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Design and Analyze the Absorber Chiller Machine Based on High Pressure and Low Velocity to Achieve a Higher Efficiency Using Iot Sensor

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Abstract
Utilities are essential to industry because not all chemical reactions occur at room or atmospheric temperature. The equipment is needed to achieve the required temperature for chemical reaction and other purposes in chemical plants. These auxiliaries help to achieve the required chemical temperature, i.e. H high or low temperature for chemical processes. Besides VAM, a cooling tower is also used to lower the cooling water temperature. Previously, we discussed the types of cooling towers in which we include the operation of the cooling tower. In this article, we are going to find out how the vapor absorption machine works / how the vapor absorption chiller works The redesign the sections of the heat exchanger, where the process must be performed with different input parameters than the existing model. With a modification of the entrance section, in order to obtain greater and better efficiency, and compared to the work done previously. The Absorber section is modeled in Solid Works 2022 and analyzed in Ansys 18.1. The graphical representation of the overall water flow efficiency was compared and the results obtained show that the redesigned Model II has increased efficiency and that there is an even distribution of water flow in the heat exchanger.The result of the existing model is about 115 liters per second, which has been improved to 186 liters per second in the distribution of the supply water in the heat exchanger. The parameters used previously are Velocity and Pressure. Limits are used before being changed by increasing pressure and low speed, cumulatively the wall thickness of the exhaust pipes, adding relative and absolute roughness. The process determines that it is a trial and error method in the software process. With the existing design, the model has been modified in possible ways. Due to the position of the flow direction of the inlet pipe, the size of the outlet pipe, the dimensions and the realization of additional parts in the heat exchanger head, we have achieved greater efficiency than in the previous work.
The component material used is steel. Composed of key components are evaporator, absorber, condenser, generator and solution heat exchanger.
Key words: component material, heat exchanger, cooling tower,solid works, outlet pipe, evaporator, absorber, condenser, generator

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1. Introduction

Heat exchanger

Heat exchangers are used to transfer thermal energy from one medium to another. The medium can be a gas, a liquid or a combination of liquid and gaseous substances. The holder is separated by a wall to avoid mixing or direct contact. Heat exchangers can increase the efficiency of a system by transferring heat from the systems to other types of media.

The fluids in heat exchangers generally flow rapidly to facilitate heat transfer by forced convection. This rapid flow leads to pressure drops in the fluids. The efficiency of heat exchangers refers to how well they transfer heat in relation to the pressure drop encountered. Modern heat exchanger technology minimizes pressure drop while maximizing heat transfer and meeting other design objectives, such as: B. Resistance to high fluid pressure, resistance to contamination and corrosion, cleaning and repair.

2.The elements of Heat exchanger

Steam

Hot water

Cooling water

Fresh water

Brine

Electricity and much more

Different utilities are used based on temperature needs and today in this article we will learn how to make chilled water using an absorption chiller also known as a VAM chiller.

Before learning and understanding the operation of the steam absorption machine, we must brush up on the law of gas, that is the law of Gay-Lussac, also known as the law of pressure temperature.

This law states that the pressure of a given quantity of gas maintained at a constant volume is directly proportional to the Kelvin temperature.

Pressure∝Temperature

Explanation- This means that as the system pressure increases, the system temperature also increases.

What is a steam absorbing machine? The Vapor Absorption Machine (VAM), also known as a vapor absorption chiller, is used to produce chilled water using a heat source such as steam, hot water and fuel gas. this sounds strange, ie it produces chilled water through the use of the stem but yes it is possible. These are the simplest words possible to describe VAM.

In the steam absorption machine there are mainly two compartments and four more sub-compartments

The two main compartments of the vapor absorption chiller are:

Low pressure side

High pressure side

These two main components are again divided into two parts as below.

1 Low pressure side

1) Evaporator:

2) Absorber:

2 High pressure side

1) Generator

2) Condenser

Work material in vapor absorption cooler

Refrigerant - DM Water (Demineralized Water)

Absorbent (salt) - Lithium bromide (LiBr)

Coolant: - The coolant of the vapor absorption machine is pure (distilled) water. The coolant water flows in a closed circuit and is recirculated.

The boiling water is changing the different pressure and the different temperature;

For instance

1. Sea level

Temperature 100 ° C

Pressure 760 mmHg

2. High-altitude Everesttop

Temperature 70 ° C

Pressure 525 mmHg

3. Vacuum packed

Temperature 3.7 ° C

Pressure 6 mmHg

absorbent

The absorbent of the vapor absorption machine is lithium bromide (LiBr). LiBr is a highly hydrophilic chemical, meaning it has a high affinity for water. The higher the concentration and the lower the temperature, the stronger the absorption power. LiBr is a non-toxic but highly corrosive aqueous solution in the presence of oxygen. LiBr has a corrosive effect on metals in the presence of oxygen, but since the absorption chiller is an almost oxygen-free vacuum vessel, it will not damage the MOC of the machine.

The chemical details of LiBNr are as follows

Chemical formula: LiBr

Molecular weight: 86,856

Component: Li = 7.99% / Br = 92.01%

Specific gravity: 3.464 at 25°C)

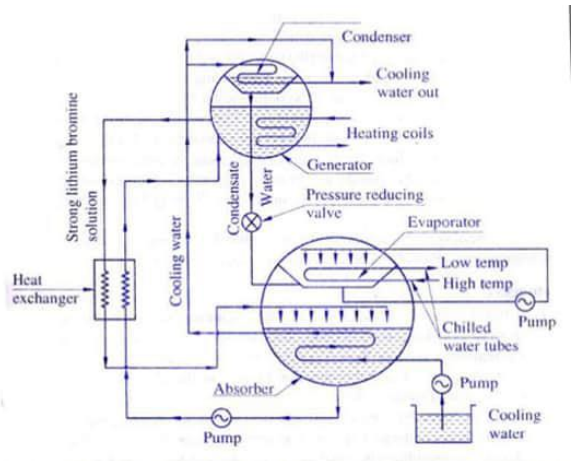
Melting point: 549°C

Boiling point: 1265°C

See the Wikipedia page on lithium bromide for more details on LiBr

How does the steam absorption machine work?

The description of the main parts of lithium bromide absorption chiller is given in detail



Source: https://chemicaltweak.com/vapour-absorption-machine-working/.low pressure side

Fig1. vapour-absorption-machine-orking/.low pressure side

1. Evaporator

The function of the evaporator is to cool the water circulating in a coil. The evaporator is maintained under a vacuum of about 6 mmHg, for which the water in the refrigerant boils at about 4°C

Water as a refrigerant enters the evaporators at very low pressure and temperature. because the pressure in the evaporator is very low. This cooling water absorbs the heat of the substance to be cooled and is completely vaporized and then enters the absorber.

2. Absorbers

The function of absorber is to maintain the pressure of the vacuum evaporator by absorbing the evaporated refrigerant vapor in the evaporator

A concentrated solution of lithium bromide is available in the absorber because water is very soluble in the lithium bromide solution and then converted into dilute LiBr which is formed. This solution is pumped to the generator

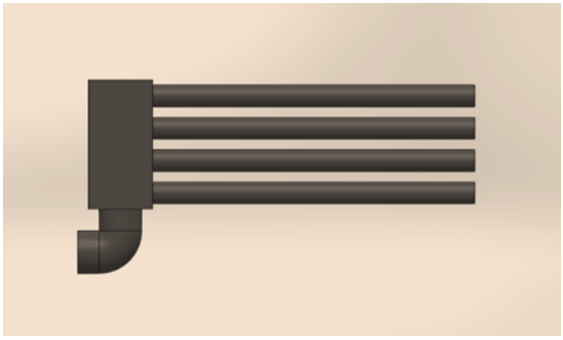


Fig.2 3D model of Prototype model

Meanwhile, you can view the cooling tower efficiency calculation

high pressure side

1. Generator

The function of the generator is to enrich the LiBr solution to its original concentration. When the lithium bromide solution is exhausted, the effect of absorbing refrigerant vapor decreases. The solution diluted with the LiBr absorbent flows towards the generator to regain its concentration. It is a vessel in which the dilute absorbent solution is heated by steam, hot water or direct gas. Dilute solution releases refrigerant vapor and becomes concentrated solution

The hot concentrated solution, having now regained its strong affinity to absorb more refrigerant, returns to the absorber.

3. Condenser

The function of the condenser is to cool and liquefy the refrigerant vapors given off by the generator. Hot refrigerant vapor leaving the regenerator flows through separators or separators to the condenser, cooling water from a cooling tower circulates through the condenser to remove heat from the refrigerant vapor. This vapor is condensed into a liquid refrigerant where it passes through a pressure reducing valve into an

evaporator which operates under vacuum.

4. Techniques

Problem Identified at Absorber Section

The absorber function is to maintain the pressure of the evaporator with the vacuum by absorbing the refrigerant vapor evaporated in the evaporator

A concentrated solution of lithium bromide is in the absorber, water is highly soluble in lithium bromide solution then converted in dilute LiBr formed. This solution is pumped to the generator.The problem is found out in this section isthe flow of water is not even when it comes out from the header section.

The Absorber section consists of Header, Inlet pipe and Outlet pipes. The header section in placed inside the Absorber. The inlet pipe is placed below the header section and the Outlet pipe is placed on the face section of the header.

The water flow comes through the inlet and passes through the header to outlet pipe. The number of the pipes are inlet is 1 and outlet is 8. The flow is calculated with help of Ansys software. The parameters are mentioned below in upcoming topics.

4.1 Problem Statement

The problem of this kind of heat exchanger is found in the distribution of the water, which is not even in the flow passage. The passage of the water gets lack by the flow of the water inside the tubes. The water passes through one pipe of inlet and gets exist of 1110 pipes. Here the passage of the water pipe gets distracted and the flow of the water is also got error in the pipes passage.

4.2 Problem Solution

The problem is found out from the existing model. By the analysing of the model, the problem statement is found in the place where is gets occur. And the problem is fixed by the flow correction obtain from the software work.

4.2.1 Advantages of Vapour Absorption Chiller

1. It is a simple heat exchanger working at different pressure it is relatively cheaper and reliable, also it requires very little maintenance and operating cost.
2. It works on environment-friendly refrigerant on the place of CFC which has an adverse effect on the ozone layer
3. As there are no moving parts which makes it free of noise and vibration.
4. All the operations are fully automated hence it requires very little human intervention and make the process easy

5. EXPERIMENTAL METHOD

The conceptual design and the isometric view of Absorber section is shown in below Fig5 is drawn with the 3D modelling software and each parts made is explained below. Conceptual design and the parts design are shown below in isometric view in the following topics.

This model dimensions are taken from the existing component and made an alter within the inlet section and in the header section.

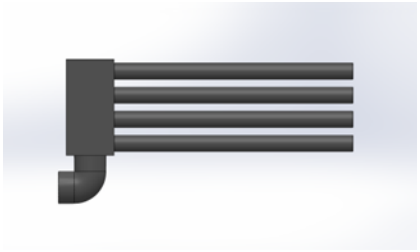


Fig5 3D model of Prototype model

So that the component looks slight differ from the existing design model.

5.1 Components

List of components are,

i. Inlet pipe (Elbow)

ii. Header

iii. Outlet pipe (Hallow)

i. Inlet pipe

The inlet pipe is a model of elbow type. It is made up of steel. The inlet pipe is placed below the header section. The parameters are given below.

parameters	Measurement
Diameter	ø 400mm.
Length	400*400mm.
Radius R	200mm.
Material	Steel
Type	Elbow pipe

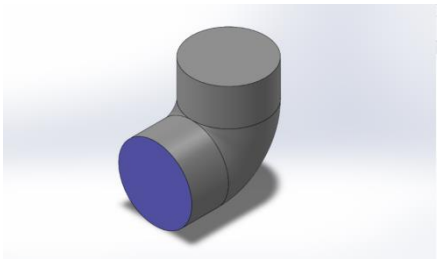


Fig.6 3D model of Inlet Pipe.

ii. Header section

The headers section is in the shape of a rectangle box. It has an inlet pipe at bottom side and outlet pipes in the face side. So the water flows from the inlet bottom side to the header and passes to the outlet.

Paramenter	Description
Dimension	1200*600*800mm. (L*B*H)
Material	Steel
Type	Rectangle

It has outlet pipes on it (face side)

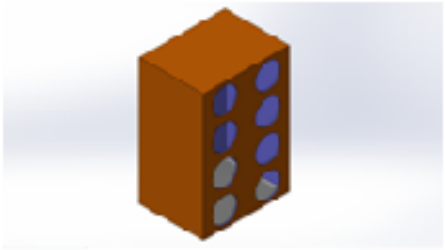


Fig.7. 3D model of Header section.

iii. Outlet pipe

The outlet pipe is fixed on the face side of the header section. The parameter of the outlet pipe is given below.

It is a straight-line pipe.

Diameter=ø 204.71mm. (As per calculation)

Length = 3000mm.

Material = Steel

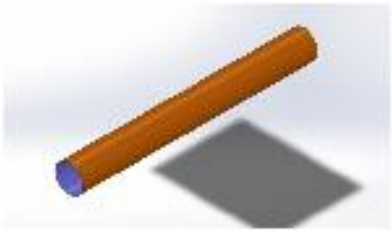


Fig.8 . 3D model of Outlet pipe.

The model which is made is a prototype, that is compared with the existing model. The Actual model has an outlet pipe of 1110 numbers and the Prototype model has 08 outlet pipes. The flow of water is compared in both the outlet pipes by using Reynold's number formula, so that the model will be done with the correct dimensions.

Comparison of number of outlet tubes

Here, in the existing model, the number of outlets pipeis about 1100. Therefore, in prototype model we use about 08 pipes.

The comparison of the flow in the outlet pipes are based on the Reynold's number. The equation is ($\rho VD \div \mu$). By the given formula, the values of the existing model parameters and the prototype parameters has been compared.

The given parameters are

ρ – Density

V- velocity

D – Diameter

μ – Viscosity.

Here the parameters are taken for the material – Water. And the Density and the Viscosity are constant for the both the models as the material is water.

Existing model

Let us consider that the Reynold's number model is multiplied by the (n) number of outlet pipes.

Therefore, ($\rho VD \div \mu$) * n

Here $\rho \; and \; \mu$ are constant. Therefore, the equations become as (V*D*n)

Let,

V = 0.28 m/s

D = 0.016 m

n = 1100

By formula = 0.28*0.016*1100

= 4.928

Prototype model

Let us consider that the Reynold's number model is multiplied by the (n) number of outlet pipes.

Therefore, $(\rho VD \div \mu)$ * n

ρ *and* μ are constant,

Therefore, the equations become as (V*D*n)

Let,

V = 3 m/s

D = 0.20471 m

n = 8

By formula = 3*0.20471*8

= 4.913

From the calculation result, we can assume that the flow in the outlet pipes of existing model and prototype are similar by the calculation of the Reynold's number.

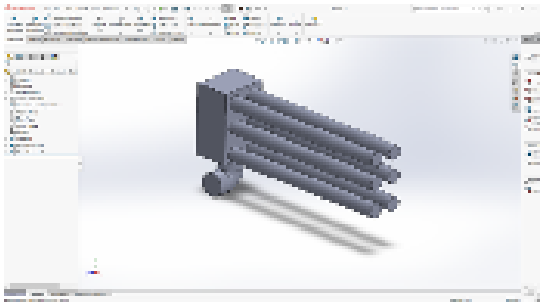


Fig.9 3D Design of Existing model

This Fig.6 describes the dimensions are taken from the existing model. The taken dimension and structure is used in the Trail method with some alters made in the header section and inlet pipe also. The model and measurement are done with the help of the existing design. From the above Fig.6we get the dimensions as per model, that will be altered and be designed in the upcoming Prototype model with alter in parameters also. The Calculated value and Actual value are noted for the next process.

Fig.10. Meshing Picture of Existing Model

Fig.10 shows that the model has been fine meshed with the Ansys software. Followed by the meshing process, the input parameters are inserted for the Stimulation process.

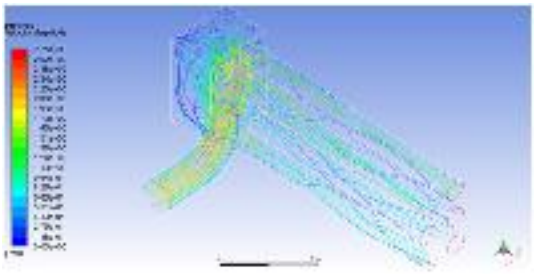


Fig.11 Path lines of Existing model (Back view)

The path lines shows that the water flows in the header section in and comes out from the outlet pipes. The flow of water is not even in the flow distribution in the outlet pipe. This is because the flow of Water velocity, Inlet pressure and the Design model of the Header section and Inlet pipe.

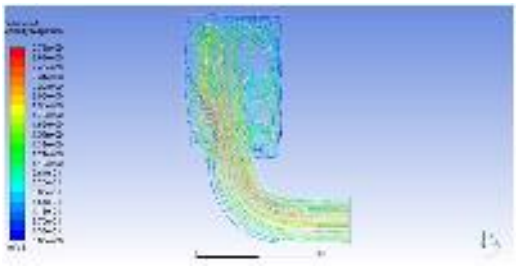


Fig.12 Path lines of Existing model (Isometric view)

The water level distribution is low in the outlet pipe. From Fig12., it is to understand that the flow inside the header section passes the water to the outlet pipe, which is not even in distribution of the water passage.

Fig.13 3D model of Prototype model

Fig.13 describes that the Prototype model made from the same dimensions and with alter of the inlet section direction and header section modification with help of Inlet parameters alterations. The alterations are made in the section of Inlet Velocity, Inlet and Outlet Pressure, Thickness of outlet pipe wall, Header section modification and Inlet pipe modification.

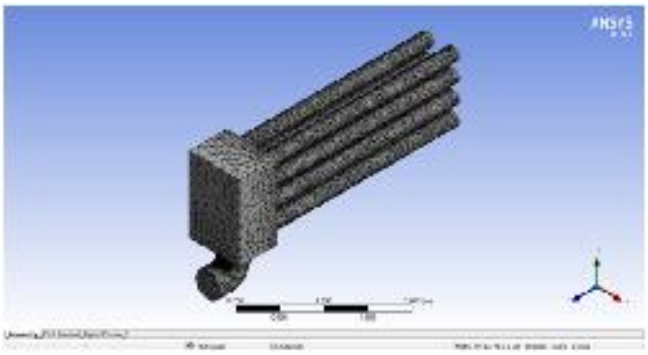


Fig.14 Meshing Picture of Prototype Model

Fig.14 shows that the model has been done in Solid works and fine mesh with the Ansys software. Followed by the meshing process(Figure 15) , the input parameters are inserted for the Stimulation process.

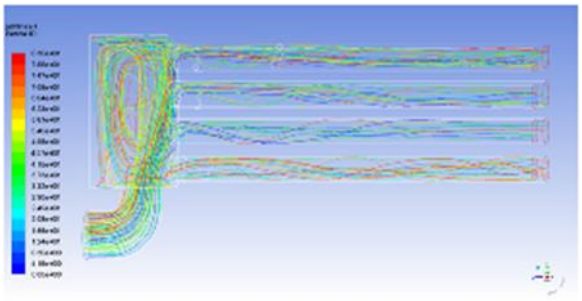


Fig.15 Path lines of Existing model (Side view)

The path lines shows that the water flows in the header section in and comes out to the outlet pipes. The flow of water is similar in the flow distribution of the outlet pipe. This is because the flow of Water velocity, Inlet pressure and the Design model of the Header section and Inlet pipe.

6.Conclusion

The problem was found out from the existing model. And there were number of methods gone under the trial-and-error process. The Prototype model used of baffles, fins, U – tube arrangements, Shells etc to get a better result. By adding some of the materials in the header section, we got the results as better improvement when compared with the Existing model. As per the prototype model, there are some modifications given for the improvement of the flow distribution in the Absorber section, which is shown from the Calculated value and from the Ansys Value. Due to the alteration and modifications made in the Header Section, Inlet Pipe and Inlet parameters, the model has been shown and the result has been improved.

Table 1 Comparison values

	Machine Value		Prototype Value	
	Cal. Value	Actual Value	Cal. Value	Ansys
Velocity	0.5 m/s		3 m/s	
Pressure	1 bar		3 bars	
Día	0.019 m		0.20471 m	
Flow Discharge	157.35 l/s	115.26 l/s	186.56 l/s	274.2 l/s

Table 1 describes the amount of value from the machine value and the prototype model result. This shows that the flow of water is better in the prototype model when compared to the machine value. The alterations made in the Prototype model has a better water distribution in the outlet pipes.

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 Dr. Y.Baby Kalpana has completed her Doctoral degree in the year 2013. She has completed her P.G in CSE in Government College of Technology. She is currently working as an Associate Professor in P.A. College of Engineering and Technology, Coimbatore. She has published more than 25 papers in various national international journals. She has guided more than 25 M.E projects and 55 B.E projects. She is grateful to Dr.P.Appukutty, Chairman,P.A. Group of Institutions, Dr.T.Manigandan, Principal, P.A. College of Engineering and Technology, CEO, P.A.Group of Institutions for their continuous encouragement in publishing this work.

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