POWER AND CHEMICAL ENGINEERING

V. L. Yusha, S. S. Busarov
Method for calculating actual capacity of single-stage long-stroke reciprocating compressors

The article presents a generalized method for calculating the actual performance of low-speed longstroke air compressor stages of compression, based on determining the flow rate as a set of coefficients reflecting the influence of various factors on productivity losses. The method takes into account the design and operating features of low-speed long-stroke air compressor stages of compression and differs significantly from a similar method used to calculate high-speed stages of reciprocating compressors.

Keywords: reciprocating compressor, low-speed long-stroke stage, delivery ratio, heating ratio, density ratio, experiment, temperature diagram.

A. I. Borovkov, Yu. B. Galerkin, O. A. Solovieva, A. A. Drozdov, A. F. Rekstin, V. B. Semenovsky, P. N. Brodnev
Development of mathematical model and computer program for primary design of transonic axial compressor

The mathematical model underlying the program for calculating and designing axial compressors is presented. The process of calculating the pressure loss in the elements of the axial compressor stage flow path is described. The loss coefficient consists of losses on the limiting surfaces, secondary losses and profile losses. The effect of roughness on the pressure loss is taken into account by introducing the corresponding empirical coefficient. An algorithm for calculating the blades and vanes angles of the impeller and the guide apparatus is presented by calculating the incidence angle and the lag angle of the flow. The flow lag angle is the sum of the lag angle of the flow on the profile and the lag angle due to viscous flow on the limiting surfaces.

Keywords: axial compressor, impeller, return channel, flow rate, radial equilibrium, head loss.

A. A. Drozdov, Yu. B. Galerkin, O. A. Solovyeva, K. V. Soldatova, A. A. Ucekhovscy
Mathematical model of the 9th version Universal modeling method: features and results of identification

The Universal modeling method is a complex of computer programs for calculating the characteristics and optimal design of centrifugal compressors based on mathematical models of efficiency and head. Practical experience allows improving the mathematical models that underlie the Method. Determining the non-incidence inlet in a blade cascade is an important part of calculating the compressor gasdynamic characteristics. In the 8th version of the Universal modeling method, a formula is used to calculate the direction of the critical stream line, containing an empirical coefficient X. The practice of application has shown that the value of the empirical coefficient changes the amount of losses in the impeller in off-design flow rates. A new scheme for modeling velocity diagrams is proposed. It is made for the stage operation mode corresponding to the zero incidence angle. The successful use of the model for the impeller made it possible to extend it to the vane diffuser and return channel. Several other improvements are made too. A new mathematical model is developed for calculating the flow parameters in the exit nozzles of centrifugal compressor stage. The mathematical model for calculating the flow parameters in the vaneless diffusers is modernized. The applicability boundary of the new model is expanded to a range of diffusers of low consumption stages with a relative width of up to 0,006. The resulting mathematical model is identified by the test results of two family model stages and plant tests of industrial compressors.

Keywords: mathematical modelling, centrifugal compressor, vaneless diffuser, efficiency, exit nozzle, impeller.

V. V. Karabanova, A. D. Vanyashov, V. L. Yusha
The influence of blade profile shape of inlet guide vane on performance map of centrifugal compressor stage

The object of the study is a centrifugal compressor stage with an inlet guide vane. The performance map of the stage are investigated in the modes of combined regulation by changing the rotor speed and changing the swirl of the flow in front of the impeller by turning the blades of the inlet guide vane. Two variants of the design of the profile of the blades of the inlet guide vane are considered and the method of turning the blades by performance map. As a result of the study, it is found that a profile with a fixed inlet part at large swept angles has a lower loss coefficient, which contributes to an increase in the efficiency of the stage. The effect of regulation to achieve the set point in terms of pressure and flow for the re-profile stage is achieved at lower speeds.

A. V. Tsygankov, V. I. Lysev, A. K. Rubtsov, A. S. Shilin
Optimization of heat and mass transfer processes in air conditioning systems in public buildings

Increasing the energy efficiency of air conditioning systems in public buildings and structures is an actual task. A mathematical model is proposed for determining the values of internal air temperatures and temperatures of the surfaces of enclosure in order to calculate the predicted values of heat fluxes in buildings and structures. An experimental study has been carried out showing the relevance of the proposed method.

L. V. Galimova, D. Z. Bairamov
Thermodynamic analysis of combined cycle plant operation as part of an energy-saving system based on an absorption bromide-lithium refrigerating machine

The main directions of research of the current energy-generating system, taking into account its technical limitations, are optimization and forecasting based on the analysis of its operating modes. Thermodynamic analysis involves determining the efficiency of the system based on the research of exergy efficiency and exergy losses. In this project, we propose methodic and results of exergy analysis of combined cycle gas plant operation as an object of energy production, the efficiency which is provided by cooling the outdoor air using an absorption bromide-lithium refrigerating machine. Conducting exergy analysis for determination of exergy destruction allow to determine the potential for increasing the efficiency of the system. A flow graph and an incident matrix are presented. The exergy efficiency of the combined cycle gas plant under the specified conditions is 46,5 %. Based on the exergy analysis, the final diagram of the distribution of fluxes and losses of exergy of the combined cycle gas plant is presented.

C. R. Baggley, M. G. Read
Investigation of a thermo-fluidic exchange pump in trilateral flash and organic Rankine cycles / trans. from Engl. M. A. Fedorova

It is well known that large amounts of energy loss occurs at low temperature states in a wide range of industrial processes. The recovery and reuse of this energy is at the forefront of increasing the overall efficiencies of industrial systems. The aim of this paper is to investigate the effectiveness of using a Thermo-Fluidic Exchange (TFE) pump at low temperature conditions in both a Saturated- Vapour Organic Rankine Cycle (SORC) and a Trilateral Flash Cycle (TFC). For some low temperature applications, TFCs have been shown to achieve higher net power output than conventional SORCs, due to their ability to extract more heat from the source fluid. This is the subject of current research as a result of

advancements made in the design of positive displacement machines for operation as twophase expanders. Conventional turbines cannot be used for TFCs as they must operate in the vapour phase. One drawback of the TFC is the higher working fluid mass flow rate required. Depending on the scale of the system, this can potentially cause difficulties with pump selection. A TFE pump uses heat input to the system to increase the pressure and temperature of the working fluid, rather than the work input in a standard mechanical pump. This paper compares the net power output achievable using both mechanical and TFE pumps with SORC and TFC systems. The results suggest that the TFE pump could be a viable option for TFC systems.

Keywords: thermogas lift, organic Rankine cycle, triangular cycle, adiabatic expansion, wet steam, recirculation.

D. A. Ozherelev, V. V. Shalay
Choosing optimal separator design using hierarchy analysis

The article describes the possibility of using the «Method of analysis of hierarchies» when choosing the type of separator. These calculation methods are used to determine the vector of priorities and alternatives according to specified criteria, as well as to assess the consistency of expert opinions. The task is set, alternative options and criteria for selecting a separator design are presented. A hierarchical structure is built for various designs of separators. The method of calculation for a variety of indicators that characterize the types of separation equipment is presented. Based on the results presented in accordance with the technical and economic indicators, the optimal design of the separator is determined.

Keywords: gas separator, hierarchy analysis method, comparison matrix, gas-liquid flow, apparatus productivity, gas pressure, separation process efficiency.

S. Yu. Kaigorodov, A. A. Shaposhkov, I. V. Tsvetkov
Method for calculating the use of nozzle hydrodiodes in design of two-tube hydraulic shock absorber

The development of a method for calculating the use of nozzle hydrodiodes in the design of a twotube hydraulic shock absorber is carried out by considering such problems as the fragility and wear of movable elements (valves) in the design of a hydraulic shock absorber. The paper considers a method of calculation of the shock absorber with hydrododone (the fixed elements). The scientific novelty and task is to replace the movable hydraulic valves in the shock absorber design with nozzle hydraulic diodes, which, theoretically, will extend the service life of this unit, due to the lack of movement dynamics and wear of moving parts.

Keywords: hydraulic shock absorber, valve, herodium, local resistance, diode.

AVIATION AND ROCKET-SPACE ENGINEERING

E. V. Krivonos
Investigation of deformation of shell with waffle reinforcement during rolling and development of method for compensation of deviations forms

When the waffle panel of AMg6 alloy rolls into the cylindrical shell, a shape defect occurs. Manual elimination of this defect causes local irregularities on butt welded edges of the waffle shell. This leads to difficulties in the process of welding by friction welding with mixing of shells in the section of fuel tanks. It is necessary, on the basis of computer analysis and existing theories, to determine the stresses in the waffle shell that cause internal deformations that result in a general shape error, and to derive patterns under which external influence on the geometry of the mold at the time of bending is possible. The proposed campaign will make it possible to determine auxiliary technological elements for setting standard rolling equipment for defective rolling of wafer shells of missile fuel tanks with various geometric versions of reinforcements. It, in turn, will increase the efficiency of forming shells and the quality of welds when they are welded.

Keywords: waffle panel, waffle shell, rolling, missile fuel tank, AMg6 alloy, friction stir welding.