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SUMMARY and KEYWORDS

POWER AND CHEMICAL ENGINEERING

S. S. Evgenev, V. A. Futin
Determination of circulating gasdynamic force acting the rotor of centrifugal compressor with opposed impellers

This paper considers the main factors affecting the occurrence of a circulating gas-dynamic force in the labyrinth seal of a two-section high-pressure centrifugal compressor acting on the rotor. A method for calculating the circulating force is presented on the example of a real centrifugal compressor.

Keywords: centrifugal compressor, impeller, side clearance, labyrinth seal, circulating forces.

V. L. Yusha, G. I. Chernov, I. D. Obukhov, O. G. Bessonov, V. V. Denisenko, A. A. Goncharenko, V. B. Shipov
Multipurpose conversion of marine diesel engines when creating piston motorcompressor units

This paper present an assessment of the energy efficiency of various combinations of piston stages of an internal combustion engine, a compressor, and a Rankine engine as part of piston motor-compressor units based on modernized marine diesel engines. An eight-cylinder single-row diesel engine 8Ch23/30-1 is chosen as the object of research, the base of which is used as a single platform for creating powertechnology units for various purposes and power. The proposed variants for converting the original engine allow, with minimal costs for the development of design and manufacturing technology, to create gas engine compressor units with reduced fuel consumption and improved weight and size characteristics in comparison with the known mobile compressor stations driven by diesel internal combustion engines. In the paper, on the basis of the developed mathematical models of working processes, the possibility of joint operation of diesel cylinders with piston expanders of the Rankine cycle and one or more stages of a piston compressor is assessed. Various possible combinations of diesel cylinders, compressor cylinders and expander cylinders are considered, as well as the dependences of engine power and compressor performance depending on the number of compressor stages and the number of diesel power cylinders used.

Keywords: recuperation, Rankine cycle, internal combustion engine, compressor.

S. S. Busarov, A. V. Nedovenchany, T. A. Vinnikova, N. G. Sinitsin, K. A. Bakulin
The method of searching for the ratio of design and operating factors in relation to low-speed compressor stages

The paper presents a methodology for finding the ratio of design and operating factors in relation to lowspeed compressor stages.The technique is based on the simplex method, which allows you to choose from a database created on the basis of a well-known technique for calculating the working processes of low-speed compressor stages, the best solution for specific search criteria taking into account their importance. The technique is implemented in Microsoft Excel, an example of the implementation of the technique with five criteria is presented: temperature, flow rate, indicator efficiency, weight and overall dimensions.

Keywords: low-speed long-stroke compressor, workflow, optimization methods, search criteria, criteria weight, integral characteristics.

D. Kh. Sadvakasov, G. I. Chernov, V. L. Yusha
The analysis of uncertainty factors influence on mathematical modeling of ammonia compression in wet vapor area

The paper presents the influence analysis of such uncertainty factors as the heat transfer coefficient calculation method and the working chamber wall temperature on the mathematical modeling of the ammonia compression in a reciprocating compressor stage during the condensation of ammonia vapors. The mathematical model is based on the equation of the first law of thermodynamics for bodies with variable mass, the equation of state for real gases, the Clausius–Clapeyron and Newton–Richman equations. When determining the heat transfer coefficient value, several well-known dependencies for calculating these coefficients for dropwise and filmwise condensation have been considered. The calculation data shows that the instantaneous values of the ammonia pressure and temperature, as well as of the dryness fraction during compression in the wet steam region, significantly depends on the chosen method for calculating the heat transfer coefficient. Moreover, the walls temperature value of the compressor working chamber, where the compression occurs, has a considerable impact on the process under discussion. They are the determining factors and require special attention when the ammonia compression process is mathematically modelled in a reciprocating compressorstage, taking into account its vapors condensation.

Keywords: compression, vapor region, heat transfer, ammonia, condensation.

A. A. Serov, A. V. Tsygankov
Comparing ways of calculation efficiency of regenerative heat exchanger

This article contains information on various methods for calculating the efficiency of regenerative heat exchangers in an air ventilation system. The equations of heat balance and heat transfer are described. The results obtained on the CFD model are compared with the results obtained by various mathematical calculations. The obtained results of the computational study can give an assessment of the accuracy of computational methods to obtain the value of the efficiency of regenerative heat exchangers.

Keywords: regenerative heat exchanger, heat storage coefficient, CFD modeling, heat transfer coefficient.

J. A. Shostak, N. K. Nikulin, G. T. Tsakadze, P. A. Shostak, A. M. Shostak
The influence of interstage channel on efficiency of molecular drag stage in hybrid turbomolecular pump

The interstage channel is one of the factors affecting the efficiency of the molecular drag stage in a hybrid turbomolecular pump (TMP). The influence of parameters of the channel on the pumping performance of the molecular drag stage is investigated. The offered approach allows calculating the pumping performance of a molecular drag stage taking into account the effect of the interstage connecting channel on the pumping process. The comparison of the pumping characteristics of a molecular drag stage obtained in calculation taking into account the effect of the channel and excluding it is given. This article assesses the efficiency of the molecular drag stage in a hybrid TMP depending on geometric and dynamic parameters of the channel. The outcomes and recommendations allow to expand the range of working pressures of a hybrid TMP exclusively by means of parameters of the connecting channel.

Keywords: turbomolecular pump, molecular drag pump, channel conductivity, volumetric gas flow, moving walls channel, pumping speed, resistance, gas flow.

A. V. Burakov, A. A. Kotlov, A. A. Levikhin
Compressor equipment for enhancing efficiency of solid organic waste processing plants

The article describes the experience of the Compressor holding company in the creation of compressor equipment for various industries. The use of compressors as part of complexes for the processing of organic waste in the framework of solving urgent environmental problems has been demonstrated. The process of compression of synthesis gas to increase the efficiency of the processing process has been investigated. To ensure stable parameters, reliable operation of syngas reciprocating compressors is required in wide ranges of operating parameters. Ensuring the operability of the compressor in wide ranges of parameter variation requires multivariate calculations in order to find the best design parameters of the compressor. A compressor is proposed for the most efficient implementation of the task and its characteristics are calculated.

Keywords: recycling, organic waste, synthesis gas, piston compressor, mathematical model.

M. W. Tofique, A. Löf, C. Millward, Z. Günther
Testing and calculation of impact fatigue strength of Flap-X and SS 716 flapper valve steel grades
/trans. from Engl. M. A. Fedorova

During the operation of reciprocating compressors, the flapper valve opens and closes under fluid pressure and flow. As it closes, it strikes against the valve seat, generating stresses and noise. This cycle of loading produces bending and impact fatigue stresses in the reed. This load pattern is repeated billions of times during the service life of a compressor and it defines the service life and reliability. The goal of this study was to calculate the impact fatigue strength of the Flap-X and the SS 716 grades and, to provide the compressor manufacturers with the information they can use to specify a steel grade to be used in their compressors, for reliable service. Impact fatigue tests were conducted on a custom-built impact fatigue test rig that used air pulses to produce movement of the reed valves manufactured by a major European compressor manufacturer Nidec Global appliance GmbH, at a frequency of 315 Hz and pulse width of 2,2 milliseconds. The testing was conducted according to the staircase test method detailed in the International Standard SS-ISO 12107:2012. The impact fatigue strength of the Flap-X and SS 716 steel valves was calculated in terms of the impact velocity according to the modified staircase test method in the standard. The test results and their statistical analysis showed that the impact fatigue strength of the Flap-X grade was higher compared to the SS 716 grade. The calculation and testing of the impact fatigue strength of the flapper valve steel grades could help the compressor designers to select the optimum material for their compressor designs, to provide reliable service. The higher impact fatigue strength of the Flap-X grade, lower failure rate and longer impact fatigue life will allow the compressor manufacturers to design thinner valves, as Flap-X can sustain higher impact fatigue stresses reliably for longer time and, at the same time help reduce noise, as thinner valves produce less noise for a given pressure and frequency.

Keywords: reciprocating compressor, reed valves, impact fatigue strength, experiment, comparative tests.
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AVIATION AND ROCKET-SPACE ENGINEERING

V. I. Kuznetsov, V. V. Makarov, A. Yu. Shander
Physical and mathematical model of working process of jet ejector

A refined physical model of the jet ejector working process has been compiled. On the basis of the refined physical model, a mathematical model has been developed that takes into account the exchange of work and heat between the ejected and ejected gases. Based on the solution of this mathematical model, it is possible to formulate a method for calculating the optimal geometric dimensions of the jet ejector to obtain the specified thermodynamic parameters and a method for calculating the characteristics of the jet ejector with known geometric dimensions. The effect of viscosity on energy exchange is shown. The agreement between the calculated and experimental data is satisfactory.

Keywords: jet ejector, compressor, viscosity, tangential stresses, difference in linear velocities.

E. V. Krivonos
Justification scheme for milling waffle background

In the manufacture of dry and fuel compartments of missiles ensuring weight tolerance is a priority. In practice, this is ensured by the introduction of lightweight materials together with the optimal design of the supporting set of ribs (waffle background) of orthotropic shells and waffle shells. The manufacturing technology of which is difficult and costly in view of the difficulty of ensuring the accuracy and perfection of the shape of the waffle background cell. In modern conditions, when manufacturing a waffle shell for a fuel tank, reinforcement processing is carried out by milling on a monolithic blank using specialized machine systems. At the same time, the choice of the waffle background processing scheme remains an urgent issue: on a flat panel or on a bent shell. The problem of selection arises due to the

requirements for the accuracy of the waffle background. It is important to maintain the part mass tolerance and geometric perfection of the cell shape. All this generally affects the perception of design loads and the carrying capacity of the rocket. At the same time, the methods and processes of processing the waffle background should be productive and economically feasible. The proposed justification will make it possible at the start of the design of new promising products to more accurately determine the technological and production costs necessary for the production of parts with a waffle background with given parameters and accuracy.

Keywords: waffle panel, waffle shell, waffle background milling, missile fuel tank, AMg6 alloy.

Yu. V. Shchipkova
Determination of static and dynamic forces for manufacture of corrugated belts for wind tunnel heat exchangers

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. The experiments are carried out on a horizontal milling machine model 6H81. The results of the experiment are applied to stainless steel tapes with a thickness of 0,3 to 0,4 mm.

Keywords: static force, dynamic force, corrugated tape, wind tunnels, rolling, vibration installation.