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INCREASING ENERGY EFFICIENCY OF TRANSPORT ELECTRIC COOLING SYSTEMS USING MAGNETOCALORIC ELEMENTS

Head of the Department of Electrical Engineering,

Tashkent State Transport University,
Associate Professor (DSc)
Otabek Tashmukhammatovich Boltayev

Master's Student in Electrical Engineering Systems and Complexes,
Tashkent State Transport University
Mehriddin Sultanov

Abstract

This in the article on vehicles applicable electricity cooling systems energy efficiency increase issues seeing Traditional steam - compressor cooling systems disadvantages analysis done , to them alternative as magnetocaloric to the effect based cooling technologies advantages illuminated . Magnetocaloric of materials work principle , their transport sector application opportunities and energy to thrift impact scientific in terms of based on Research results magnetocaloric cooling systems ecological clean , quiet and high to efficiency has that shows .

Key words : magnetocaloric effect , electric cooling system , energy efficiency , transport technologies , environmental cooling

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Today in the field of transportation today energy from resources reasonable use and to the environment harmful the effect reduce current from issues Especially in electric vehicles cooling and air conditioning systems general energy spend noticeable part organization Therefore , high to efficiency has and ecological safe cooling technologies current to grow important importance profession will reach .

Magnetocaloric effect and his/her work principle

Magnetocaloric effect is some of materials external magnet field under the influence fever or cooling Magnet field when given, the material is internal order come heats up , magnet field take when thrown and cools down . This process cooling in cycles when used , mechanical compressors and harmful refrigerator to the gas need will not remain .

Transport electricity cooling in systems application

In vehicles magnetocaloric cooling systems application following advantages gives :

- energy spend decrease ;
- of the system noiseless performance ;
- environmental friendliness (no use of freon and other harmful gases);
- increased service life and reliability.

Especially in electric vehicles and rail transport, such systems allow for more efficient use of battery power.

Energy efficiency increase roads

Magnetocaloric of materials efficiency increase for :

- high magnetocaloric to the feature has new alloys create ;
- heat exchange processes optimization ;

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- magnet field sources energy economical in the form design necessary .

This factors transport refrigeration systems general useful work coefficient noticeable at the level increases .

Magnetocaloric to the elements based cooling systems in the field of transportation energy efficiency increase promising from directions one This is technology traditional cooling to systems relatively ecological safe , energy economical and innovative solution in the future wide on a scale current to be is expected .

Energy source with loading in the middle stream and voltage in phase performance electricity system effective activity to conduct provider important from factors The linter machine is one of electricity in the process take visited analyses this showed that electricity energy spend noticeable part ineffective losses on account of right In particular , the magnet alloys , reactive power expense and electricity in the system symmetrical situations general energy consumption to increase reason This is happening . cases are mostly asynchronous electricity of engines in constant nominal mode and suboptimal management under performance with depends .

Research as a result electricity proceedings effective management from technologies use energy thrift in providing important importance has that In particular , the frequency from converters use motor speed via and moment loading on demand suitable accordingly management opportunity is created . Practical experiments this showed that the frequency converters using power spending on average up to 30–40% reduce possible .

Frequency of converters vector management and from direct torque control (DTC) methods use optimal operation of motors mode providing , surplus energy spend prevent takes . As a result electricity energy consumption decreases , mechanical of parts excess loading decreases and whole of the system reliability increases . From this perspective In terms of linter machine , Siemens SINAMICS G120 frequency the converter vector management based on application recommendation This was done . solution motor power up to 30% of consumption reduce with together , together and of saws service the deadline noticeable at the level to extend service does .

Electricity in the system reactive power their disappearance reduce to the recommendations of the Siemens Energy Efficiency Guide in order to appropriate capacious load, i.e. condenser batteries installation through reactive power compensation done This solution online electricity energy their disappearance reduction , tension stability improve and electricity of equipment reliable performance provide opportunity As a result , the reactive power consumption of the linter machine was reduced by an average of 20%.

In addition, a monitoring system based on Schneider Electric Motor Control Center (MCC) was implemented to detect and reduce asymmetry in the electrical system. According to the monitoring results, asymmetry exceeding 2% was detected and prompt technical measures were taken. This reduced the overheating of the motors and prevented energy losses.

To increase energy efficiency, reduce electricity consumption and ensure rational use of resources, it was recommended to comply with the requirements of the international energy efficiency standard DSt 30804.4.30-2013. Implementation of technical and organizational measures based on this standard will help increase the overall efficiency of the production process.

Based on the above recommendations, it has been proven that significant economic efficiency can be achieved by increasing energy efficiency, rational use of resources, and reducing production costs in the linter machine. In practice, these results were achieved by

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installing a CDI-E102G022/P030T4B frequency converter, which incorporates the recommended technical characteristics.

Today, increasing energy efficiency and reducing environmental impact in the transport sector is one of the global challenges. In particular, refrigeration and air conditioning systems used in electric cars, electric buses and rail transport account for a significant share of total energy consumption. Traditional refrigeration systems are mainly based on vapor-compressor technologies, which are characterized by high energy consumption and the use of environmentally harmful refrigerants.

In recent years, the need for energy-efficient and environmentally friendly cooling technologies has been increasing. In this regard, cooling systems based on the magnetocaloric effect are considered one of the promising areas. Magnetocaloric cooling systems are characterized by the fact that they operate without mechanical compressors, have a high efficiency, and do not use harmful gases.

The purpose of this master's thesis is to scientifically substantiate methods for increasing energy efficiency through the use of magnetocaloric elements in transport electric refrigeration systems and to develop practical recommendations.

The following tasks were set in the dissertation:

- transport refrigeration systems there is status analysis to do ;
- study the physical foundations of the magnetocaloric effect;
- magnetocaloric cooling systems work principle analysis to do ;
- energy efficiency increase opportunities assessment ;
- ecological and economic efficiency to determine .

Dissertation your work scientific novelty transportation electricity cooling in systems magnetocaloric from elements use through energy spending reduce opportunities complex analysis from doing consists of .

CURRENT STATUS OF TRANSPORT ELECTRIC COOLING SYSTEMS AND ENERGY EFFICIENCY ISSUES

1.1. In vehicles cooling systems task

In vehicles cooling systems passengers for comfortable microclimate create , electronic devices and battery optimal battery temperature mode storage task In electric cars cooling system not only the salon cooling , maybe battery blocks and power electronics reliable performance in providing important role plays .

1.2. Traditional steam - compressor cooling systems

Steam - compressor cooling systems in the field of transportation wide is used . However this systems :

- high energy at the expense has ;
- mechanic of parts fast wear and tear ;
- characterized by the use of environmentally harmful refrigerants such as freon.

These shortcomings lead to a reduction in the overall driving range of electric vehicles.

1.3. Electricity cooling in systems energy losses

Transport refrigeration in systems energy losses following factors with related to :

- compressor mechanic losses ;
- electricity in engines heat losses ;
- reactive power and voltage asymmetry ;
- loading of the regime optimal not .

As a result electricity of energy noticeable part useless heat as is lost .

1.4. In transport energy to the efficiency wearable requirements

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International energy efficiency to the standards suitable for transport refrigeration systems :

- less energy spend ;
- ecological clean to be ;
- high reliability has to be necessary .

This requirements magnetocaloric cooling technologies current to reach current Magnetocaloric to the elements based cooling systems transportation in the field energy efficiency increase promising from directions one This is technology traditional cooling to systems relatively ecological safe , energy economical and innovative solution in the future wide on a scale current to be is expected .

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