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SUMMARY and KEYWORDS

POWER AND CHEMICAL ENGINEERING

O. S. Malinina, A. V. Baranenko, M. A. Al-Furaiji, E. E. Lydova, K. A. Komarov
Efficiency of lithium bromide absorption chiller with multi-stage absorption and generation processes with associated mass flow

A study of the cycles of a lithium bromide–water absorption chiller with two-stage absorption and three-stage generation of a working substance vapor with an associated mass flow with different supply of the cooling medium to the apparatus has been carried out. The temperature of the heating source necessary for the implementation of the actual thermodynamic cycle of the Lithium Bromide–Water Absorption Chiller (LBWAC) and the most effective thermodynamic cycle has been determined. A comparative analysis of the cycle understudy with the sample cycle (one-stage cycle) LBWAC is carried out. Despite the lower values of the coefficient of performance (COP), the cycle under study provides a doubling of the cooling capacity of the machine, at the same flow rate of the heating source, which is an advantage when the flow rate of the heating source is limited. This circumstance is explained by the fact that in LBWAC with multi-stage absorption and generation, the heating source sequentially passes through three generator stages. Therefore, the degree of cooling in the chiller with the considered cycle is three times higher than this value of a single-stage LBWAC.

Keywords: lithium bromide–water absorption chiller, two-stage absorption, three-stage generation, associated mass flow, efficiency, actual thermodynamic cycle.

A. B. Sulin, A. A. Nikitin, T. V. Ryabova, S. S. Muraveinikov, I. N. Sankina
Energy-efficient outdoor air flow control in ventilation systems

A method for controlling the ventilation system flow characteristics is considered based on the forming principle an air temperature and carbon dioxide concentration predicted estimate in a room based on the changes dynamics analysis in these parameters in the supply and exhaust ducts. The expected microclimate parameters predicted assessment in real time opens up the possibility of using such elements and algorithms for controlling the ventilation and air conditioning system, which provide the required air quality with minimal energy consumption. The analysis calculates the finding probability the measured parameter inside or outside the control zone after a specified time interval. The algorithm for the control system actuators actuation for the channels of temperature and carbon dioxide concentration is presented in the block diagram form. The decision-making logic for actuating the actuators is based on the changes direction and intensity analysis in temperature and carbon dioxide concentration in the exhaust duct and the temperature difference between the supply and exhaust.

Keywords: ventilation and air conditioning systems, intelligent control systems, adaptive control, air quality, pollutants concentration, control channels.

A. M. Andreev, A. Yu. Baranov, E. V. Sokolova, T. A. Malysheva, L. V. Ivanov
The analysis of energy efficiency of LNG filling pipeline from choice of thermal insulation structure

Reduction of technological losses of natural gas during production, transportation and storage is of major energy and environmental importance. Losses of natural gas are the target for active criticism by «green energy» representatives. It is necessary to develop and popularize the new technological solutions aimed at reducing the indirect impact on the environment associated with the production and use of liquefied natural gas, to demonstrate the readiness of specialists of this energy sector to take into account modern social preferences. The article presents the numerical analysis of the energy efficiency for one of the stages of large-scale LNG production, namely, the LNG delivery from a storage tank to a LNG carrier vessel via a cryogenic pipeline. The mathematical model of the thermal enclosure of the pipeline has been considered, and the production cryoproduct losses due to thermal inertia of pipeline materials have been

estimated. The performance of the schemes recommended for utilization of LNG vapors has been evaluated.

Keywords: liquefied natural gas, heat inflows, pipeline, thermal insulation, vapor re-liquefaction, heat removal capacity.

S. S. Jenblat, O. V. Volkova
Estimation of multi-layer coating efficiency for passive radiative cooling

Passive radiative cooling is a promising direction in energy conservation and environmental protection. One of the ways to increase the efficiency of radiative cooling systems is the use of multi-layer coatings. In recent years, several novel materials with high emissivity have been proposed, which allow the creation of radiators that provide an average daily cooling power of approximately 100 W/m2 during daytime. Based on the developed mathematical model, the optical properties of the multi-layer coating for the radiative cooling system were evaluated by the Transfer Matrix Method and the effectiveness of radiative cooling was determined due to the use of the multi-layer coating in the climatic conditions of Syria (Latakia). The results of modeling the atmospheric transmittance in the summer months in Syria (Latakia) are presented. The developed mathematical model, methods for modeling atmospheric transmittance, calculating solar radiation, and evaluating the optical properties of multi-layer coating, allow determining an effective multi-layer coating for radiative cooling systems in any climatic conditions.

Keywords: passive radiative cooling, multi-layer coating, atmospheric transmittance, Transfer Matrix Method, Syria (Latakia).

A. Yu. Uss, A. V. Chernyshev, A. S. Pugachuk
Design of gas-jet drive with vortex valve thrust control system

The article is devoted to the design of a gas-jet drive with a traction control system using a vortex valve. A diagram is given and the principle of operation of a vortex jet device designed to control the gas flow is considered. The selected scheme of a vortex jet device with a distributed supply of a feed and a concentrated supply of control gas flows, designed to control the thrust of a gas-jet engine. The profiling of the Laval nozzle was carried out using a simplified technique from [G. N. Abramovich, Applied Gas Dynamics]. Computational and theoretical studies of the gas flow from a gas-jet drive with a vortex valve in the maximum thrust mode and in the thrust control mode have been carried out.

Keywords: vortex amplifier, vortex valve, swirl chamber, gas flow regulation, fluidics, gas jet engine.

A. A. Tatevosyan, S. S. Busarov, A. V. Nedovenchany, I. S. Busarov, A. O. Zhukov
Experimental evaluation of system characteristics «compressor stage–linear magnetoelectric drive»

In this work, tests of low-speed compressor stages with a linear magnetoelectric drive are carried out. The developed system makes it possible to measure the instantaneous parameters of the compressed gas in the working chamber of the piston stage, as well as to take the operating characteristics of the drive — consumed current, voltage, power. The work presents examples of the obtained characteristics. In the future, the use of the measuring system is assumed in scientific research on the study of effective modes of operation of the magnetoelectric drive and as a teaching and laboratory stand in the implementation of the educational process.

Keywords: linear magnetoelectric drive, low-speed long-stroke compressor unit, workflow, experimental research.

S. Elbel, P. Hrnjak
Performance optimization of two-stage compressor system using transcritical R744 /
trans. from Engl. M. A. Fedorova

The use of transcritical R744 systems has become increasingly popular in recent years in a variety of different applications. For applications that span a wide temperature range between the heat source and heat sink, the use of two-stage compressor results in numerous advantages in terms of efficiency and compressor discharge temperature. This paper presents experimental data for a transcritical R744 compressor system operating at high heat rejection temperatures. A comprehensive system model was developed and validated with the experimental results. Based on this, the simulation tool was used to further optimize the system design specifically to accommodate the two-stage compression process. The optimum heat transfer area distribution has been determined to simultaneously ensure efficient intercooling at intermediate pressure and gas cooling at the high-pressure level. Simultaneously, the system was also optimized with respect to optimal intermediate pressure and the results show that for this particular system, the optimum intercooler pressure deviated substantially from the standard design approach that uses the geometric mean between suction and discharge pressures.

Keywords: refrigeration unit, unitary-type air conditioner, carbon dioxide, heat exchangers, covered heat exchange air-side area, volumetric cooling capacity, refrigeration coefficient of performance (COP), theoretical research, experiment.
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AVIATION AND ROCKET-SPACE ENGINEERING

V. I. Kuznetsov, V. V. Makarov, A. Yu. Shander
Physics and mathematics model of vortex tube working process

Based on the physical model of the Ranque effect, proposed earlier, a simplified mathematical model of the working process of a vortex tube is compiled taking into account the exchange of work and heat during the interaction of peripheral and axial gas flows. The effect of viscosity and angular velocity gradient on the transfer of kinetic energy from the axis to the periphery is shown. The difference in thermodynamic temperatures when heat is supplied from the periphery to the axis is taken into account, which leads to a decrease in the cooling efficiency of the axial gas flow. Energy exchange is based on the assumption that the peripheral gas layers are compressed by the axial flow. The axial flow work is determined by the pressure difference between the valve and the outlet of the diaphragm.

Keywords: vortex tube, compression energy, expansion energy, work exchange, heat exchange.

V. I. Trushlyakov, I. Yu. Lesnyak, V. A. Sevoyan
Creation of experimental base for investigation the effect of laser radiation on intensity of process of evaporation of liquid from porous metal structures

A review of existing methods for drying porous structures including porous metallic materials, is carried out, and a method based on electromagnetic action, in particular, laser radiation, is selected. Recommendations have been developed for physical models of the evaporation process of a model liquid from the developed versions of experimental samples that simulate various investigated porous metallic materials, an experimental stand. A program and methodology have been developed for preliminary experimental studies of the process of exposure to laser radiation on model liquid taking into account the dynamics of the surface and evaporation of model liquid for various experimental samples options including for working out the modes and parameters of laser radiation exposure. Preliminary experimental results have been obtained for the implementation of the developed program of the processes of laser radiation influence on the breast for two variants of experimental samples.

Keywords: liquid evaporation, drying, heat and mass transfer, physical model, porous metal structure, laser action.

M. M. Dron, A. B. Yakovlev
Analysis of properties of inertia regulator of thrust control system of liquid rocket engine

The quality of the flight task of a space rocket system is determined among other things by the accuracy of maintaining and regulating the thrust of the rocket engine. Improving the accuracy and reducing errors in the engine mode control system will reduce the cost of space launches or allow you to put a large payload into orbit. The article presents a mathematical model of a controller with an inertial booster of a liquid-propellant rocket engine, identifies parameters and values that affect its accuracy, and considers measures to reduce static error.

Keywords: accuracy, automatic control system, static error, liquid fuel.

Yu. V. Shchipkova, A. Yu. Popov, Yu. A. Rogoza, D. A. Kormakov
Determination of rolling forces of corrugated profiles on stainless belt of heat exchanger for wind tunnels

The efficiency of regenerative heat exchangers with heat storage nozzles made of rolled corrugated tapes depends on the type of their corrugation profile. The most effective form is a triangular one with sharp peaks and troughs. It is technically advisable to get corrugations of a given shape by rolling between two rollers. Determining the required contact load and forces is one of the main tasks when rolling corrugated belts. Insufficient load leads to incomplete formation of the profile, and excessive load leads to warping of the belt. The article presents the results of an experimental study aimed at determining the required load when rolling a corrugated heat exchanger belt for wind tunnels. Experiments and force measurements are carried out on a standard milling machine with a spring dynamometer. The results of the experiment are applied to stainless steel strips with a thickness of 0,3 to 0,4 mm and triangular fluting.

Keywords: contact area, contact pressure, corrugation profile, stainless tape, force.