

recycling or reusing turbine materials contributes to a significant reduction in the ecological footprint from their disposal.

Depending on the initial parameters of the energy turbine and the combination of the aforementioned optimization methods applied at different stages of its life cycle, emissions can be reduced by 40% to 65%.

Conclusions. The conclusion is made that optimization of the environmental aspects of energy turbines at all stages of their life cycle is a necessary condition for reducing emissions and ensuring the sustainable development of the energy sector. The use of the latest technologies to reduce carbon, nitrogen oxide, and sulfur emissions, as well as the optimization of designing, manufacturing, operation processes, etc., significantly improves the environmental performance of energy turbine emissions. Considering environmental aspects at each stage of the life cycle contributes to achieving global goals for pollution reduction and combating climate change.

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USE OF THE PELTIER EFFECT IN THE DESIGN OF COOLING SYSTEMS

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Abstract. The primary practical use of the Peltier effect in semiconductors is to generate cold for thermoelectric cooling devices or, conversely, to heat objects at low or negative temperatures—thermostabilization. The thermoelectric cooling method offers a number of advantages compared to other cooling techniques. Thermoelectric devices are characterized by simple

control, precise temperature regulation, silent operation, and high reliability. Despite the low cooling capacity, an efficient scheme for applying Peltier elements was developed to cool the lubricant in the sliding bearing systems of rolling mills at metallurgical plants.

Keywords: lubrication systems, thermal regime of lubricant, oil cooling in bearings, thermoelectric effects, Peltier effect, heat exchanger, thermostabilization, Peltier element.

Introduction. Cooling devices utilizing the Peltier effect were historically unable to compete with compression machines due to their limited temperature reduction capabilities and higher cost. The Peltier effect is based on the phenomenon that a heat flux is either absorbed or emitted at the junction of two different conductors when direct current flows through them. The situation improved after studies demonstrated the high efficiency of doped semiconductor materials. This is because efficiency depends on both the number of charge carriers and the energy barrier at the junction. Dielectrics have low carrier concentration, and metals have low energy barriers. The optimum lies with doped semiconductors.

Currently, interest in thermoelectric cooling is increasing significantly. This is due to the development of new materials based on nanotechnologies that have significantly improved their efficiency, as well as increasing demands for environmental and consumer characteristics—reliability, structural and maintenance simplicity, silent operation, and the emergence of cooled microelectronics. The above advantages and modern trends in thermoelectric materials suggest the possibility of significantly improving the energy performance of thermoelectric coolers, making them comparable in efficiency to traditional compression systems.

At present, cooling devices based on the thermoelectric effect are being produced and used: refrigerators, climate control systems, electronics coolers, and more. These devices are especially attractive when both cooling and heating are needed due to seasonal conditions. For instance, stable liquid friction in sliding bearings requires constant oil viscosity, which heavily depends on temperature. Therefore, thermal stabilization is necessary: heating in winter and cooling in summer. This issue is addressed in the present study.

The Aim of the Research is to develop and optimize Peltier-effect-based cooling systems to improve their energy efficiency.

The Tasks of the Research

Analysis of the physical foundations of the Peltier effect, review of modern cooling systems using the Peltier effect, study of the influence of Peltier effect parameters on the cooling efficiency of lubrication systems, modeling of thermal processes and determination of optimal parameters of Peltier elements for use in cooling systems, conducting experiments with different configurations of Peltier thermoelements, development of a model of

a cooling system using Peltier elements, analysis of experimental data to assess the effectiveness of the proposed model.

Presentation of the Main Research Material

A theoretical model and prototype of a cooling system using the Peltier effect, potentially applicable in various industrial and electronic fields, have been developed. The oil thermostabilization system may be based either on traditional refrigeration machines (vapor-compression or absorption) or thermoelectric systems. Both schemes have their pros and cons. The main drawback of the thermoelectric system is its lower energy efficiency, while its advantages include design simplicity, ease of operation, and high reliability.

Considering advances in thermoelectric materials (especially in figure of merit), a thermoelectric cooling scheme was chosen for the design. The key component is a liquid heat exchanger with thermoelectric modules installed on its surfaces. The thermal contact between the module and the heat exchanger must have low thermal resistance. Similarly, the other side of the modules should be in contact with a finned surface to exchange heat with the air. The air-side heat transfer coefficient on the hot side of the modules, even with forced convection via fans, is significantly lower than that of the coolant liquid in the heat exchanger channels. To intensify heat transfer, the hot side is equipped with radiators and fans. For ease of installation and maintenance, each module is allocated a heat exchanger surface area twice the module's size.

To cool oil from 50°C to 30°C at a flow rate of 0.1 kg/s, the system must provide a cooling capacity of 3.4 kW. Based on practical application data, an operating current of $I = 1.04$ A is recommended for optimal energy efficiency and satisfactory size, mass, and operating parameters of the system.

Conclusions. A thermostabilization system for oil viscosity is essential for the reliable operation of sliding bearings. A comparison of the classical and proposed oil thermostabilization schemes shows that the system using thermoelectric modules, despite lower energy efficiency, is significantly simpler to build and regulate. It offers higher reliability, and allows for simultaneous operation in different modes for various oil heat exchangers. Based on literature data, the properties of semiconductor materials for thermoelectric modules have been determined. Requirements for competitive thermoelectric devices have been developed, a mathematical model has been constructed, and heat exchange calculations have been carried out for the Peltier-based cooling system. Electrical parameters of the system have been modeled using Mathcad software.

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COMPREHENSIVE ECOLOGICAL CONTROL OF FILLING STATION PLANNED ACTIVITY

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Abstract. This study analyses hazardous environmental impact of filling station's planned activity. It needs special attention because of rapid growth of the urban environment, which leads to constant expansions of filling station's networks to fulfill population's need at fuel. As filling stations are considered as ecological dangerous objects that are necessary to control their activity with environmental impact assessment procedure (EIA). However, EIA procedure concentrates mostly on atmospheric air impact, ignoring impact on water and soils. So, it is proposed to develop informational software for the measures of continuous comprehensive control of filling station activity's ecological