side must be individually protected for short circuit and overcurrent conditions.

VFD BENEFITS

VFDs offer additional operating benefits, such as maintenance and sound reduction. An adjustable acceleration time results in a soft start rather than full load starts, which place heavy stresses on mechanical components. Soft starts enable the VFD to gradually ramp the motor speed, preventing high stresses on belts, bearings, and fans. In addition to smoother cooling tower operation, VFDS prevent other system components, like the chiller, from overshooting and undershooting. Therefore, smooth system operation improves total system efficiency.

Cooling tower fan sound levels can be very important when the equipment is installed near residential and commercial buildings. The cooling tower fan sound level increases with increasing tip speed, so by reducing the fan speed to the current heat load, the VFD will reduce sound levels compared to those generated at full speed. Soft starts and fluent accelerations also eliminate extreme startup noise, especially during periods of relatively low wet bulb temperatures that lead to frequent fan cycling.

VFD will reduce sound levels compared to those generated at full speed. Soft start and fluent acceleration also eliminate extreme startup noise, especially during periods of relatively low wet bulb temperature that lead to frequent fan cycling. The advantages gained after installing VFD are as follows:

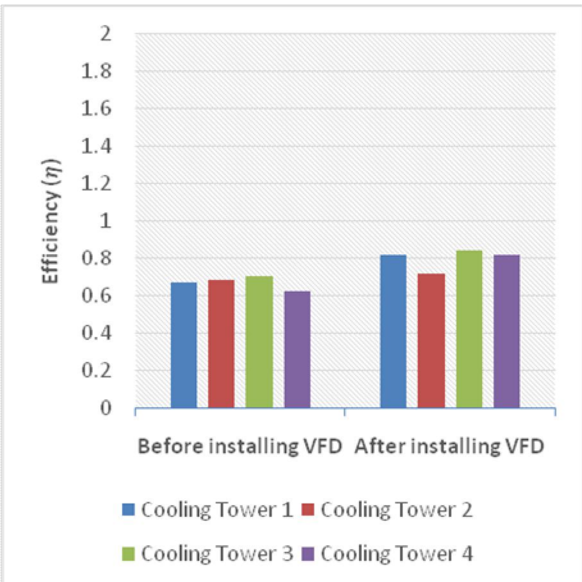
1. Increased productivity & product quality
2. Noise reduction along energy savings of 30%
3. Power factor correction close to 1.

IV. CONCLUSION

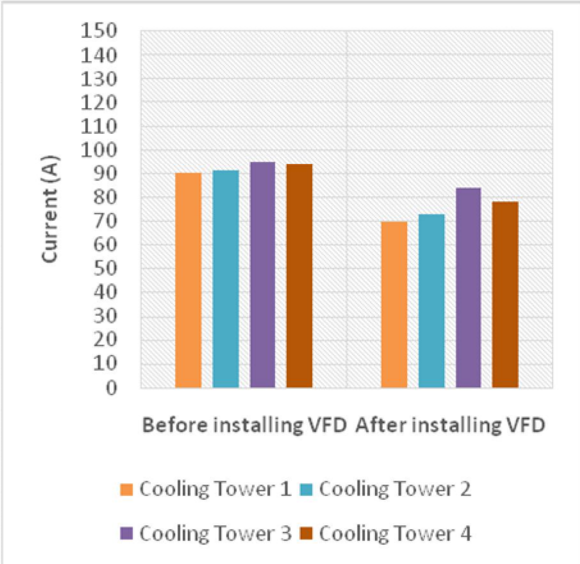
Energy conversion of thermal power plant is very important. For achieving turbine efficiency. In our project we are mainly concentrating maximize the condenser and turbine efficiency by using cooling tower modification. With increasing costs of water, efforts to increase Cycles of Concentration (COC) by Cooling Water Treatment would help to reduce make up water requirement 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 off. VFDs 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 method in the cooling water system condenser efficiency and turbine efficiency was improved.



Efficiency vs Cooling tower



Current vs Cooling Tower

REFERENCES

[1] Ali Jahangiri, AliakbarGolneshan, (2011) “Feasibility Study of the Thermal Performance Improvement of Natural Draft Dry Cooling Towers Due to Flue Gas Injection” World Applied Sciences Journal pp : 568-575.

[2] Clemente GarciaCutillas, Javier Ruiz Ramirez, and Manuel Lucas Miralles (2017) “Optimum Design and Operation of an HAVC Cooling Tower for Energy and Water Conservation” International Conference on Sustainable Refrigeration and Air Conditioning, volume 10, issue 3 pp: 1-27.

[3] Rajendra Patel, Dharmesh Patel (2015) “Energy Conservation Opportunity with Variable Frequency Drive in Forced Draft Fan in Boiler House”.IJSRD International Journal for Scientific Research & Development Vol. 3, Issue 04 pp: 546-560.

[4] Rishabh Agrawal, Subhash Chand Kaushik, (2015) “A Simplified Thermal Modelling of Cooling Tower for Optimization of HVAC Systems to Enhance Energy Efficiency”.0pen Journal of Applied Sciences Volume 5 pp: 335-343

[5] Sen Huang, WangdaZuo, Michael D. Sohn(2016) “Amelioration of the Cooling Load based Chiller Sequencing Control” Open Journals of Applied Science pp:205-215.