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SUMMARY and KEYWORDS

POWER AND CHEMICAL ENGINEERING

A. N. Noskov, M. Shaposhnikova
Features of refrigeration screw compressor operation at ambient temperature decrease

With a decrease in ambient temperature, the heat gain on the refrigeration machine and condensation pressure decrease, which requires a decrease in cooling capacity and geometric compression ratio of the screw compressor. A condensation pressure decrease below a certain value disrupts the stable operation of throttling devices. The article describes the operation scheme of the refrigeration machine with a screw compressor and a liquid pump before the throttling devices, which allows it to work at a decreased condensation pressure. The dependences of changes in net efficiency, cooling capacity, power consumption and cooling coefficient at full and partial capacity with co-regulation of cooling capacity and geometric compression ratio are given. The experimental and calculated characteristics of a screw compressor operating with R22 freon are used.

Keywords: oil-flooded screw compressor, condensation temperature decrease, co-regulation of cooling capacity and geometric compression ratio, liquid pump before throttling devices.

V. L. Yusha, G. I. Chernov, D. V. Rubtsov, S. L. Terentjev
Heat loss recovery system of mobile compressor unit based on absorption refrigerating machine

The paper considers the heat loss recovery system of a compressor unit based on the absorptionrefrigerating machine. The calculation of energy savings for driving the compressor based on the use of the mentioned system is performed. The energy saving amount is shown to be 14,86 %. The parametric analysis is conducted of the dependence of the power consumed by the compressor on the solution pressure after the pump, the refrigerant solution concentration and mass flow rate fraction of the phlegm returned to the generator fr om the dephlegmator.

Keywords: heat loss recovery, compressor unit, absorption refrigeration machine, energy saving.

S. S. Busarov, V. L. Yusha, R. E. Kobylskiy
Experimental evaluation of effectiveness of lip seal of cylinder-piston group of long-stroke compressor stage

In slow-moving compressor stages the piston-cylinder seal is one of the most critical components affecting the tightness of the working chamber. In the present work, conditional clearances in the lip seal of low-speed compressor stages are determined by the method of static blowing. A comparative assessment of the leak-tightness of the piston-cylinder seal with a different number of cuffs and different wall temperatures is carried out.

Keywords: long stroke piston compressor; lip seal, conditional clearance, gas leaks, tightness of the working chamber.

A. P. Tsoy, A. V. Baranenko, A. S. Granovskiy, D. A. Tsoy, D. A. Koretskiy, R. A. Jamasheva
Computer simulation of annual work cycle of combined refrigeration system using night radiative cooling

Evaluation of energy efficiency of a combined cooling system that uses night radiative cooling together with refrigerating machine with accumulation of cold without a phase transition and the supply of liquid coolant (propylene glycol) to the air cooler is performed based on the results of computer simulation. In the cooling system located in Kostanay (Kazakhstan), there are radiators (12 m2) that cool the coolant at night, as well as a conventional vapor compression refrigerating machine with a reciprocating compressor. The cooling system is used to maintain air temperature at the level of 0±1 °C in a small refrigeration chamber (36 m3) with a low value of heat emission from stored products and the absence of

other operational heat influx. It is found that 78,8 days a year the cooling system can maintain the required temperature due to the operation of radiators without turning on the refrigerating machine. This saves 242 kWh of electricity. Thus, the combined refrigeration system provides 7,6 % reduced energy consumption, and also reduces physical deterioration of the refrigerating machine compressor for the annual cycle, which should reduce the financial costs for operating the refrigeration warehouse.

Keywords: Radiative cooling, refrigeration, free cooling, cold storage.

A. A. Serov, A. V. Tsygankov, A. Hildayati
Modes of gas motion in equivalent channel of regenerative heat exchanger

The model of equivalent channels for the heat storage nozzle of a regenerative heat exchanger is considered. Differential heat transfer equations between the heat carrier flow and the surface of the equivalent channel are given. It is suggested to evaluate the efficiency of heat transfer by the coefficients of accumulation and heat recovery of ventilation flows. Criteria for calculating the heat transfer coefficient under laminar and transient modes of gas motion in an equivalent channel is given. The results of a computational study are presented, which make it possible to evaluate the effects of air velocity in the channel on the efficiency of a regenerative heat exchanger.

Keywords: regenerative heat exchanger, equivalent channel, heat transfer coefficient, criterion dependences, heat storage coefficient, turbulence.

A. Yu. Uss, A. S. Pugachuk, A. V. Chernyshev, F. G. Tukhbatullin
Development of stand for visualization and experimental study of working process in vortex jet device

The work is devoted to the development of a stand for physical modeling of the workflow and visualization of gas flow in the flow cavity of a vortex jet device. Based on the literature review, a number of examples are found for visualizing the workflow in the flow cavity of a vortex jet device. The developed stand allows performing physical modeling of working processes in the flow cavity of a vortex jet device using its incomplete layout. Using similarity criteria, the developer can get the necessary workflow parameters in a real research object. The developed stand also allows us to study the distribution of gas flows in the flow cavity of a vortex jet device. The study of the gas flow process in various models of vortex jet devices using the developed stand will allow the developer to make a conclusion about the influence of geometric design parameters on the aerodynamics of the vortex chamber, as well as to study the flow of gas in the flow cavity. The stand is recommended to be used as a tool in the design methodology of vortex jet devices based on multi-criteria optimization of geometric parameters of the flow cavity based on the zero-order method (simplex method).

Keywords: vortex amplifier, optimization, swirl chamber, gas flow regulation, fluidics.

V. S. Evdokimov, G. I. Chernov, A. A. Gladenko, A. A. Isaev
Experimental study of thermal pile characteristics

The article is devoted to an experimental study of the efficiency of a heat pump. The relevance of this work is due to the widespread use of thermal piles for soil stabilization in permafrost zones in order to prevent deformation and ruptures of gas and oil pipelines. The purpose of this work is to assess the impact of climatic conditions and the degree of damage to the soil heat stabilizer on its performance. An experimental study showed that with an increase in the blowing speed and a decrease in the air temperature, the heat capacity of the heat pump increases. It was also found that damage to up to 30 % of the working surface of the heat pump leads to a slight (up to 12 %) decrease in its thermal capacity.

Keywords: thermal stabilizer, climate chamber, heat capacity of the heat pump, efficiency of the heat pump.

A. A. Girchenko, A. A. Rumyantsev, A. A. Kazantsev, D. I. Bukhanets, A. V. Timoshenko, A. A. Murashev
Monitoring process of developing system for providing temperature, air supply and filtration

of transported control modules

The article presents an approach to formalizing the process of creating a system for providing temperature, air supply and filtration (TAFS) of transported control modules of aerospace defense complexes. The use of line graphs to control the creation of such systems has recently shown its inconsistency and requires improvement in terms of how to manage the processes of creating such systems. As a basis, it is proposed to use the dynamic theory of graphs, which allows one to take into account not only resource-time constraints, but also possible changes in the structure of relations of sequences of work performed to create TAFS. The paper shows that the key element of managing the process of creating TAFS is a complex modeling stand, which can be used to obtain objective data on the development of system equipment. The availability of this information allows taking control on the process of creating TAFS at all stages of the life cycle using a network model. The composition and structural diagram of such a stand are given in the article.

Keywords: system for providing temperature, air supply and filtration, transportable control unit, network planning, stand, tests.

O. Yu. Manikhin, V. V. Shalay
Implementation and evaluation of efficiency of gas preliminary drying system during operation of process equipment of complex gas treatment unit

In order to increase the efficiency of the absorption dehydration of the integrated gas treatment unit during peak summer operating modes, when the temperature of the dried gas significantly exceeds +25 °C, a preliminary dehydration system has been introduced into the processing flow chart. The implemented technical and technological improvements both of the internal elements of the separation equipment and the piping system of the gas dehydration shop made it possible to reduce the carryover of droplet moisture from the separation and absorption equipment, as well as to ensure compliance with the current standards for commercial gas for the key parameter dew point temperature, in compliance with the required technological reserve.

Keywords: gas absorption drying, gas preliminary drying system, triethylene glycol, dew point temperature.

K. Klotsche, F. Micus, C. Thomas, U. Hesse
Waste heat recovery for reciprocating compressors / trans. from Engl. M. A. Fedorova

In many important industries (oil and gas, process gases, chemical process engineering) multi-stage reciprocating compressors are used, especially for high pressure ratios. The gas is compressed in multiple consecutive stages and cooled after each stage in order to reduce the maximum process temperatures. The rejected heat is often dissipated to the environment and the usable part — the exergy — is lost. The aim of this paper is to show how the waste heat potential of reciprocating compressors can be used. For this purpose, the waste heat available per stage is quantified for different compression scenarios. Based on this, the processes for the waste heat recovery suitable for the temperature range of the discharge gas as heat source are presented — in particular, the structure, working principle and characteristics of the waste heat recovery system. It is shown that the waste heat can be used flexibly for different purposes (heating, power generation, cold supply). The potential of the possible methods of waste heat recovery can be estimated with the aid of the given efficiencies of the respective energy conversion processes.

Keywords: reciprocating compressor, waste heat recovery, heating, thermoelectric generator, organic Rankine cycle, absorption refrigerator.

M. T. White, M. G. Read, A. I. Sayma
Comparison between single and cascaded organic Rankine cycle systems accounting for the effects of expansion volume ratio on expander performance / trans. from Engl. M. A. Fedorova

Compared to single-stage organic Rankine cycle (ORC) systems, cascaded ORC systems, in which a high-temperature topping cycle and low-temperature bottoming cycle are coupled together, could have

advantages in terms of removing the potential for sub-atmospheric condensation conditions and improving expander performance as the expansion process is effectively divided across two stages. Moreover, reducing the expansion volume ratio could facilitate the use of volumetric expanders, such as twin-screw expanders, which, in turn, could facilitate two-phase expansion to be utilised in one, or both, of the cycles. The aim of this paper is to compare single-stage and cascaded ORC systems, accounting for the effect of the expander volume ratio on expander performance. To investigate this, thermodynamic models for singlestage and cascaded ORC systems are developed, which include variable efficiency expander models for both radial turbines and twin-screw expanders that can estimate the effect of the expansion volume ratio on the expander isentropic efficiency. Using this model, three different scenarios are compared for different temperature heat-source temperatures, namely: (i) single-stage ORC systems with vapourphase expansion obtained using a turboexpander; (ii) single-stage ORC systems operating with a twinscrew expander, with the possibility for two-phase expansion; and (iii) cascaded cycles with either vapour- or two-phase expansion. The results from this comparison are used to identify applications wh ere cascaded ORC systems could offer performance benefits.

Keywords: single-stage Rankine cycle, cascaded Rankine cycle, turboexpander, screw expander, isentropic efficiency.

AVIATION AND ROCKET-SPACE ENGINEERING

N. V. Vologodskij, A. V. Pronevich, A. B. Yakovlev
Experimental study of cyclone filters of pneumatic automatic control system of gas turbine engine for increasing degree of purification

An experimental study of cyclone filters of various designs is conducted. The parameters that allow increasing the degree of air purification from dust are identified: air pressure at the filter inlet, working air temperature, as well as the diameter of the nozzle of the purified air consumer simulator and the diameter of the ventilation nozzle. The results obtained make it possible to increase the reliability of pneumatic units and reduce the erosive wear of their working cavities.

Keywords: aircraft engine, pneumatic systems, separation, centrifugal dust collector, cleaning degree.