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Improving the performance of Air Conditioning System with the addition of nano particles into the refrigerant

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ABSTRACT

Engineered nanoparticles have expanded dramatically in production and use, exposing workers and consumers to greater risk. Novel opportunities and risks are presented by the development and use of new materials, respectively. The ecosystem and human health are being disrupted by the application-related uncertainty of ENPs. Proper use of nano particles in the refrigerant with small amount increases the performance of air conditioning system. In this paper pure refrigerant R134a is mixed with nano particle copper oxide in the concentration 0.1% & 0.5% of weight. The results shows that using nano refrigerant the energy consumption is reduced compared to using pure refrigerant alone. The time taken to reach the cabin temperature is less using nano refrigerant.

***KEYWORDS:** Global warming potential, Ozone depletion potential, air conditioning system, power consumption, Nano particles*

1. INTRODUCTION

Montreal Protocol of 1989 resulted from the discovery of the Antarctic ozone hole and increased global awareness. (Aisbett & Tuan Pham, 1998)CFCs were also found to have made a major contribution to the global greenhouse warming issue during this time period. It demonstrates that using hydrocarbons as CFC replacements in vehicle air conditioning can result in large refrigerant cost reductions and a lower but still sizable reduction in greenhouse gas emissions. (Ciantar & Hadfield, 2000) It shown how intricate environmental concerns in product development can become because of the several engineering disciplines that have an impact on them. The hermetic compressor is not designed to be easily reused because it is thought to be a robust device.(Koroneos et al., 2010) Utilization of conventional refrigeration systems has a number of limitations, including increased electrical energy consumption, frequent peak electrical loads, environmental issues brought on by the use of refrigerants, and an increase in installed electric power generation. The fundamental goal of solar air conditioning systems is to replace fossil fuel-based systems in order to achieve a significant energy saving that will be beneficial to the economy.(Susanti et al., 2011) The findings demonstrated that manufacturing buildings with naturally ventilated cavity roofs have excellent potential to improve the inside thermal climate and save energy without the need for intricate cooling solutions or long-term power use. (Wan et al., 2011) Significant environmental gains will result from China replacing HCFC-22 with HFC-410A and HC-290 in the house hold air conditioning system. It protects the ozone layer by reducing the emission of chemicals that deplete the ozone layer. Because refrigeration technology is becoming more efficient, it will indirectly save energy and cut greenhouse gas emissions. Efficiency in energy conservation and the protection of the ozone layer will rise quickly as HCFC-22 is being phased out in increasing proportions. Unlike the HC-290, which will use less energy, unlike HFC-410A (Cardoso et al., 2012) This investigation's goal is to evaluate window and split air conditioners using the least energy required by Brazil performance criteria. Consumers can utilize energy labeling and MEPS as buying guidelines when purchasing energy equipment, which encourages manufacturers to keep improving and revising their products. (Basaran & Ozgener, 2013) The analysis revealed that the types of refrigerants have an impact on system performance. The heat exchanger (evaporator) has been found to be crucial to the efficiency of the system. Energy and exergy efficiency fall as the exergy destruction brought on by the refrigerants in the HE rises. Some refrigerants, particularly CFCs, have a harmful impact on the environment. For the geothermal binary power plants, refrigerants that contribute to environmental issues such pollution, global warming, and ozone depletion shouldn't be chosen as the working fluid.

2. Environmental and Climatic Impact

Natural refrigerants are promoted as the best, most,(Bolaji & Huan, 2013) HFC have mostly replaced CFC and HCFC refrigerants. Refrigerants inside the system are not the issue; rather, it is their release into the environment. Both mineral oil, used in CFC systems, and poly-oy-ester oils, used in HFC systems, are miscible with natural refrigerants, particularly hydro carbons and their combinations. Nano particles in refrigerant.(Kumar et al., 2021) It was the goal of the current research project, "Performance Evaluation of Refrigeration System Using Nano-fluid," to combine nanoparticles with hydrocarbon refrigerant. Nanoparticles between 20 and 30 nm in size will be used. To examine the effectiveness of a refrigeration system, various nanoparticle concentrations were used.

3. Experimental setup and Material used

CuO copper oxide nano particle is used in this study is purchased from M/s amnium technologies, Pune and the details of the product given below:

Name of product: CuO_Nano 10
Form: Dry powder
Solvents: Dispersible in aqueous solvents
Color: dark brown/black
Particle size range: -10 nm
Particle shape – spherical

Figure 1. Nano particle

4. Experimental setup

The major parts of the experimental setup are taken from a Maruti 800 automobile, are shown in the figure 2 below including the car compressor, air-cooled condenser, expansion device, and evaporator. The refrigerant compressor was run independently from the engine using a separate AC 3 phase motor with a 1600 rpm and 2 HP capacity. The motor pulley and refrigerant compressor were connected by a belt drive. To alter and change the speeds, a stepped pulley is permanently mounted to the motor. Digital tachometer of the non-contact kind was used to measure the motor speed. Using an anemometer, the velocity of the evaporator fan flow rating is measured to determine the cabin air flow rate. To measure the precise temperature difference, PT100 temperature sensors are mounted at various locations. It is a temperature scanner

Figure 2. Experiment setup

5. Method to Perform the Experiment

The temperature inside the cabin is raised to 50°C and held there for an hour. The compressor motor is then turned ON after that. In order to obtain the necessary compressor speed, the motor belt is modified. The temperature sensed by all RTDs is thus recorded every 10 seconds. The speed of the compressor is continuously checked and kept at 1600 rpm. To steadily lower the cabin temperature, the evaporator head load is altered. To provide uniform cooling throughout the cabin, the heat load is gradually lowered. Once the cabin reaches 20 °C, it is maintained there for an hour while all measurements are taken. All areas maintained a 0.5C temperature difference.

6. Results & Discussion

The figure 3. below illustrates the pull-down characteristics of an automotive air conditioning system. The pull-down test is run with no load and a 2000W heat load. Five different compressor rpm trials have been run for each heat load. One hour is spent soaking. The time taken to reach the cabin temperature of 20C is depicted in the graph. The mass flow rate rises as the compressor speed does, speeding up the cooling process. As a result, it will take less time to reach the set point the faster the compressor runs. During the no load pull down, at a speed of 1600 rpm the time required to reach the set point of 20◦C is 300s for R134a and for nano refrigerant R134a+0.1nm is 290s. At 1460 rpm the time for R134a is 325s whereas for nano refrigerant is R134a+0.5nm is 298s. Therefore, the time taken to reach the set point is less for nano refrigerant when compared with pure R134a refrigerant.

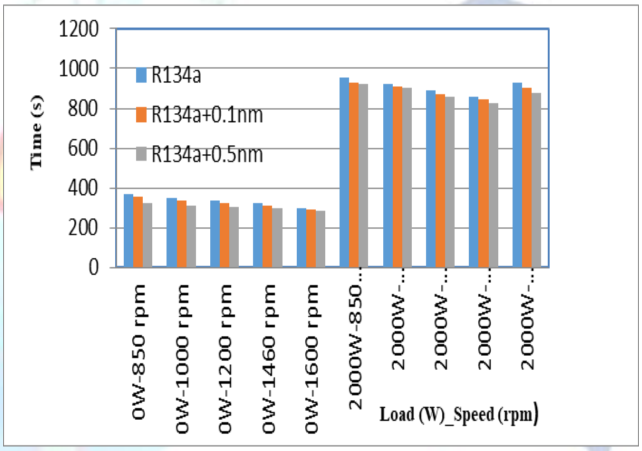

Figure 3. Pull down time of R134a and nano refrigerant during no load and 2000W load at different speeds

The figure 4. Illustrates the test results of the energy consumption study for a duration of six hours. The bar chart of energy consumption at 850, 1000, 1200, 1460 and1600 rpm at a constant load of 2000 W. The energy consumption for pure refrigerant is more than nano refrigerant. The energy consumption is reduced by using for nano refrigerant. At 850 rpm the energy consumption of pure refrigerant is 630 watts which is reduced by 5% by using nano refrigerant. The energy consumption of nano refrigerant R134a+0.1nm at 1000 rpm is 670 watts which is 4% less than pure refrigerant. Similarly, the energy consumption of nano refrigerant of R134a+0.1nm is 1050 watts which 14% less than pure refrigerant.

The figure 5. shows the cabin cooling characteristics for both refrigerants will be the same because there is little variation in the time it takes to reach the set point. The draw down is depicted in the above figure for an hour. For nano refrigerant R134a+0.1nm, the first pull down is quicker. However, it later combines with that of pure refrigerant R134a. This is explained by the variation in mass flow rate that occurs over time.

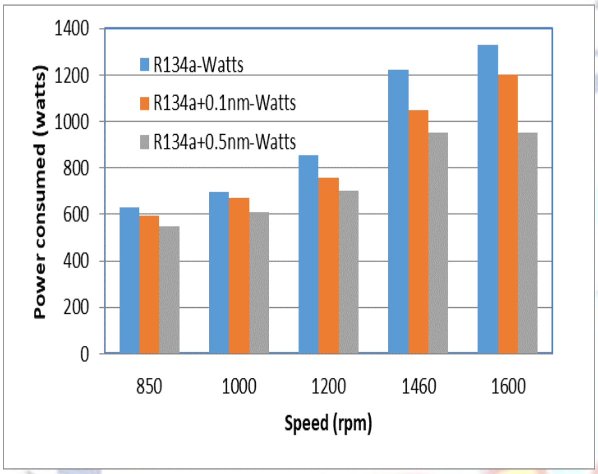

Figure 4. Energy consumption study at various compressor speeds

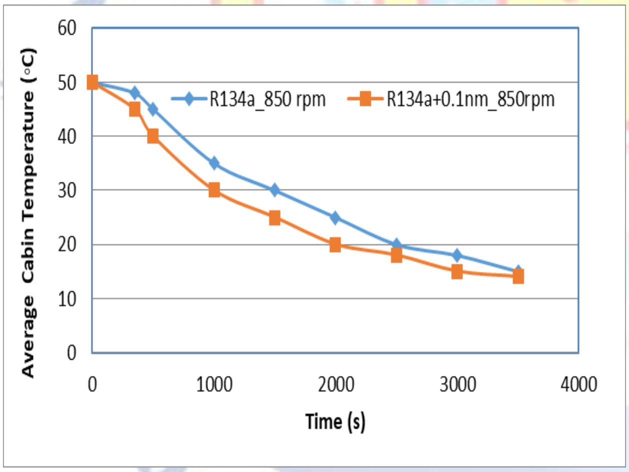

Figure 5. Variation of cabin temperature with respect to time during pull down at 2000 W and 850 rpm.

7. Conclusion

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

From the above experimental study it is observed that during the no load pull down, at a speed of 1600 rpm the time required to reach the set point of 20◦C is 300s for R134a and for nano refrigerant R134a+0.1nm is 290s . At 1460 rpm the time for R134a is 325s whereas for nano refrigerant is R134a+0.5nm is 298s. The time taken by the nano refrigerant to reach cabin temperature is less compared to pure refrigerant R134a. The energy consumption is reduced by using for nano refrigerant. At 850 rpm the energy consumption of pure refrigerant is 630 watts which is reduced by 5% by using nano refrigerant. The energy consumption of nano refrigerant R134a+0.1nm at 1000 rpm is 670 watts which is 4% less than pure refrigerant.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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