Performance of Glass Wool and Cyclopaintain in Domestic Refrigeration

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Abstract: *The refrigeration is the process of removal of heat from the system under controlled conditions. Insulating material is the one of the main sub systems. The primary function of thermal insulating material used in domestic refrigerator is to reduce the transfer of heat through the walls, pipes of the system. Hence the efficiency of the system is depends upon the on the insulating material in the refrigerator. So the selection of proper insulating material for the refrigerator system is therefore significant factors in order to improve the performance of the system. In this paper the two types of insulating materials are observed for the performance in domestic refrigeration named as Glass wool and cyclopaintain. This paper gives the idea, which insulating material is best for the domestic application and which material have high heat resistance and good temperature holding capacity.*

Keyword: Domestic refrigeration system, Glass Wool, Cyclopaintain, Performance of Glass Wool, Performance of Cyclopainatain.

1. Introduction

The refrigeration is the process of removal of heat from the system under controlled conditions. It is also the process of reducing and maintaining temperature of system below the temperature of surrounding. This function of holding the low temperature is carried out by the number of subsystems. Insulating material is the one of the main sub systems. The primary function of thermal insulating material used in domestic refrigerator is to reduce the transfer of heat through the walls, pipes of the system. Hence the efficiency of the system is depends upon the optimum thickness of the insulating material in the refrigerator. So the selection of proper insulating material and its optimum thickness for the refrigerator system is therefore significant factors in order to improve the performance of the system.

2. Object

Evaluate the performance of domestic refrigerator with the insulating material glass wool and cyclopaintain w. r .t following parameters

- Heat transfer rate.
- Capacity of holding the temperature.
- Energy requirement.

3. Working Principle

The Refrigeration Test Rig works on Vapor Compression Cycle. The refrigeration i.e. (process of maintaining a closed space temperature below ambient temperature), as shown in fig 1. is accomplished by continuously circulating, evaporating and condensing a fixed supply of refrigerant in a closed system. Evaporation occurs at a low temperature and low pressure while condensation occurs at a high temperature and pressure. Thus it is possible to transfer heat from an area of low temperature (in this case test chamber) to an area of high temperature (the surroundings). The compressor pumps the low-pressure refrigerant from the evaporator, increases its pressure, and discharges the high-

pressure gas to the condenser. In the condenser, the refrigerant rejects its heat to the surroundings by passing air over it. At that pressure, the refrigerant loses its latent heat and liquefies. Then the refrigerant passes through the drier/filter where any residual moisture or foreign particles present, these are plugged. The flow of refrigerant into the evaporator is controlled by expansion device where its pressure and consequently temperature is lowered to the saturation temperature at the corresponding pressure. The low temperature refrigerant enters the evaporator where it absorbs heat from the surrounding medium and evaporates. The compressor sucks the cold vapors and the cycle repeats. The required instrumentation is provided to measure the various parameters at different points. This includes pressure gauges, temperature indicators and controller, energy-meters for compressor and heater
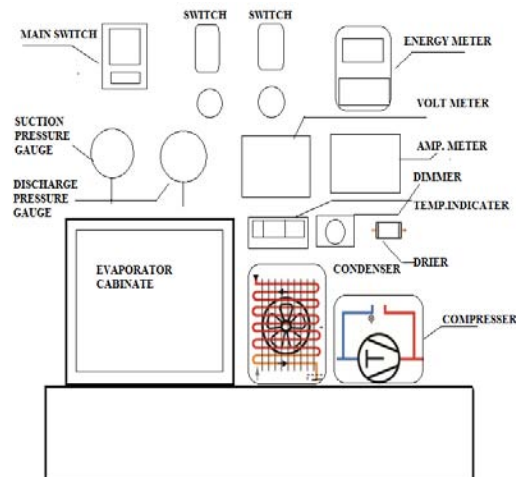

Figure 1: Test Rig of Refrigeration System

In this set up different insulating materials are used to study heat distribution and temperature holding capacity of evaporator. Principally the glass wool and cyclopaintain insulating materials are used in the set up. During the first term temperature capacity in evaporator cabinet has been studied by using the glass wool insulating material. In this

case the with help of the glass wool the construction of insulating cabinet done and capacity of heat transfer and temperature holding of glass wool has been studied. In second term instead of glass wool the cyclopaintain has been used, In this case the with help of the cyclopaintain construction of insulating cabinet done and capacity of heat transfer and temperature holding cyclopaintain has been studied.

4. Observation s For Glass Wool

- The compressor ON for 4 min to 5 min.
- The compressor OFF for 6 min to 8 min.
- In 24 hours with the ambient temp. 27 to 31oC .the energy meter show the following readings
- Initial energy meter reading: 5.5
- Final energy meter reading: 6.4
- Total power consumption= Final energy meter reading - Initial energy meter reading.
- Total power consumption= 6.4 – 5.5=0.9
- Total power consumption= 0.9/24=**0.037 Kw hrs**

4.1 To Evaluate Theoretical C.O.P. for glass wool:

Suction gas temperature = 10
Discharge gas temperature = 55
Temperature after condensation = 45
Temperature after expansion = 2
Average suction pressure in bar =32 to 36 psi
Average discharge pressure in bar =150to 170 psi
Absolute suction pressure= suction gauge pressure + barometric pressure.
Absolute suction pressure= 32/14.5+1.014=3.22 bar
Absolute discharge pressure= discharge gauge pressure + barometric pressure.
Absolute discharge pressure=150/14.5+1.014=11.35
Accordingly enthalpies of refrigerant at salient point are,
$H1$= enthalpies of refrigerant at inlet of compressor = 400
$H2$= enthalpies of refrigerant at outlet of compressor = 430
$H3$= enthalpies of refrigerant after condensation =260
$H4$= enthalpies of refrigerant after expansion =260
Theoretical refrigeration effect=N=H1-H4 =140 KJ/KG
Theoretical compressor effect = W = H2-H1 = 30 KJ/KG
Coefficient of performance = C.O.P= N /W =140/30 = **4.66**

4.2 To calculate the actual C.O.P for Glass Wool

Actual refrigeration effect= heater load
Initial energy meter reading =1.5
Final energy meter reading = 1.8
Final energy meter reading-Initial energy meter reading
Actual refrigeration effect= 1.8-1.5= 0.3 KWHR.
Actual compressor work:
Initial energy meter reading 10.3
Final energy meter reading 10.6
Actual compressor work: =Final energy meter reading-Initial energy meter reading
Actual compressor work: 10.6-10.3=0.3 KWHR
Actual C.O.P 0.3/0.3**= 1**

5. Observations for Cyclopaintain

- The compressor ON for 3 min to 4 min.

- The compressor OFF for 6 min to9 min.
- In 24 hours with the ambient temp. 26 to 31oC .the energy meter show the following readings
- Initial energy meter reading:6.4
- Final energy meter reading:7.2
- Total power consumption= Final energy meter reading - Initial energy meter reading.
- Total power consumption= 7.2-6.4=0.8
- Total power consumption= 0.8/24=0.033 Kwhrs

6. To Evaluate Theoretical C.O.P.

Suction gas temperature = 13
Discharge gas temperature = 58
Temperature after condensation = 37
Temperature after expansion = 1
Average suction pressure in bar =32 to 36 psi
Average discharge pressure in bar =150to 170 psi
Absolute suction pressure= suction gauge pressure + barometric pressure.
Absolute suction pressure= 32/14.5+1.014=3.22 bar
Absolute discharge pressure= discharge gauge pressure + barometric pressure.
Absolute discharge pressure=150/14.5+1.014=11.35
$H1$= enthalpies of refrigerant at inlet of compressor = 410
$H2$= enthalpies of refrigerant at outlet of compressor = 439
$H3$= enthalpies of refrigerant after condensation = 257
$H4$= enthalpies of refrigerant after expansion = 257
Theoretical refrigeration effect=N=H1-H4 = 153 KJ/KG
Theoretical compressor effect = W = H2-H1 = 29 KJ/KG
Coefficient of performance = C.O.P= N /W =153/29= **5.2**

7. To Calculate Actual C.O.P

Actual refrigeration effect= heater load
Initial energy meter reading = 2.0
Initial energy meter reading=2.6
Actual refrigeration effect =Final energy meter reading-Initial energy meter reading
Actual refrigeration effect=2.6-2.0=0.6 KWHR.
Actual compressor work:
Initial energy meter reading=10.8
Final energy meter reading= 11.2
Actual compressor work =Final energy meter reading-Initial energy meter reading
Actual compressor
Actual C.O.P= Actual refrigeration effect/ Actual compressor work
Actual C.O.P= 0.6/0.4=1.5

8. Results and Conclusion

Theoretical C.O.P glass wool= 4.66
Actual C.O.P glass wool= 1
Power consumption of glass wool= 0.037kwhrs
Theoretical C.O.P cyclopaintain= 5.2
Actual C.O.P cyclopaintain= 1.5
Power consumption of cyclopaintain=0.033kwhr

In the present experiment two types of insulating materials are used. It consists of glass wool and cyclopaintain. From reading and calculation it is found out that…..Capacity of heat resistance in cyclopaintain is more than that of glass

wool, besides it produces temperature holding more than glass wool. If cyclopaintain used instead of glass wool less quantity of electricity is used by refrigeration system. Capacity of heat resistance in cyclopaintain is more than that of glass wool, besides it produces temperature holding more than glass wool. If cyclopaintain used instead of glass wool less quantity of electricity is used by refrigeration system.

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References

[1] Important of insulating material: *Source*: ASHRAE, 1981
[2] Properties of insulating material: *Source*: Prepared by authors based on data from ASHRAE, 1981 and Melgarejo, 1995
[3] American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc www.ashre.org. Reprinted by permission from ASHRAE 2001 Handbook-Fundamentals.
[4] Cengal, Yunas, and Michael Boles. Thermodynamics: An Engineering Approach. Highstown: McGraw Hill, 1998.
[5] "Hand Book On Insulation and Refractory"; D.N Nandi; edition 2004.

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