ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 6 | Issue: 6 | June 2020 || Journal DOI: 10.36713/epra2013 || SJIF Impact Factor: 7.032 ||ISI Value: 1.188

DESIGN AND MANUFACTURING OF CUSTOMIZED WATER CHILLER FOR INDUSTRIAL PROCESS COOLING

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ABSTRACT

Refrigeration can be costly in terms of equipment and energy, if not done correctly will fail to achieve its objectives and lower the quality and safety of the product. To ensure that refrigeration is effective, we need to be able to calculate, heat load, fluid temperatures, over all dimensions of the system.The refrigerant used is R-407C, which is ozone friendly. Incorporated in this report is the literature study, which discusses the components of the chiller and the detail design of the chiller, including the specifications of the standard components and the designs of the heat exchangers is mentioned..

1. INTRODUCTION

This chapter gives us an introduction about the working principle of the system. It explains in detail the each main component which constitutes the system. Heat exchangers, expansion valves, suction accumulators and the compressor theory will be discussed. Heat exchangers are to be designed whereas the expansion valve, compressor and suction accumulator are to be standard components. Therefore more in depth designs of different types of heat exchangers will be discussed, both for condensers and evaporators. A chiller is a system which functions to chill or cool water to desired temperatures which is usually a temperature of about 15°C. This is a thermodynamic vapour compression system which can be used for air-conditioning, industrial and aerospace applications.A water chiller has four main parts: evaporator, condenser, compressor and expansion valve. The main purpose of a water chiller is to remove the heat from water and replace the heat with cold. Not only does a water chiller remove heat from water, it removes heat from the air surrounding the water. An

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inlet of water at a temperature of about 20 to 30°C flows through a heat exchanger which works as an evaporator. This is to remove the heat and thus cools the water. A cold refrigerant is generally used to boil the gas, and the pressure is increased using a compressor. This vapor is then at a temperature higher than that of the ambient. The heat absorbed from the water, and the work of the compressor is then released to the environment, and as a result, the refrigerant is condensed. The refrigerant then flows through an expansion valve which decreases the temperature, before it once again flows through the evaporator and the cycle begins again.

Fig.No.1-Experimental Setup

2. WORKING PRINCIPLE

Heat flows naturally from hot to cold body. In refrigeration system the opposite must occur, i.e. heat flows from a cold to hot body. This is achieved by using a substance called refrigerant, which absorbs heat and hence boils or evaporates at low pressure to form a gas. This gas is then compressed to higher pressure, such that it transfers the heat. The refrigeration cycle can be broken down into following stages:

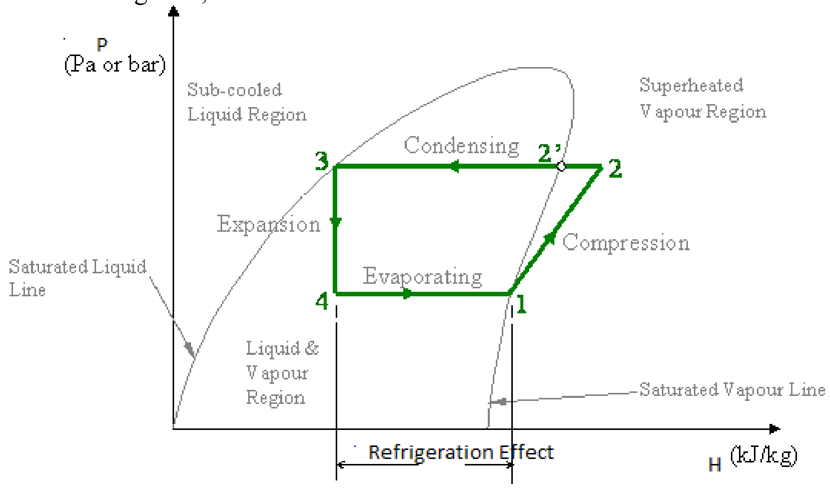

Fig.No.2-p-h Diagram

- Process (4-1) :

Low pressure liquid refrigerants in the evaporator absorb heat from its surroundings, usually air, water or some other process liquid. During this process it changes it state from liquid to gas and at the evaporator exit is slightly superheated.

- Process (1-2):

The superheated vapor enters the compressor where its pressure is raised. There will also be a big increase in temperature; because of proportion of energy input into compression process is transferred to the refrigerant.

- Process (2-3):

The high pressure superheated gas passes from the compressor into the condenser. The initial parts of the cooling process (2-2') de-super heats the gas before it is turned back into liquid (2'-3). The cooling for those processes is usually achieved by using air or water. Further reduction in temperature happens in pipe work and liquid receiver (3-4), so that the refrigerant liquid is sub cooled as it enters the expansion device.

- Process (3-4):

The high pressure sub cooled liquid passes through the expansion device, which reduces both the temperature, pressure and controls the flow into evaporator. It can be seen that the condenser has to be capable of rejecting the combined heat inputs of the evaporators and the compressor; i.e. (1-2) + (2-3) has to be the same as, (3-4). There is no heat loss or gain through the expansion device.

3. DESIGN DETAILS

- Refrigerant :
  R407C
- Scroll Type Compressor:
  Power required for compressor (P) =3 KW
  Flow rate of refrigerant = 0.215 kg/sec
- Condenser:
  Number of tubes (Nt) = 22
  Number of passes = 4pass
- Gasket Plate Heat Exchanger
  Inlet temperature = 45^{o}C
  Outlet temperature = 5^{o}C
- Thermostatic Expansion Valve Selection
  TGE 10 DANFOSS

4 .ADVANTAGE OF 3 UNITS OF 6.3 TR OVER SINGLE UNIT OF 20 TR SYSTEM

Consideration	20TR system	6.3TR system
Refrigerant used	410A High cost, high efficiency, more energy consumption rate	407C Low cost, medium efficiency, less energy consumption
Compressor	Recirculating compressor (due to friction there is more energy loss and high compression work)	Scroll compressor upto 20% energy saving is obtained
Shell and tube condenser	System operates at the pressure of 45 degree C. Hence, high pressure was operating heat exchange during requires.	Same goes for 18.6 bar pressure range at 40 degree C, high pressure operating heat exchange during requires
Evaporator	Shell and tube type	Plate heat exchanger causes upto 21% energy consumption and is suitable for low pressure range and low specific volume
COP	15.8	7.5

By considering above parameters:

5. CONCLUSION

- 20TR system has been divided into 3 parts that is 6.3TR for the objective of reducing energy consumption and to achieve flexibility in operation.
- The 3 units (6.3TR each) of chiller circuit as compared to whole of 20TR reduces the risk of shutdown in process industry.
- COP efficiency of normal operating system and flexibility in operating system may differ but it has an advantage of energy saving and flexibility.
- Each of energy component contribute to less maintainace, power rating.

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