Experimental analysis of The Performance of R22, R134a, R32 and R32/R134a Refrigerants with Different Standard Geometry of Filter-Driers on Air-Conditioning Test Rig

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Abstract

In this research work we have presented three variation of filter-driers with the various new alternative of R22, the new refrigerant are R134a, R32 at different proportion are taken ratio of the new refrigerant R32/R134a are 10:90, 20:80 and 30:70 by mass percentage. The coefficient of performance of refrigerant R32/R134a and blending ratio 30/70 by mass percentage at 3/8 inch and length 104mm is 62.30% more than R22, 50.38% more than R134a, 46.67% more than R32, 48.50% more than blending ratio 10:90, 41.14% more than blending ratio 20:80. For filter-drier of size 1/4 inch and 104mm length the coefficient of performance of refrigerant R32/R134a and blending ratio 30/70 by mass percentage is 52.38% more than R22, 33.19% more than R134a, 44.23% more than R32, 21.53% more than R32/R134a blending ratio 10:90, 14.31% more than R32/R134a blending ratio 20:80. The coefficient of performance of refrigerant R32 and 1/2 inch and length 104mm is 55.62% more than R22, 39.96 more than R134a, 41.62 more than R32/R134a blending ratio 10:90, 32.54% more than R32/R134a blending ratio 20:80 by mass percentage, 12.80% more than R32/R134a blending ratio 30:70 by mass percentage. Therefore R32/R134a 30:70 by mass percentage is an energy efficient refrigerant to replace R22 used in air conditioning test rig.

Keywords: Refrigerant, Coefficient Of Performance, Filter-Drier, Air Conditioning, Compressor Power

I. INTRODUCTION

Results from many researches show that the ozonosphere is being depleted because of the presence of chlorine within the stratosphere. The final consensus for the reason behind this can be that CFCs and HCFCs are large classes of chlorine containing chemicals, which migrate to the stratosphere where they react with ozone. And later, chlorine atoms still convert more ozone to oxygen. The invention of the depletion of the earth's ozonosphere, which shields the earth's surface from UV radiation, has resulted in an exceedingly series of international treaties demanding a gradual termination of halogenated fluids. The CFCs have been banned in developed countries since 1996, and in 2010, producing and using of CFCs are going to be prohibited completely everywhere the globe.

There are many sorts of refrigerating equipment, from common domestic refrigerators and freezers to air-conditioners, heat pumps, and

chillers, all of them care for the identical principle. Domestic refrigeration represents a major portion of the refrigeration industry, because of an oversized number of units in commission.

In accordance with the Montreal and subsequent Protocols on substances that deplete the ozonosphere, CFCs and HCFCs refrigerants are subjected to total phase-out during a scheduled time frame. R134a was the primary chlorine-free HCF refrigerant that was found as a replacement for R12 in domestic refrigeration systems, because of its excellent thermodynamic and thermophysical properties. However, due to its relatively high global warming potential, its production and use are terminated within the near future. During this study, the performances of R32, which is environment-friendly refrigerants with zero ozone depletion potential and low global warming potential, were investigated experimentally in an air conditioning test rig and compared with the performance of the system when R134a was used as a refrigerant. After the successful investigation on the performances of R22, R134a, R32 and blind R32/R134a. 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, a 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 for 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 a large volume of products in the refrigerated area.

- **Industrial Refrigeration**

The usage of refrigeration systems for industrial needs is always more complex than the commercial needs. Typical industrial

applications of refrigeration systems 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 the system takes every detail about the 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 sizes of filter-drier 3/8, 1/4 & 1/2 and length is fixed which 104mm previous system filter drier is and different refrigerant and its different type of refrigerant bland.

After that we have to make the three different geometry of filters with the help of refrigeration and air conditioning tool kit. We have to purchase different type of filter drier and refrigerant first cut the all size of drier in the length of 104mm with the help of tube cutter than 5/8” copper tube cut 104mm length and fixed them to the swaging tool and then with the help of a flaring tool resize the diameter of the tube after the finished filter drier is welded to the main line between the outlet of the condenser and inlet of the rotameter.

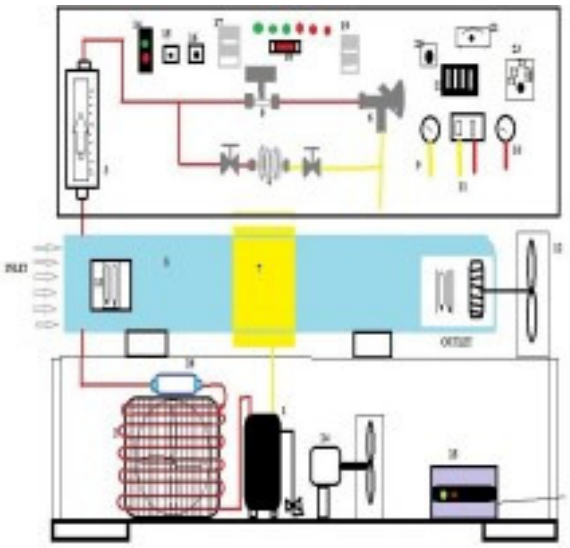


Figure 1. Schematic diagram of Air conditioning test rig

Filter-Drier of tube shape inside the bigger tube and press the tube and then breezing is done with the help of copper flux cored soldering brazing flux and gas welding torch with hose than same to the other side all the three standards size of filter drier same procedure use of making the filter drier of tube shape. After making the three different filter driers close the mainline in a suitable position.

After attached the filter-drier 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 vacuum pump then charging prose of the refrigerant into the compressor chamber with the help of refrigerant

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

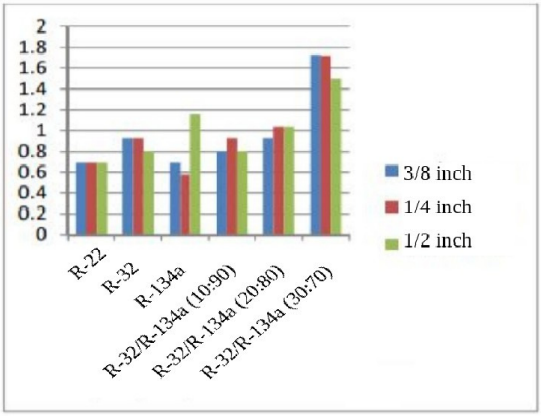
Figure.2 Physical experimental test rig of air conditioning

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, R32 and R134a, 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

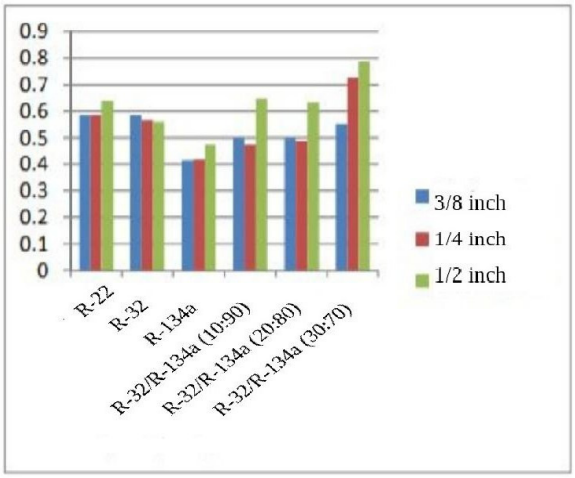
- For refrigerant R-22 at filter drier of size 3/8 inch, 1/4 inch and 1/2 inch with same length 104mm. The value of the refrigeration effect is 0.6916 kW.
- For refrigerant R-134a at filter drier of size 3/8 inch, 1/4 inch and 1/2 inch with same length 104mm. The values of refrigeration effect are 0.9213 kW, 0.9221 kW & 0.8049 kW respectively.
- For refrigerant R-32 at filter drier of size 3/8 inch, 1/4 inch and 1/2 inch with same length 104mm. The value of refrigeration effect is 0.6916 kW, 0.5763 kW and 1.1572 kW respectively.
- After blinding the refrigerant R134a/ R32 at different blending ratio 10:90, 20:80, 30:70 at filter drier of size 3/8 inch, 1/4 inch and 1/2 inch 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-32, R-32/R-134a

Compressor power

- For R-22 the compressor power at filter drier of size 3/8 inch, 1/4 inch and 1/2 inch are 0.5853 kW, 0.5853 kW and 0.64 kW respectively.
- For R-134a the compressor power at filter drier of size 3/8 inch, 1/4 inch and 1/2 inch are 0.5853 kW, 0.5647 kW and 0.5581 kW respectively.
- For R-32 the compressor power at filter drier of size 3/8 inch, 1/4 inch and 1/2 inch are 0.41383 kW, 0.4179 kW and 0.4752 kW respectively.
- For R-32/R-134a blending ratio 10:90 the compressor power at filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 0.5 kW, 0.4752 kW and 0.6486 kW respectively.
- For R-32/R-134a blending ratio 20:80 the compressor power at filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 0.5 kW, 0.4897 kW and 0.6316 kW respectively.
- For R-32/R-134a blending ratio 30:70 the compressor power at filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 0.5517 kw, 0.7273 kw and 0.7869 kw respectively.

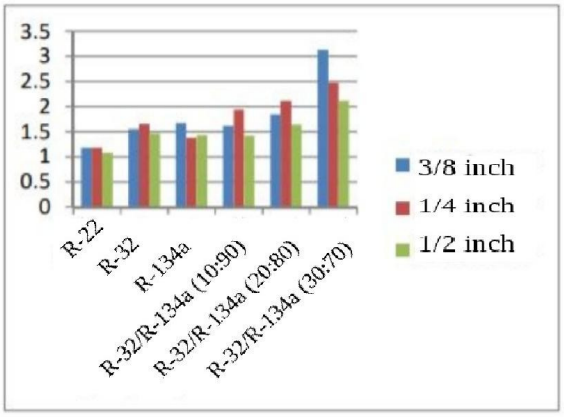


Graph: 2 Variation of Compressor Power with Blinding Ratio Refrigerant R-22, R-134a, R-32, R-32/R-134a

Actual coefficient of performance

- For R-22 the value of actual COP at different standard sizes of filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 1.1816, 1.1816 and 1.0806 respectively.
- For R-134a the value of actual COP at different standard sizes of filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 1.5549, 1.6522 and 1.462 respectively.
- For R-32 the value of actual COP at different standard sizes of filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 1.6713, 1.379 and 1.4351 respectively.
- For R-32/R-134a blending ratio 10:90 the value of actual COP at different standard sizes of filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 1.6138, 1.9404 and 1.4216 respectively.

- For R-32/ R-134a blending ratio 20:80 the value of actual COP at different standard sizes of filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 1.8448, 2.1190 and 1.64226 respectively.
- For R-32/ R-134a blending ratio 30:70 the value of actual COP at different standard sizes of filter driers of size 3/8 inch, 1/4 inch and 1/2 inch are 3.1341, 2.473 and 2.1233 respectively.



Graph: 3 Variation of Coefficient of Performance with Refrigerants & its Blinding Ratio Refrigerant R-22, R-134a, R-32, R 32/R-134a

IV. CONCLUSION

- The coefficient of performance is maximum in refrigerant R32/R134a and blending ratio 30/70 % at 3/8 inch filter drier and 104mm length compared with overall results.
- The coefficient of performance is maximum in refrigerant R32 at 1/2 inch filter-drier and 104mm length compared with individual.
- The coefficient of performance of refrigerant R32/R134a and blending ratio 30/70 at 3/8 inch filter-drier and 104mm length is 48.50% more than blending ratio 20:80, 41.14% more than blending ratio 10:90 .
- 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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