International Journal of Progressive Research in Science and Engineering
Volume-1, Issue-3, June-2020
www.ijprse.com

Studies to Increase Refrigeration Efficiency

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Abstract: - Domestic Refrigerator consumes significant energy in percentage of total energy used in India. Aim of this paper is to improve coefficient of performance of system. To improve the coefficient of performance, it is to require that compressor work should decrease and refrigerating effect should increase. Modifications in condenser are meant to increase degree of sub-cooling of refrigerant which increased refrigerating effect or more cooling water is required in condenser. The purpose of a compressor in vapor compression system is to elevate the pressure of the refrigerant, but refrigerant leaves the compressor with comparatively high velocity which may cause splashing of liquid refrigerant in the condenser tube, liquid hump and damage to condenser by erosion. It is consumption is less for same refrigerating effect so performance is improved. In this paper we describe the different ways to reduce the losses in evaporator, condenser and compressor. Finally, we note that future efforts to reduce losses in evaporator, condenser and compressor should be accompanied by a corresponding effort to improve evaporator, condenser and compressor thermodynamic performance.

Key Words:— *Refrigerator, condenser, thermodynamic performance.*

I. INTRODUCTION

Refrigeration is the method of removal of heat from a low temperature zone to a high temperature zone under controlled conditions. The work of heat removal is done through mechanical work. Refrigeration has many applications, viz. domestic refrigerators, industrial freezers, cryogenics, and in air conditioning.

Types of Refrigeration Systems:

Refrigeration as it is known these days is produced by artificial means. Based on the working principle, refrigeration systems can be classified as:

- Vapor Compression refrigeration
- Vapor Absorption refrigeration
- Gas refrigeration
- Steam jet water vapor refrigeration
- Vortex tube refrigeration
- Thermoelectric refrigeration
- Magnetic cooling
- Liquefaction of natural gases

There are four main components in this refrigeration system:

- The Compressor
- The Condenser
- The Metering Device or expansion valve
- The Evaporator

Compressor:

Two different pressures exist in the refrigeration cycle. The evaporator or low pressure and the condenser, or high pressure. These pressure areas are divided by the other two components. On one end, is the metering device which controls the refrigerant flow, and on the other end, is the compressor. The compressor is the heart of the system. The compressor does just what its name is. It compresses the low pressure refrigerant vapor from the evaporator and compresses it into a high pressure vapor. The inlet to the compressor is called the “Suction Line”. It brings the low pressure vapor into the compressor. After the compressor compresses the refrigerant into a high pressure Vapor, and the outlet of the compressor is called the “Discharge Line”.

Condenser:

The “Discharge Line” leaves the compressor and runs to the inlet of the condenser. Because the refrigerant was compressed, it is a hot high pressure vapor. The hot vapor enters the condenser and starts to flow through the tubes. Cool air is blown across the outside of the finned tubes of the condenser (usually air by a fan or water with a pump). Since the air is cooler than the refrigerant, heat jumps from the tubing to the cooler air (energy goes from hot to cold – "latent heat"). As the heat is removed from the refrigerant, it reaches its "saturated temperature" and starts to change state, into a high pressure liquid. The high pressure liquid leaves the condenser through the "liquid line" and travels to the "metering device" through a filter dryer to remove any dirt or foreign particles.

The condenser can be free air cooled (domestic refrigerator), forced air cooled (window air conditioner), water cooled (Central air conditioning plant in a library, cinema house and evaporative cooled (ice plant unit or a cold storage unit).

Expansion Device:

Metering devices regulate how much liquid refrigerant enters the evaporator as per heat load on evaporator.

Common used metering devices are, small thin copper tubes referred to as "capillary tubes", thermally controller diaphragm valves" (thermostatic expansion valves, called "TXV‟s. This valve has the capability of controlling the refrigerant flow. If the loads on the evaporator change, the valve can respond to the change and increase or decrease the flow accordingly. As the metering devices regulates the amount of refrigerant going into the evaporator, the device lets small amounts of refrigerant out into the line and loses the high pressure to low pressure.

Evaporator:

The evaporator is where the heat is removed from the space or the area/ products to be cooled. Low pressure liquid leaves the metering device and enters the evaporator. The cooler refrigerant in the evaporator tubes, absorb the warm room air. The change of temperature causes the refrigerant to "flash" or "boil", and changes from a low pressure liquid to a low pressure cold vapour. The low pressure vapour is pulled into the compressor and the cycle starts over.

II. FACTORS WHICH REDUCES THE LOSSES IN EVAPORATOR, CONDENSER AND COMPRESSOR

A. Reduces Evaporator Losses

Evaporator losses can be increasing the evaporator pressure or temperature. A high evaporation pressure/temperature indicates the system is drawing heat from the product without expending too much energy.

Thermostat setting:

Setting thermostats only as low as necessary will keep the evaporating temperature as high as possible, absorbing less heat energy into the refrigerant and therefore reducing the load on the compressor.

Correctly sized evaporator:

Size the evaporator to suit the load. A small evaporator may have a low capital cost but may require a larger compressor to cope with the load and so have higher operating costs.

Clean and defrost evaporator coils:

When necessary, clean and defrost evaporator coils to prevent the buildup of ice and subsequent reduction of heat transfer efficiency. If water is used for defrosting, investigate opportunities to reduce or reuse the water elsewhere in the plant. Good ventilation can also assist in defrosting.

Hot gas defrosts:

Hot discharge gas from the compressor can be used to defrost evaporators and offers an excellent alternative to water or air defrosting, saving energy and added into the cooling space. Defrost cycles can be set automatically to occur at the end of production shifts or breaks, helping to extend production run times.

B. Reduces Condenser Losses

Correctly size condensers:

Size condensers to suit the load. If the condenser is too small the condensing temperature will increase or if it is too large, it will cause sub-cooling and vaporization of the refrigerant.

Clean condenser:

Keeping condensers clean and in good condition, e.g. not blocked or corroded, promotes efficient energy transfer.

Locate condenser to allow good airflow:

Providing fresh air and unrestricted air flow (e.g. not against a wall or condenser housing) to condensers that reject heat into the outside air will prevent air recirculating back into the condenser inlet.

Variables speed drives on condenser fans:

Installing variables speed drives on condenser fans can reduce operating costs by two to three percent, especially on systems with fixed-head pressures.

Purging:

Air entering the system through seals and valve packing when systems are open (for repair, coil-cleaning or when oil or refrigerant is added) can create an insulating barrier. This barrier reduces the effective size of the condenser and heat transfer efficiency. By purging the system of air this barrier can be minimized. Purging can be manual or automatic manual purging does not totally eliminate the air and can be dangerous as refrigerants may be flammable and are discharged to the atmosphere.

C. Reduces Compressor Losses

Compressor of the refrigerator system consumes work 80 to 100% of the total energy used.

Compressor Selection:

The efficiency of the system is measured by the co-efficient of performance (COP). This is the ratio of cooling output (kilowatt) compared with energy input (kilowatt), thus the higher the COP, the more efficient the system.

Compressor Load:

The most widely used compressor for refrigeration is the screw compressor; its efficiency decreases for partial loads. Compressor capacity should be matched with cooling load as operating it at partial loads will cause the compressor to stop and start frequently, reducing efficiency. Multiple compressors with a sequencing or capability control can be used to match the load. Compressors operating in sequence should be reviewed to ensure the time intervals at which individual machines operate at part load ratios is less than 70 %.

Compressor Location:

Compressor should be located in cool and well-ventilated areas as they generate large amounts of waste heat and where possible waste heat should be recovered for reuse.

Insulation On Suction Lines:

Insulating the suction lines reduces energy loss as compressor efficiency is improved with lower suction gas temperature.

III. Result And Discussion

By considering all losses with reduces its effect, which result refrigerating effect are increases thus COP increases. By using different methods to reduces the losses in evaporator, condenser and compressor, the ability to increase the efficiency increases and some amount of pressure increases in compressor so compressor work is decreases or power consumption is decreases. Thus performance or COP is increases. In evaporator losses we consider some important points such as size of evaporator, defrost and other thermostat setting. Similarly, in condenser and compressor such important points are purging, cleaning condenser, speed drives in condenser fans, compressor load, insulation of suction and selection of compressor.

IV. Conclusion

COP of Vapor Compression Cycle is increased by lowering the power consumption /work input or increasing the refrigerating effect. By reduces the losses in condenser, compressor and evaporator inlet refrigerating effect increases and power consumption or work input decreases. Thus performance of cycle is improved. This paper presents reason of the decreasing efficiency due to some different types of losses in evaporator, condenser and compressor. Due to these losses different problems be associated which is solved by above solutions.

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