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" Sizing of Air Conditioning Components In VCRS for Electric Vehicle"

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ABSTRACT

Emission requirements have been more stringent in recent years, sparking increased interest in environmental pollution issues. Customer demand for a green automobile that emits no hazardous gases has grown natural, and pure EVs represent this demand (Electric Vehicle). However, the driving range of an electric vehicle is limited by the need for A/C (Air Conditioning) for occupant comfort, particularly in extremely hot or cold conditions. As a result, the A/C system sizing is more critical than in the case of a traditional internal combustion engine car. Because there is no engine heat rejection for interior heating and no operating power of the compressor from the engine for interior cooling, EVs use electric power from the battery pack to adjust the comfortability of the passenger compartment. As a result, cabin cooling/heating energy usage must be tuned for EV energy efficiency. Various system performance factors, including as system COP, cabin cool-down time, and system heat load capacity, can be tuned.

Keywords : Electric Vehicle, COP, driving range, efficiency.

1.Introduction

Because of rising oil prices and rigorous emission rules, the car industry has recently been confronted with a greater demand from the market for a vehicle that has better fuel economy and environmentally friendly features. In general, electric vehicles use 70% to 85% of the electric power stored in the battery, while fossil fuel combustion energy is generally lost through heat dissipation.[1] The AC system cools, heats, and ventilates the EVs' cabins, which is required to control the vehicle's interior thermal conditions (including temperature, relative humidity, and air velocity) and assure visibility (defogging and deicing)[2] The maximum vehicle speed of an electric vehicle is lower than that of a conventional engine car, and the possible driving range per single charging is one of the important characteristics impacting EV marketability. The solution of these flaws has the potential to greatly stimulate the existing EV market. In particular, the A/C system used to cool or warm the cabin for thermal comfort has a direct impact on the reduction in driving range, hence adequate size of refrigerating and heating systems in EVs is critical.[3]

The flaw in this method in a vehicle is the potential for water condensation or frost to form on the interior HX during defrosting, which facilitates flash fogging when the system is switched back to heating mode, and the cold air exiting the interior HX, which cannot be blown into the vehicle cabin without drastically reducing thermal comfort. The driving range of a vehicle can be reduced by 10% in the winter and 15% in the summer if a reversible vapour compression heat pump is used, compared to a vehicle with no indoor climate control, under typical weather conditions [4-5] Climate control in the passenger cabin is one of the largest supplementary loads on a vehicle. Electric cars (EVs) require climate control, just like conventional vehicles, to keep occupants comfortable and safe, but cabin heating and air conditioning reduce driving range for all electric vehicles. The reduction in range due to climate control and other variables is a hurdle to EV adoption. Reduced thermal demands on the climate control system will increase driving range, lowering range anxiety among consumers and enhancing EV market penetration. The National Renewable Energy Laboratory's researchers looked into car climate management systems. [6]) For extended driving range, battery-powered electric vehicles (EVs) require an effective electric heating system[7] SINDA/FLUINT and the Thermal Desktop (e- Thermal) System, as well as AutoCAD. It is used to calculate the overall efficiency of thermal subsystems in vehicles, such as Power Train Cooling (PTC) and Heating, Ventilation, and Air Conditioning (HVAC) systems .[8]

2. Component Sizing of Refrigerating System

The A/C control module, passenger compartment, and air handling systems make up the vehicle's HVAC system. Previously, the HVAC (**Heating Ventilation and Air Conditioning)** system was built to meet a peak demand from clients, such as rapid cabin cooling after a hot soak. However, optimum A/C system sizing is proven to be critical in improving the energy efficiency of electric vehicles.

- Evaporator Sizing
- Compressor Sizing
- Condenser Sizing

2.1 Evaporator Sizing-

First, the air temperature in the cabin is determined by the temperature at which the passenger feels comfortable, and the air temperature through the evaporator is considered to be increased in accordance with reality until the passenger's breathing area[10]

Process to Determine Evaporator Load

- Determine if there is no bodily flow.

- Module air inlet and evaporator discharge temperatures.

- In e-Thermal, use the Psychrometrics tool.

- To obtain the enthalpy and moisture ratio at the air inlet and outlet conditions.

- Calculate the evaporator load.

- Calculate the amount of condensation that is produced.

2.2 Compressor Sizing

The evaporator capacity computed in the previous section determines compressor speed and working power. The compressor utilised in the manufacturing EV is identified. It has a capacity of 36 cc and a maximum speed of 7000 rpm. Using the refrigeration cycle tool in e-Thermal, the compressor's revolution speed and operating power are estimated to reach the goal air temperature at the evaporator output.[11]

2.3 Condenser Sizing

The idle state, which necessitates the compressor's maximum revolution speed, is used to determine condenser capacity. With the highest condenser load, this is the worst state. This is the worst case scenario with the most condenser load. Based on the compressor sizing information.The refrigerant's high end pressure is 1800 kPa, while the compressor's maximum speed is 7000 rpm.[12]

3. HFO-1234yf Refrigerant

1994 when refrigerant R12 ceased production and R134a became the standard automotive refrigerant. Scientists had found that R12 depleted our ozone layer and was bad for the environment. R134a was significantly safer, and has a GWP (Global Warming Potential) of 1,430, compared to R12's GWP of 10,900. HFO-1234yf does have one nasty little character trait though – It is mildly flammable. Automotive refrigerants are constantly exposed to high temperatures, and car AC systems can spring a leak in many common circumstances. A front end collision will likely puncture your car's AC condenser which will release refrigerant. . A failed AC component can do the same. Road debris may also create system leaks. All of these scenarios make scientists nervous – All it takes is a heat source to cause a fire and furthermore, create very toxic by-products. [13]

3.1 Driving Range Impact on Refrigerating System

The most notable feature of the EV refrigerating system is the use of an electric compressor rather than a mechanical one. Because the power for this electric compressor comes from a charged battery, it has a major impact on the driving distance.[14] In this study, the variation in driving range is examined in relation to the functioning of the compressor sized for the EV's refrigerating system. For this, we use the e-Thermal model created for EVs to assess the SOC (State of Charge) of the battery system, and a CAE study is performed for the driving mode mimicking vehicle conditions throughout the hot summer season.[15]

4. Conclusion

In this review paper eThermal, GM's in-house tool for determining the overall performance of the vehicle's thermal subsystem, determines the capacity of each component of the EV refrigerating system. The interior cooling system for GM's next-generation electric vehicle has been designed and implemented. In addition, the study consider the impact of driving distance on refrigerating system sizing.The enthalpy and moisture ratio for the ambient air condition on each driving condition were used to compute evaporator capacity and condensate flow rate. On each driving condition, the compressor's revolution speed and working power were determined to meet the needed air temperature at the evaporator outlet. The capacity of the condenser, the refrigerant temperature, and the airflow rate required for condenser cooling were all taken into account while sizing the condenser for an EV refrigerating system. Increased compressor operating power improves interior cooling performance, but it reduces the driving range on a single charge. According to this research, each 20% increase in compressor working power reduces the driving range by 3 km. Apart of being ecofriendly HFO-1234yf used in the compressor consumes less battery power as compared to conventional refrigerants. This in turn has positive impact on the driving range of vehicle as the power lost is running compressor is just 12% that is loss of 14kms in driving range.

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