ME – PhD Thesis Defence

Experimental and Numerical Studies on an Automobile Air Conditioning System with Refrigerants R134a, R1234yf and R1234ze(E)

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ABSTRACT

The HydroFluoroCarbons (HFCs) synthesized as alternatives to ChloroFluoroCarbons (CFCs), though friendly to stratospheric ozone, have high Global Warming Potential (GWP). Despite this, numerous applications are making use of HFCs for refrigeration and air conditioning. The Kyoto protocol, negotiated in 1997 and came into force in 2005, put the HFCs in the green house basket and stated that the emissions of these gases need to be checked and controlled. The EU regulation of 2015 and the recent Kigali amendment (2016) to Montreal protocol suggested phase out of HFCs and this process will last until 2036 for developed countries and until 2047 for developing countries to achieve a state of 85% reduction in the use of HFCs. Among the HFCs, the HFC134a, used in automobile air conditioning has a Global Warming Potential (GWP) of 1300, which led to a search for new low-GWP refrigerants. Recent research has revealed that the HydroFluoroOlefin (HFO) refrigerants, namely, HFO1234yf and HFO1234ze(E), with a GWP of 4 or less, show promise for application in Mobile Air Conditioning (MAC) field. In the present study, the performance of an Automobile Air Conditioning (AAC) system is investigated experimentally and numerically with the low-GWP refrigerants R1234yf and R1234ze(E) and a comparative study is done with the existing refrigerant HFC134a. An experimental setup is developed to simulate an automobile air conditioning system with the necessary controls and instrumentation. The setup also accommodates an Internal Heat Exchanger (or liquid-to-suction heat exchanger). Based on the mathematical formulations, computer programs are developed to the performance of the AAC system with and without the IHX, for the three refrigerants considered. The effects of compressor speed, condenser inlet air temperature, condenser face velocity, evaporator inlet air temperature and evaporator face velocity on the refrigerant mass flow rate, cooling capacity, Coefficient of Performance (COP), condenser heat rejection rate, pressure ratio, evaporator air outlet temperature and humidity ratio are examined. The results show that higher compressor speed, lower condenser inlet air temperature, higher condenser inlet air velocity, higher evaporator inlet air temperature and air velocity produce better performance. The deviation in results between the numerical and experimental investigations are less than 8% for a system without IHX and less than 15% for a system with IHX. The performance of R134a is better than the alternatives considered. The difference between R134a and R1234yf results are less than 15% without IHX and less than 10% with IHX. The difference between R134a and R1234ze(E) results are less than 33% without IHX and 25% with IHX. It is found that R1234yf with IHX is the better alternative to existing R134a systems without IHX.

ABOUT THE SPEAKER

Gurudatt, H. M. is an ERP Ph. D. research scholar in the Department of Mechanical Engineering, IISc, Bangalore. He completed his B. E. in Mechanical Engineering from PES College of Engineering, Mandya (affiliated to Visvesvaraya Technological University, VTU-Belagavi) in 2013. He completed his Master's (M. Tech.) degree from the Mechanical Engineering Department, PES College of Engineering, Mandya, in 2016. His research interests are broadly in experimental and numerical studies on refrigeration and air conditioning systems. Currently he is Assistant Professor in the Department of Mechanical Engineering at the Vidyavardhaka College of Engineering, Mysore.