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Experimental Analysis of Several Geometry of Capillary Tube in Air-Conditioning Test Rig by Eco-friendly Refrigerants

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ABSTRACT

In this research work we have presented three variation of capillary tube diameter with the various new alternative of R22, the new refrigerant are R134a, R600a at different proportion are taken ratio of the new refrigerant R134a/R600a are 50:50, 70:30, 30:70 by mass percentage. The co-efficient of performance of refrigerant R134a/R600a and blending ratio 30/70 by mass percentage at 50mm capillary diameter and length 6feet is 62.30% more than R22, 50.38% more than R134a, 46.67% more than R600a, 48.50% more than blending ratio 50:50, 41.14% more than blending ratio 70:30. For Capillary tube diameter 55mm and 6feet length the co-efficient of performance of refrigerant R134a/R600a and blending ratio 30/70 by mass percentage is 52.38% more than R22, 33.19% more than R134a, 44.23% more than R600a, 21.53% more than R134a/R600a blending ratio 50:50, 14.31% more than R134a/R600a blending ratio 70:30. The co-efficient of performance of refrigerant R600a and 64mm capillary diameter and length 6feet is 55.62% more than R22, 39.96 more than R134a, 41.62 more than R134a/R600a blending ratio 50:50, 32.54% more than R134a/R600a blending ratio 70:30 by mass percentage, 12.80% more than R134a/R600a blending ratio 30:70 by mass percentage.
There for R134a/R600a 30:70 by mass percentage is energy efficient refrigerant to replace R22 used in air conditioning test rig.
Keywords: Refrigerant, Co-Efficient Of Performance, Capillary Tube, Air Conditioning, Compressor Power

I. INTRODUCTION

Positive impact on reduction of pollution from automobile exhaust is the key activity of the present thesis work. Pollution by human through various means create strong threats to the environment. Among the various pollutions, air pollution causes a severe damage to the earth which leads to terrific changes in the climatic conditions, ozone layer depletion, and global warming. Though other harmful changes occur on the earth, global warming has been the solemn crisis that needs Immediate attention. The impact of global warming is due to increase in temperature on the earth which results in greenhouse effect and a significant change in the earth's climate. These changes are the major reason for melting of glaciers in the poles, rise in the sea level and changes in the rainfall, shrinking of the forest area, and create significant negative impacts on humans, animals and plant life. Severe air pollution is the base for all the major environmental problems on the earth. The air pollution is caused mainly through low Global

Warming Potential (GWP) gases emitted by the motor vehicles particularly from air-conditioned cars. Refrigeration and air conditioning systems of automobiles play a major role in increasing ozone layer depletion and global warming by the emission of the refrigerant vapours to the earth's atmosphere.

Refrigerant is employed as the working fluid in the refrigeration systems to transfer heat from a region of low temperature to that of elevated temperature in the cycle of refrigeration.

Refrigeration systems are extensively used in all kinds of applications as the temperature of the system has to be maintained inferior to that of the surrounding. The applications of refrigeration system are clustered into the following categories:

- Domestic refrigeration
- Commercial refrigeration
- Industrial refrigeration
- Marine and transport refrigeration
- Comfort air-conditioning system
- Industrial air-conditioning system

- **Domestic Refrigeration**

Domestic refrigeration systems are generally small in size and factory-made with the capacity ranges from 20 litres to 850 litres for a wide variety of applications. Domestic refrigeration subsidized an important portion of the refrigeration industry due to more number of units in service. R134a is the most widely used refrigerant in domestic refrigerators, and naturally weighed about 50–250 g. These systems are utilized in food preservation for household purposes, medical uses, laboratories, hospitals, and other noncommercial areas like offices.

- **Commercial Refrigeration**

In the present scenario, massive population needs incredible quantities of seasonal and perishable commodities which have to be well Preserved over time. The time duration may be as short as hours and as long as years. Moreover, the need of medicines in the world is also enormous. For these purposes, the commercial refrigeration systems are the most appropriate and also encompass their applications in biological units too. Commercial refrigeration systems are employed in retail stores, restaurants, hotels, food processing units, medicine storages, ice plants and so on. The capacity of these systems is high because it needs to preserve large volume of products in the refrigerated area.

- **Industrial Refrigeration**

The usage of refrigeration system for industrial needs is always complex than the commercial needs. Typical industrial applications of refrigeration system are like meat dispensation units, fish preservation plants, poultry, frozen food preservation units, food packing plants, breweries, and creameries. The prerequisite of industrial refrigeration is also extended to oil refineries, chemical plants, rubber treating units, cold storages, ice making units, and so on.

- **Marine and Transport Refrigeration**

Marine refrigeration is one of the primary applications in marine vessels. This refrigeration arrangement is used for preserving marine products and in cold storage vessels for perishable materials, storage containers, etc. Transport refrigeration systems are used in trucks, container storages, railway wagons etc., to preserve the goods in a fresh environment for a long distance and also in local transport applications.

- **Comfort Air Conditioning System**

Air conditioning is the method of maintaining the room temperature inferior to the atmospheric temperature and also to maintain humidity with air motion. Comfort air conditioning system focuses on the conditioning of air inside the control volume for human comfort which is realized by circulating the air over the evaporating coil. Comfort air conditioning systems are applied in households, commercial and transportation etc.

- **Industrial Air Conditioning System**

The industrial air-conditioning system is extensively used in conditioning of air in various industries like textile industry (to sustain stiffness of yarn), chemical industry (to conserve the properties of the layers), pharmaceutical industry (to preserve the microbes and preparation of medicines), agricultural industry (to prolong and produce products), and manufacturing industry (to avoid thermal expansion of the components).

II. METHODOLOGY

In the available air conditioning refrigeration system we have to first understand what is the system function which type of component on system take every detail about component and its function. After taking all the detail we have to decide we work on capillary tube and compressor refrigerant for improving its performance. We have to select three different diameter of capillary which is 50mm, 55mm, and 64mm and length is fixed which 6 feet previous system capillary is and different refrigerant and its different type of refrigerant bland.

After that we have to make the three different capillary with the help of refrigeration and air conditioning tool kit. We have to purchase different type of capillary and refrigerant first cut the all size of capillary in the length of 6 feet with the help of tube cutter than 5/8" cupper tube cut 5cm length and fixed them to the swaging tool and then with the help of flaring tool increase the diameter of the tube after finished taper mouth is developed these tube one side taper mouth is bolt side and other is capillary and side.

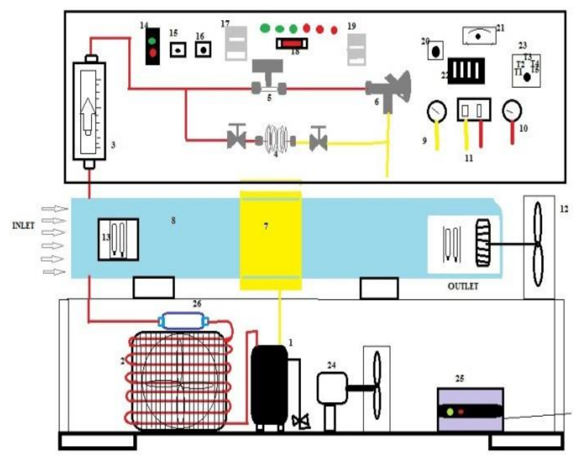


Figure 1. Schematic diagram of Air conditioning test rig

1. Compressor
2. Condenser
3. Rotameter
4. Capillary tube
5. Solenoid valve
6. Thermostatic expansion valve
7. Evaporator
8. Air conditioner duct
9. Suction pressure gauge
10. Discharge pressure gauge
11. HP cut off
12. Evaporator fan
13. DRY and WET bulb Thermometer
14. Main switch
15. Dimmer for Heater H1
16. Dimmer for heater H2
17. Energy meter for CF/EF/H1/H2
18. Digital temperature indicator
19. Energy meter for Condenser
20. Range
21. Thermostat TH
22. SV/CF/EF/ECF Switch
23. Temperature sensor nobe
24. Extra cooling fan
25. Stabilizer
26. Filter drier

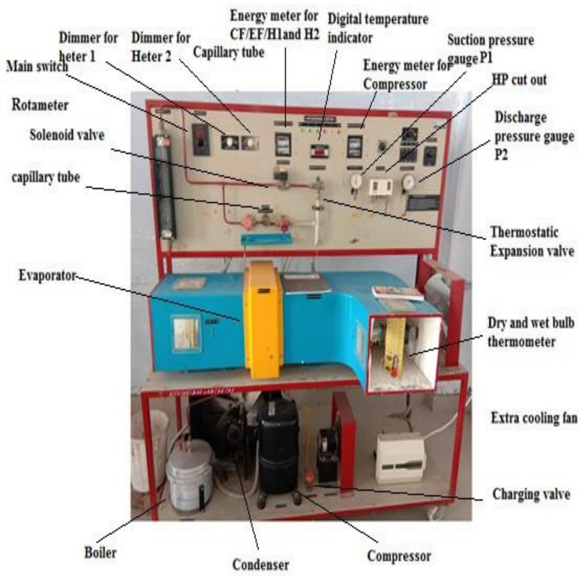


Figure.2 Physical experimental test rig of air conditioning

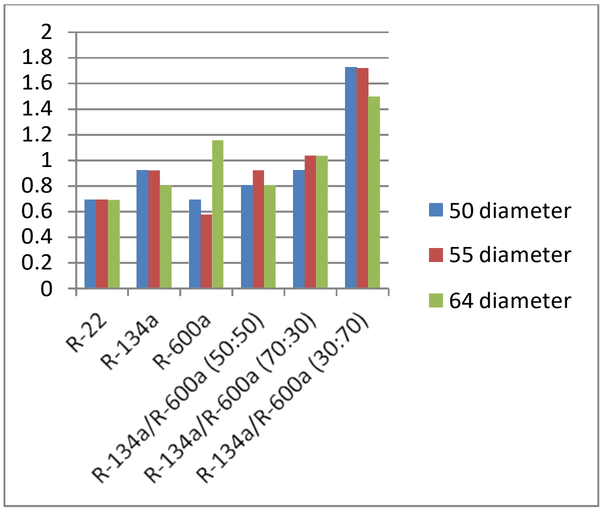
Capillary tube inside the bigger tube and press the tube and then breezing is done with the help of cupper flux cored soldering brazing flux and gas welding torch with hose than same to the other side all the three capillary same procedure use of making the capillary tube. After making the three different capillary tubes close the both side of the valve than with the help of the nut bolt tight manifold the threading.

After attached the capillary tube in the air conditioning system, the charging the compressor both capillary side of the valve is closed, Reset the HP/LP pressure switch manually first clean all the line of the system with compressor with the help of vacuumed pump then charging prose of the refrigerant into the compressor chamber with the help of refrigerant can or cylinder first we have to weight the cylinder with the help of weight machine then attached the gas charging hose, adaptor from R134a hose, high side single manifold without gauges for R22, R134a,R600a, dispenser valve for gas can charging manifold and hose, all the attachment is done then slowly open the valve of the manifold and small amount of the refrigerant passing through the charging cable into the compressor chamber then close the both side of the valve, the start the system than again both the valve open slowly and refrigerant enter in the air conditioning refrigeration system we have to see the HP/LP pressure switch the pressure are not increase to reset pressure if the pressure is increase the rest pressure then the system is trip so very carefully charging the compressor.

III. RESULT AND DISCUSSION

Refrigeration effect

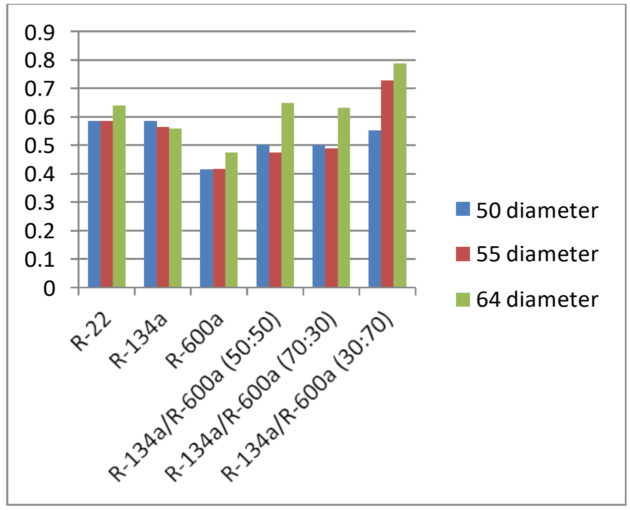
- For refrigerant R-22 at capillary diameter 50 mm, 55 mm, 64 mm & length 6 feet. The value of refrigeration effect is 0.6916 kW.
- For refrigerant R-134a at capillary diameter 50 mm, 55 mm, 64 mm & same length 6 feet. The values of refrigeration effect are 0.9213 kW, 0.9221 kW & 0.8049 kW respectively.
- For refrigerant R-600a at capillary diameter 50 mm, 55 mm, 64 mm & same length 6 feet. The value of refrigeration effect is 0.6916 kW, 0.5763 kW and 1.1572 kW respectively.
- After blinding the refrigerant R134a/ R600a at different blending ratio 50:50, 70:30, 30:70 at capillary tube diameter 50mm, 55mm, 64mm 0.80690kW, 9221kW, 80690kW, 92241kW, 03771,kW 03751kW,7291kW, 1.7205kW, 1.4986kW respectively



Graph: 1 Variation of Refrigeration Effect with Blinding Ratio Refrigerant R-22, R-134a, R-600a, R-134a/R-600a

Compressor power

- For R-22 the compressor power at capillary diameter 50 mm, 55 mm and 64 mm are 0.5853 kW, 0.5853 kW and 0.64 kW respectively.
- For R-134a the compressor power at capillary diameter 50 mm, 55 mm, 64 mm are 0.5853 kW, 0.5647 kW and 0.5581 kW respectively.
- For R-600a the compressor power at capillary diameter 50 mm, 55 mm, 64 mm are 0.41383 kW, 0.4179 kW and 0.4752 kW respectively.
- For R-134a/R-600a blending ratio 50:50 the compressor power at capillary diameter 50 mm, 55 mm, 64 mm are 0.5 kW, 0.4752 kW and 0.6486 kW respectively.
- For R-134a/R-600a blending ratio 70:30 the compressor power at capillary diameter 50 mm, 55 mm, 64 mm are 0.5 kW, 0.4897 kW and 0.6316 kW respectively.
- For R-134a/R-600a blending ratio 30:70 the compressor power at capillary diameter 50 mm, 55 mm, 64 mm are 0.5517 kW, 0.7273 kW and 0.7869 kW respectively.



Graph: 2 Variation of Compressor Power with Blinding Ratio Refrigerant R-22, R-134a, R-600a, R-134a/R-600a

Actual co-efficient of performance

- For R-22 the value of actual COP at different diameter 50 mm, 55 mm and 64 mm are 1.1816, 1.1816 and 1.0806 respectively.
- For R-134a the value of actual COP at different diameter 50 mm, 55 mm and 64 mm are 1.5549, 1.6522 and 1.462 respectively.
- For R-600a the value of actual COP at different diameter 50 mm, 55 mm and 64 mm are 1.6713, 1.379 and 1.4351 respectively.
- For R-134a/ R-600a blending ratio 50:50 the value of actual COP at different diameter 50 mm, 55 mm and 64 mm are 1.6138, 1.9404 and 1.4216 respectively.
- For R-134a/ R-600a blending ratio 70:30 the value of actual COP at different diameter 50 mm, 55 mm and 64 mm are 1.8448, 2.1190 and 1.64226 respectively.

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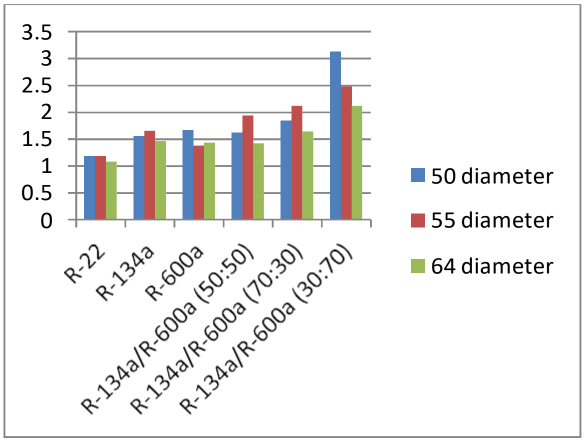
- For R-134a/ R-600a blending ratio 30:70 the value of actual COP at different diameter 50 mm, 55 mm and 64 mm are 3.1341, 2.473 and 2.1233 respectively.



Graph: 3 Variation of Co-efficient of Performance with Refrigerants & its Blinding Ratio Refrigerant R-22, R-134a, R-600a, R-134a/R-600a

IV. CONCLUSION

- The coefficient of performance is maximum in refrigerant R134a/R600a and blending ratio 30/70 % at 50mm capillary diameter and 6feet length compare with overall results.
- The coefficient of performance is maximum in refrigerant R600a at 64mm capillary diameter and 6 feet length compare with individual.
- The coefficient of performance of refrigerant R134a/600a and blending ratio 30/70 at 50mm capillary diameter and 6feet length is 48.50% more than blending ratio 50/50, 41.14% more than blending ratio 30/70.
- Mass flow rate of dry air in a rectangular duct is 0.1147 Kg/s. and velocity of dry air is 1.3 m/s.

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