

Abstract

The PhD thesis presents a technical and economic evaluation of heat pump applications in car heating and cooling systems. In the first chapters of the thesis, technical overview of heating and cooling systems in automobiles is presented. In the thesis, the author presents the history of vehicles including problems related to heating and cooling systems. A broad overview of the propulsion systems is also presented. The drive characteristics of the individual solutions are described. The operating parameters associated with heating and cooling systems in all solutions are characterized. Drive technologies and technical solutions are presented. The proposed overview of solutions and technologies in cars is described in detail. Solutions in Europe based on the most commonly used refrigerants are included. A breakdown of the systems according to refrigerants R134a, R1234yf and R744 is presented.

A detailed presentation of the solutions available on the European market identified the main problems associated with heating and cooling systems. The influence of heating and cooling systems on the basic parameters of electric vehicles was characterized. The heating-cooling system based on a heat pump in the Nissan Leaf was described, taking into account operation in various temperature conditions. The author described the state of the art of heat pump-based heating and cooling systems, taking into account the most important ecological indicators, economic aspects and competition between manufacturers. A detailed description of refrigerants is included, detailing the technological changes associated with the use of different types of refrigerants. Thermodynamic changes in refrigerant circuits are considered, identifying that changes in operating temperature conditions have the greatest impact on system operation. The presented course of the circuit in a compressor refrigeration unit, indicated the influence of temperature and pressure on heating and cooling processes. Studies of heating and cooling systems based on the heat pump principle were carried out. The influence of the materials (elastomers, steel and aluminium) from which the system components were made into account. The results indicated the complexity of the processing of the materials themselves to be used in the manufacture of the components and their influence on the effect of the system. A set of experiments was developed, to be taken into account during the validation stage of heating and

cooling systems. The proposed tests were designed to detail the manufacturing process of systems for refrigerant flow in various heating and cooling systems, including those based on heat pumps. Methodologies for all tests were developed, along with technological assumptions during production. A concept for a measuring system in a test vehicle was presented. The indicated solution has an increased potential for innovation due to the lack of such a solution at present. The advantages of a wider range of boundary conditions are presented, resulting in a more thorough validation process.