STUDY OF CHILLERS IN REFRIGERATION AND AIR CONDITIONING SYSTEM

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Abstract – *This paper presents the use of chillers in HVAC systems. The study includes the types and use of chiller in air conditioning and industrial processes. Chiller technology in vapour compression system and absorption systems are to be described. Industrial chiller system also to be studied. Comparative study of water cooled chiller and air cooled chiller are to be carried out. The refrigerant used in chiller system and its ozone depletion potential (ODP) and global warming potential (GWP) are described.*

***Key Words*: VCR System, VAR System, ODP, GWP, AC Chiller, WC Chiller,**

1.INTRODUCTION

The air conditioning machine chiller removes heat from a liquid coolant using a vapour compression or vapour absorption refrigeration cycle. The chilled liquid is then circulated through a heat exchanger for cooling the equipments or another process stream such as air or process water. The heat extracted must be exhausted to the atmosphere or sometimes recovered for heating purpose to achieve greater efficiency. The vapour compression chillers can use different types of compressors like hermetic scroll, semi-hermetic screw or centrifugal compressors. The condensing side of chiller may be either air or water cooled. The chiller is often cooled by an induced or forced draft cooling tower. Absorption chillers require heat source to function

2.TYPES OF CHILLERS

Different types of chillers are in use. They are centrifugal chillers, screw chillers, reciprocating chillers, and absorption chillers.

2.1. CENTRIFUGAL CHILLERS

The centrifugal chiller uses the vapour compression cycle for cooling the water and eliminates the heat gathered from chilled water.

2.2. SCREW CHILLERS

The screw chiller uses a screw driven compressor. It drives in refrigerant gas and its potential governs the potential of the chiller

2.3. RECIPROCATING CHILLERS

Reciprocating compressors are used in these chillers. They delivers small amount of refrigerant at high pressure

2.4. ABSORPTION CHILLERS

Heat source is used for chilling the water without using the electrical energy

3.USE OF CHILLERS IN AIR CONDITIONING

In air conditioning systems, chilled water mixed with ethylene glycol, from the chiller in an air conditioning or cooling plant is typically distributed to heat exchangers, or coils in air handlers or other types of terminal devices which cool the air in their respective spaces. The chilled water is then recirculated to the chiller to be recooled. These cooling coils transfer sensible heat and latent heat from the air to the chilled water, thus cooling and usually dehumidifying the air stream. A typical chiller for air conditioning applications is rated between 50 kW and 7 MW. Chilled water temperatures (leaving from the chiller) usually range from 1 to 7 °C depending upon application requirements. Commonly, chillers receive water at 12°C (entering temperature), and cool it to 7°C (leaving temperature). When the chillers for air conditioning systems are not operable or they are in need of repair or replacement, emergency chillers may be used to supply chilled water. Rental chillers are mounted on a trailer so that they can be quickly deployed to the site. Large chilled water hoses are used to connect between rental chillers and air conditioning systems.

4.USE OF CHILLERS IN INDUSTRIES

In industrial application, chilled water or other coolant liquid from the chiller is pumped through process equipment. Industrial chillers are used for controlled cooling of products, mechanisms and factory machinery in a wide range of industries. They are often used in the plastic industries, injection and blow molding, metal working, welding equipment, die-casting and machine tooling, chemical processing, pharmaceutical formulation, food and beverage processing, paper and cement processing, vacuum systems, X-ray diffraction, power supplies and gas turbine power generation stations, analytical equipment, semiconductors, compressed air and gas cooling. They are

also used to cool high-heat specialized items such as MRI machines and lasers, and in hospitals and hotels. Chillers for industrial applications can be centralized, where a single chiller serves multiple cooling needs, or decentralized where each application or machine has its own chiller. Each approach has its advantages. It is also possible to have a combination of both centralized and decentralized chillers, especially if the cooling requirements are the same for some applications or points of use, but not all. Chilled water is used to cool and dehumidify air in mid- to large-size commercial, industrial, and institutional (CII) facilities. Liquid chillers can be liquid-cooled, air-cooled, or evaporatively cooled. Water or liquid-cooled chillers incorporate the use of cooling towers which improve the chillers' thermodynamic effectiveness as compared to air-cooled chillers. This is due to heat rejection at or near the air's wet-bulb temperature rather than the higher, sometimes much higher, dry-bulb temperature. Evaporatively cooled chillers offer higher efficiencies than air-cooled chillers but lower than liquid-cooled chillers. Liquid-cooled chillers are typically intended for indoor installation and operation, and are cooled by a separate condenser water loop and connected to outdoor cooling towers to expel heat to the atmosphere. Air-cooled and evaporative cooled chillers are intended for outdoor installation and operation. Air-cooled machines are directly cooled by ambient air being mechanically circulated directly through the machine's condenser coil to reject heat to the atmosphere. Evaporative cooled machines are similar, except they implement a mist of water over the condenser coil to aid in condenser cooling, making the machine more efficient than a traditional air-cooled machine. No remote cooling tower is required with either of these types of packaged air-cooled or evaporatively cooled chillers. Where available, cold water readily available in nearby water bodies might be used directly for cooling, replace or supplement cooling towers.

5.VCR SYSTEM TECHNOLOGIES IN CHILLERS

A vapor compression chiller uses one of four types of compression. Reciprocating compression, Scroll compression, Screw-driven compression, and Centrifugal compression which are mechanical machines that can be powered by electric motors. Using electric motors in a semi-hermetic or hermetic configuration is the most common method of driving the compressors since electric motors can be effectively and easily cooled by the refrigerant, without requiring exhaust ventilation and no shaft seals are required as the motor can operate in the refrigerant, reducing maintenance, leaks, operating costs and downtime, although open compressors are sometimes used. With evaporative cooling heat rejection, their coefficients of performance (COPs) are in the range of 3.5 to 4.

6.VAR SYSTEM TECHNOLOGY IN CHILLERS

Absorption chiller is driven by a heat source. This heat is usually delivered to the chiller via steam, hot water, or combustion. Compared to electrically powered chillers, an absorption chiller has very low electrical power requirements very rarely above 15kW combined consumption for both the solution pump and the refrigerant pump. However, its heat input requirements are large, and its COP is often 0.5 to 1.0. For the same cooling capacity, an absorption chiller requires a much larger cooling tower than a vapor-compression chiller. However, absorption chillers, from an energy-efficiency point of view, excel where cheap, low-grade heat or waste heat is readily available. In extremely sunny climates, solar energy has been used to operate absorption chillers. The single-effect absorption cycle uses water as the refrigerant and lithium bromide as the absorbent. It is the strong affinity that these two substances have for one another that makes the cycle work. The whole process occurs in almost a complete vacuum.

Table -1: Comparison of Air cooled and Water cooled chillers

Air cooled chiller	Water cooled chiller
Simple construction	Complex construction
Uses the outdoor air as the medium to remove the heat	Water is used as the medium to remove the heat
For installation less space is needed	For installation more space is needed
Available from 7.5 to 500 tons	Available from `10 to 3000 tons
No cooling tower	Cooling tower in the system
Less maintenance	more maintenance needed (chiller condenser tube cleaning, cooling tower mechanical maintance, freeze protection etc.,)
Less operating cost	More operating cost
Operate on higher condensing temperature so more power required	Operate on lower condensing temperature
Low heat transfer capacity and no fouling effect	High heat transfer capacity and high fouling effect

7.REFRIGERANT IN CHILLER SYSTEM

Chillers used for industrial process refrigeration accepts the refrigerants R-410A, R-404A, R-407C and R-134A. A vapor-compression chiller uses a refrigerant internally as its working fluid. Many refrigerants options are available; when selecting a chiller, the application cooling temperature requirements and refrigerants cooling characteristics need to be matched. Important parameters to consider are the operating temperatures and pressures. There are several environmental factors that concern refrigerants, and also affect the future availability for chiller applications. This is a key consideration in intermittent applications where a large chiller may last for 25 years or more. Ozone depletion potential (ODP) and global warming potential (GWP) of the refrigerant need to be considered.

Table -2: ODP and GWP of Refrigerants

Refrigerant	ODP	GWP
R-410A	0	1725
R-404A	0	3260
R-407C	0	1525
R-134A	0	1300

8. CONCLUSIONS

This paper concluded with

- Chillers plays an important role in many industries such as milk dairy plants, pharmaceutical industry, the brewery industry and in meat poultry processings.
- The type of chillers either air cooled or water cooled selected based on the application.
- Water cooled chillers transfer more heat than air cooled chillers.
- Noiseless operation is very important in environments such as hospitals, libraries, banks, schools etc., water cooled chillers are used as water cooled chillers operates noiseless.
- More maintenance is required for water cooled chillers as it has more parts and also complicated construction.
- Water cooled chillers are more efficient than Air cooled chillers

REFERENCES

[1] Hebert W. Stanford, "HVAC Water chillers and cooling towers: Fundamental, Applications and Operations" 2nd edition, 2003.

[2] Keith E. Herold, Reinhard Radermacher, Sanford A. Klein, "Absorption Chillers and Heat Pumps", 2nd edition, 1996.

[3] Open Internet Sources.

BIOGRAPHIES

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