DESIGN OF PIPING SYSTEM FOR A COOLING TOWER

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ABSTRACT: HVAC stands for Heating, Ventilation and Air conditioning is the technology of automotive and inside environmental comfort. HVAC system design is based on thermodynamics, heat transfer and fluid mechanics.
A cooling tower is a specialized heat exchanger in which air and water are brought into direct contact with each other to reduce the water's temperature. It operates on the principle of removing heat from water by evaporating a small portion of water that is recalculated through the unit. The mixing of warm water and cooler air releases latent heat of vaporization, causing the water to cool. Cooling tower piping systems have evolved over the years from simplistic, dedicated hydraulic loops that lacked complexity to large-volume, multiplexed systems that offer peak operational efficiencies. The evolution of a more sophisticated system is due in part to the advent of advanced controls and the operational flexibility of modern chillers, cooling towers. Cooling tower piping systems are designed to be streamlined to keep capital costs low while yielding the most energy-efficient solution. The effects on the performances of cooling tower are determined by following parameters: (1) flow rate of water (2) diameter of pipe

Keywords: Cooling tower, Equipment, pump, Tank.

INTRODUCTION

The Paper is about designing of a piping system for cooling tower. It is a proof heat exchanger device where air and water are brought together in direct contact. The increase of surface area of the falling water will encounter the air coming in cross or counter-flow causing it to evaporate. Cooling towers may either use the evaporation of water to remove process heat and cool the working fluid to near the wet-bulb air temperature or, in the case of closed-circuit dry cooling towers, rely solely on air to cool the working fluid to near the dry-bulb air temperature.

IMPORTANCE OF HVAC

HVAC is an important part of residential structures such as single-family homes, apartment buildings, hotels and senior living facilities, medium to large industrial and office buildings such as skyscrapers and hospitals, on-board vessels, and in marine environments, where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors. 8 Ventilating or ventilation (the V in HVAC) is the process of exchanging or replacing air in any space to provide high indoor air quality which involves temperature control, oxygen replenishment, and removal of moisture, odours, smoke, heat, dust, airborne bacteria, carbon dioxide, and other gases.

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HVAC SYSTEM SELECTION

The HVAC system is selected three main factors including the building configuration, the climate conditions, and the owner desire. The design engineer is responsible for considering various systems and recommending more than one system to meet the goal and satisfy the owner of a building. Some criteria can be considered such as climate change building capacity, spatial requirements, cost such as capital cost, operating cost, and maintenance cost, life cycle analysis, and reliability and flexibility. However, the selection of a system has some constraints that must be determined. These constraints include the available capacity according to standards, building configuration, available space, construction budget, the available utility source, heating and cooling building.

BASIC COMPONENTS OF COOLING TOWER [1]

1. Drift Eliminator
2. Cooling Tower Nozzles
3. Cooling Tower Fan Motor
4. Cooling Tower Fill
5. Cold Water Basin
6. Cooling Tower Mesh
7. Bleed Valve and Float Valve
8. Cooling Tower Air Inlet
9. Cooling Tower Structure/Body
10. Sprinkle

COOLING TOWER TYPES

Cooling towers fall into two main categories

- Natural draft
- Mechanical draft

Natural draft towers use very large concrete chimneys to introduce air through the media. Due to the large size of these towers, they are used for water flow rates above 45,000 m3 /hr. These types of towers are used only by utility power stations.

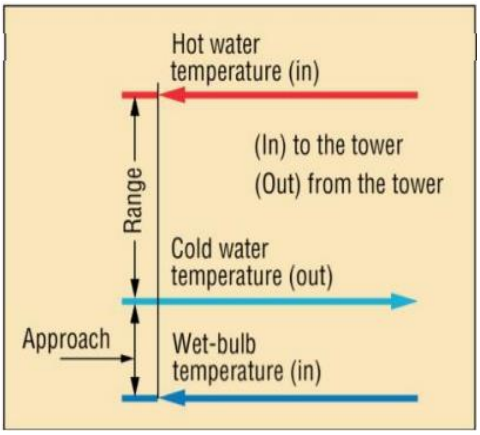
Mechanical draft towers utilize large fans to force or suck air through circulated water. The water falls downward over fill surfaces, which help increase the contact time between the water and the air - this helps maximize heat transfer between the two. Cooling rates of Mechanical draft towers depend upon their fan diameter and speed of operation[2].

Tower Materials

In the early days of cooling tower manufacture, towers were constructed primarily of wood. Wooden components included the frame, casing, louvers, fill, and often the cold-water basin. If the basin was not of wood, it was of concrete. Today, tower manufacturers fabricate towers and tower components from a variety of materials. Often several materials are used to enhance corrosion resistance, reduce maintenance, and promote reliability and long service life. Galvanized steel, various grades of stainless steel, glass fibre, and concrete are widely used in tower construction as well as aluminium and various types of plastics for some components.

Wood towers are still available, but they have glass fibre rather than wood panels (casing) over the wood framework. The inlet air louvers may be glass fibre, the fill may be plastic, and the cold-water basin may be steel. Plastics are widely used for fill, including PVC, polypropylene, and other polymers. Treated wood splash fill is still specified for wood towers, but plastic splash fill is also widely used when water conditions mandate the use of splash fill. Film fill, because it offers greater heat transfer efficiency, is the fill of choice for applications where the circulating water is free of debris that could plug the fill passageways.

TOWER PERFORMANCE



Range and Approach [3]

The important parameters, from the point of determining the performance of cooling towers, are

I)"Range" is the difference between the cooling tower water inlet and outlet temperature.

ii) "Approach" is the difference between the cooling tower outlet cold water temperature and ambient wet bulb temperature. Although, both range and approach should be monitored, the 'Approach' is a better indicator of cooling tower performance.

iii) Cooling tower effectiveness (in percentage) is the ratio of range, to the ideal range, i.e., difference between cooling water inlet temperature and ambient wet bulb temperature, or in other words it is = Range / (Range + Approach).

iv) Cooling capacity is the heat rejected in kCal/hr or TR, given as a product of mass flow rate of water, specific heat, and temperature difference.

v) Evaporation loss is the water quantity evaporated for cooling duty and, theoretically, for every 10,00,000 kCal rejected, evaporation quantity works out to 1.8 m3. An empirical relation used often is:

*Evaporation Loss (m3 /hr) = 0.00085 x 1.8 x circulation rate (m3 /hr) x(T1-T2) T1-T2 = Temp. Difference between inlet and outlet water.

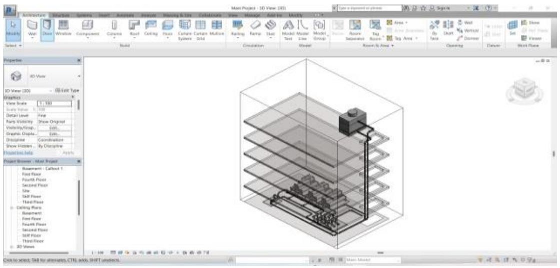
LITERATURE SURVEY

R. Ramkumar A. Ragupathy has discussed an experimental investigation of the thermal performance of forced draft counter flow wet cooling tower with expanded wire mesh type packing. The packing used in this work is wire mesh with vertical [VOWMP] and horizontal [HOWMP] orientations. The packing is 1.25 m height and having a zigzag form. From the experiments it is concluded that the vertical orientation of the packing enhances the performance of the cooling tower [4].

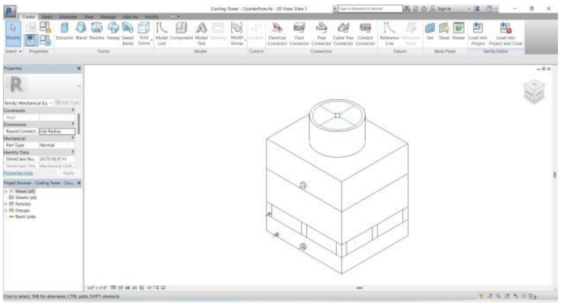
Bhupesh Kumar Yadav, S. L. Soni has discussed about cooling tower is used to reduce the temperature of hot water stream. It is mainly used in air conditioning plants, chemical plants etc. Evaporation loss and effectiveness are two important performance parameters of cooling tower. Effectiveness of the cooling tower model comes out to be 52.94%. Practical evaporation loss is calculated i.e., 9.25 kg/hr. Validation of practical values is done using empirical relations. For calculating theoretical evaporation loss various empirical relations i.e., Modified Apjohn equation, Modified Ferrel equation and Carrier equation are provided. By reviewing literature, it is coming to know that results provided by carrier equation is most satisfactory. So analytical calculation is done using carrier equation and thus theoretical evaporation loss is calculated as 5.45 kg/hr which comes nearer to practical value [5].

B Bhavani Sai, I Swathi, K S L Prasanna, K Srinivasa Rao has described a detailed methodology of an Induced draft cooling tower of counter flow type in which its efficiency,effectiveness characteristics are calculated. The technical data has been taken from a mechanical draft cooling tower. Cooling towers are heat removal devices used to transfer process waste heat to the atmosphere. Cooling towers make use of evaporation whereby some of the water is evaporated into a moving air stream and subsequently discharged into the atmosphere. As a result, the remainder of the water is cooled down significantly [6]

DESIGN CALCULATION



Defining Space of the Layout



Layout Of Tower

In this we have to calculate the water inlet diameter, Flow rate, Pipe diameter?

Assumption

Cooling Tower inlet Temperature = 40^{o}C

Cooling tower outlet Temperature = 30^{o}C

Ton of refrigeration = 1000

Formula TR= volume * Sensible heat factor* Temperature difference

1000 = GPM* 1.08* 22 GPM= 1000/1.08*22

Flow rate= 42.08 GPM

Then area of Pipe Diameter=Flow rate* Velocity

Assume Velocity =4 $\pi/4*D^2 = 42.08/60*4$

Diameter of pipe = 1.88 = 2 inch = 50mm.

Relative humidity of air from Fan increases

For suppose 25% is increases to 60% at a temp of 30^{o}

Then 0.003 to 0.016

$\Delta W = 0.016-0.003$ $\Delta W = 0.013$kg/kg

For every 1 Kg of air passed through cooling tower, we lose 0.013 kg of water to evaporation.

Assume Air flow rate $1M^3$=1.225kg = 1.225*10000/3600 =3.4Kg/s

The Amount of water escaping from the cooling tower through vapour Water vapour= ΔW*Air flow rate

=0.013*3.4 = 0.045kg/sec of water Vapour is escaping from the Cooling Tower In order to fill the tank.

From Ishrae data book

The water flow rate is 1.2m/s

Flow rate = o.713GPM

The diameter of pipe to flow the water into the tank is from the chart at 0.713 GPM, we can take ½inch pipe i.e. 12.5 MM pipe is used.

RESULT AND DISCUSSION

From the above calculation we got,

Pipe diameter of water flow into the cooling tower = 50mm

Pipe diameter of water flow into sump from the ground = 12.5mm

In this work, all the experimental results are provided including external and internal temperatures and values at the inlet and outlet of the evaporator. Using the method explained in this work, it is possible to determine whether a selected air conditioning system meets its design and comfort requirements through the cooling tower.

- The main motive of design of an HVAC for the building purely depends on the human comfort values, should be maintained irrespective of location of the project.
- All the equipment's are installed as per the manufacturer's recommendations to achieve its best efficient performance.

Thus, early identifies the requirement of the project& provides an effective way of Air-Conditioning to achieve Human comfort for the occupants.

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