Performance Evaluation of Split Air Conditioner Working with Alternate Refrigerant to R-22: A Review

[1]Chiragkumar M. Patel, [2]Dr. Ragesh G. Kapadia, [3]Dr. V.K. Matawala

[1]P.G. Student, [2]Principal, [3]H.O.D
Mechanical Engineering Department
Shri S'ad Vidya Mandal Institute of Technology, Bharuch, India

***Abstract*— This paper presents use of R-290 as alternative to R-22 in air conditioner. R-22 ODP is 0.055 & GWP is 1780. Some selected refrigerant with zero ODP have been considered as alternative to R-22 for AC. At present R-410A is considered as alternative refrigerant in AC. But its GWP is so high. R-407C is mainly consider for retrofitting & COP & Cooling Capacity is lower than R-22. So, HFC couldn't be a long term alternative which do not deplete Ozone layer but have equivalent or higher GWP than R-22. Through the deep and continuous consideration our interest has been focused on hydrocarbon especially R-290.It has zero ODP and negligible GWP doing no harm to environment & has good characteristics as refrigerant from point of view of thermodynamic and transport properties.**

***Keywords:* Air conditioner, Refrigerants, R-290, R-22**

1. INTRODUCTION

An air conditioner is device that decreases the temperature of air. The cooling is achieved through vapor compression refrigeration cycle. Its aim is to distribute cooled air to occupied space such as house, vehicle and building.

1.1 Types of Air Conditioners

1) Window air conditioner
2) Split air conditioner

❖ **Components**

1) Compressor
2) Condenser
3) Throttle valve
4) Evaporator

2. LITERATURE REVIEW

A.V. Waghmare et al. [1] studied alternatives to R-22 for air conditioner. Some selected refrigerants with zero ODP have been considered as alternatives to R-22 for air conditioner. Refrigerants studied are R-134a, R-290, R-407C, R-410A. R-134a gave the highest COP, but its cooling capacity is the lowest. This is disadvantage for compressors used for air conditioners. Characteristics of R-290 are very close to R-22. R-290 is a potential candidate provided with risk concerns.

N.K. Sane et al. [2] studied performance of R-290 as a drop in substitute to R-22 in window air conditioner. Cooling capacity of R-290 was lower in the range of 7 – 10%. COP of R-290 was higher in the range 3–9%. Discharge pressures of R-290 were lower in the range 14 –18%.

Ki-Jung Park et al. [3] studied performance of alternative refrigerants for air-conditioner. In this study, performances of two pure hydrocarbons and seven mixtures composed of propane, propylene, Dimethylether (DME) and R-152a were measured to substitute for R-22 in air-conditioners. Test results show that the COP of these mixtures is 6% higher than that of R-22. While propane showed 12% reduction in cooling capacity, most of the fluids had a similar capacity to that of R-22. For these fluids, compressor-discharge temperatures were reduced by 10–18 °C. For all fluids tested, the amount of charge was reduced up to 49% as compared to R-22.

D.B. Jabaraj et al. [4] studied a composition of R-407C/ R-290/ R-600a mixture as alternative to R-22 in window air conditioner. The behavior of R-22 and R-407C with various proportions of HC blend with m.o. as compressor lubricant has been experimentally analyzed in a window air conditioner. COP of M20 is 9 to 12% higher than that of R-22.

W. Chen [5] studied a performance of R-22 and R-410A in air conditioner. In this work, four sets of comparable R-22 and R-410A split air conditioners were developed and then their performance was studied using simulation software. The use of R-410A could helpful for air conditioner to decrease their condenser size. One of the four A.C prototypes was R-22 baseline & other three were the R-410A. Among the three R-410A air conditioners, one has same appearance size as R-22 baseline A.C, one was of compact type and the other one was of high-efficiency type. Efficiency of R-410A A.C which had the same appearance size as R-

22 baseline A.C was 5% higher than that of R-22 A.C. Efficiency of high-efficiency R-410A A.C was 14% higher than that of R-22 A.C.

Ki-Jung Park et al. [6] studied performance of R-433A for replacing R-22 used in air-conditioners. In this work, performance of R-433A and R-22 is measured in bench tester under air conditioning conditions. COP of R-433A is 5–8% higher than that of R-22.Cooling capacity of R-433A is 1– 6% lower than that of R-22. Compressor discharge temperature of R-433A is 23–28°C lower than that of R-22. Amount of charge for R-433A is 55–58% lower than that of R-22.

Jianlin Yu et al. [7] studied performance of a new refrigeration cycle using refrigerant mixture R-32 /R-134a for air-conditioner. To evaluate the performances of cycle with refrigerant mixture R-32 /R-134a theoretical model was constructed. Calculating results shows that in CRC the mixture R-32 /R-134a has close performance to that is obtain with R-22. The mixture R-32 /R-134a in NRC will result in good performance. The COP can be improved in a range of 7 – 10% over that of CRC.

Ki-Jung Park et al. [8] studied a performance of R-432A to replace R-22 in air-conditioner. In this work, performance of R-432A and R-22 is measured in bench tester under air-conditioning conditions. COP of R-432A is 9–10% higher than that of R-22. Cooling capacity of R-432A is 2–7% higher than that of R-22. Compressor discharge temperature of R-432A is 15–18 °C lower than that of R-22. Amount of charge for R-432A is 49% lower than that of R-22.

Jing Hu et al. [9] studied performance of mixture refrigerant R-32/ R-125/ R-152a in air-conditioner. This work reports a ternary blend R-32/ R-125/ R-152a with a mass ratio of 34/18/48 as a potential alternative to R-22. A drop-in test of this new mixture was performed in an air-conditioner. Calculation and experimental results showed that this new mixture could be a most likely drop-in substitute for R-22 in many applications.

L.D. Yang et al. [10] studied performance of an air conditioner retrofitted with R-290 and R-1270. An original R-22 air conditioner with energy efficiency ratio of 3.2 and cooling capacity of 2.4 kW is retrofitted with a compressor of 20% larger displacement to charge R-290 and R-1270 for performance experiments. Using same kind of lubricant of higher viscosity would offer R-1270 1% higher energy efficiency ratio and 2.5% higher cooling capacity. Replacing a compressor of 20% larger displacement would gave good performance for R-290. Alternative systems all have increases in energy efficiency ratio and cooling capacity with the decrease of outdoor temperature when compared to original R-22 system. By taking safety issues into account, R-1270 system with a compressor of 20% larger displacement gave good performance with negligible loss in energy efficiency ratio and increase in cooling capacity by 14 - 18%.

3. CONCLUSION

Refrigerants studied are R-134a, R-290, R-22, R-407C and R-410A. R-134a gave highest COP, but its cooling capacity is lowest. This is disadvantage for compressor used for air conditioner. Characteristics of R-290 are very close to R-22. R-290 is a potential candidate provided with risk concerns.

REFERENCES

[1] A.V. Waghmare, N.N. Sawant, B.M.Domkundwar, S. Devotta, Alternatives to HCFC-22 for air conditioners, Applied Thermal Engineering 21 [2001] 703-715.
[2] A.S. padalkar, N.K. Sane, S. Devotta, Performance assessment of HC-290 as a drop in substitute to HCFC-22 in window air conditioner, International Journal of Refrigeration 28 [2005] 594–604.
[3] Ki-Jung Park, Taebeom Seo, Dongsoo Jung, Performance of alternative refrigerants for residential air-conditioning applications, Applied Energy 84 [2007] 985–991.
[4] D.B. Jabaraj, A. Narendran, D. Mohan Lal, S. Renganarayanan, Evolving an optimal composition of HFC407C/HC290/HC600a mixture as an alternative to HCFC-22 in window air conditioners, International Journal of Thermal Sciences 46 [2007] 276–283.
[5] W. Chen, A comparative study on the performance and environmental characteristics of R-410A and R-22 residential air conditioners, Applied Thermal Engineering 28 [2008] 1–7.
[6] Ki-Jung Park, Yun-Bo Shim, Dongsoo Jung, Performance of R-433A for replacing HCFC-22 used in residential air-conditioners and heat pumps, Applied Energy 85 [2008] 896–900.
[7] Jianyong Chen, Jianlin Yu, Performance of a new refrigeration cycle using refrigerant mixture R-32/R-134a for residential air-conditioner applications, Energy and Buildings 40 [2008] 2022–2027.
[8] Ki-Jung Park, Yun-Bo Shim, Dongsoo Jung, Experimental performance of R-432A to replace R-22 in residential air-conditioners and heat pumps, Applied Thermal Engineering 29 [2009] 597–600.
[9] Jiangtao Wu, Yingjie Chu, Jing Hu, Zhigang Liu, Performance of mixture refrigerant R-152a/R-125/R-32 in domestic air-conditioner, international journal of refrigeration 32 [2009] 1049 – 1057.
[10] J.H. Wu, L.D. Yang, J. Hou, Experimental performance study of a small wall room air conditioner retrofitted with R-290 and R-1270, international journal of refrigeration 35 [2012] 1860-1868.