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Mini Review

Development and Research of New Compressor Equipment for the Production of Hydrocarbons and Other Minerals

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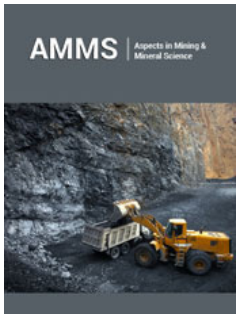

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Abstract

The aim of the ongoing research work is the development of new scientific principles for the compression of gases and gas-liquid mixtures using jet and turbine technologies with the ability to recover energy. The new scientific approach is related to the improvement of jet systems for controlling the operation of turbines and compressors. One of the promising directions for the development of this scientific work is associated with the creation of new compressors and pulse turbines for internal combustion engines. New scientific principles have been developed and patented for the compression of gases and gas-liquid mixtures, using pulse ejectors and pulse turbines. The results of the studies performed can serve as a basis for a promising technology that allows one-stage isothermal gas compression without restrictions on the degree of pressure increase in one stage.

Keywords: Production of hydrocarbons; Minerals; Compressor; Pump; Ejector; Separator; Research

Introduction

At a later stage in the development of oil and gas fields, the need for additional compressor equipment increases. When producing hydrocarbons, the operating conditions of compressor machines are complicated due to the presence of liquid fractions and solid particles in the flow of the pumped medium. The active use of known compressor technologies is often hindered by high prices for the equipment used. In this regard, an urgent task has been set to develop new cost-effective pump and compressor units. Jet pumping and compressor units are distinguished by high reliability and low cost [1-3]. In the general case, such an installation includes the following main elements: a power liquid pump, an ejector and a separator. Now the cyclic mode of the working medium outflow through the ejector nozzle is being studied more actively [4-6]. Previously, high-frequency cyclic modes of ejector operation were mainly studied, and mainly in the field of aviation technology. However, the low-frequency cyclic modes of operation of the ejector are still poorly understood. Cyclic operation of the ejector at low frequencies seems to be very promising, both for increasing the outlet gas pressure and for increasing the efficiency of the pump and compressor unit as a whole, as applied to solving practical problems in the production of hydrocarbons and other minerals. The aim of the ongoing research work is the development of new scientific principles for the compression of gases and gas-liquid mixtures using jet and turbine technologies with the ability to recover energy. The new scientific approach is related to the improvement of jet systems for controlling the operation of turbines and compressors.

Result

The specialists of the Gubkin Russian State University of Oil and Gas carry out research and experimental work to solve urgent problems in the field of mining, including hydrocarbons. The system under study includes the following basic elements: power pump, ejector, separator. The pump delivers working fluid to the ejector nozzle, in the mixing chamber of the ejector, part of the energy from the fluid flow is transferred to the pumped gas when the liquid is mixed with the gas. In the separator, the liquid is separated from the gas and sent to the pump, and the compressed gas from the separator is sent to the consumer. The laboratory

has launched scientific research and design work to create effective and cheap compressor technologies based on ejector systems, with the implementation of a cyclic working process at low frequencies [4-8]. A mathematical model has been developed to describe the cyclic operation of a jet compressor unit. The developed computer program is registered in the patent office of the Russian Federation. The development of an experimental model of a jet compressor unit has been completed. The promising directions of research and design work to improve the efficiency of the jet compressor plant have been found, and new principles of gas compression using ejector systems have been patented. A laboratory stand has been created to study new ejector systems. In accordance with the developed program, research tests of the new compressor unit were carried out. In the course of physical experiments, new principles and new patented technical solutions were successfully tested, aimed at the development of ejector systems. Compressor technology and equipment have been developed and patented in the course of scientific research, the results and scientific novelty of these works are supported by patents of the Russian Federation: No. 2674042, No. 2680021, No. 2680028, No. 2702952, No. 2707989, No. 2714989, No. 192513.

Discussion

In known ejector systems, the gas pressure is several times lower than the pressure of the working fluid, and the ratio of these pressures is at the level from 0.15 to 0.3 for optimal operating conditions. During the research it was shown that there are additional possibilities for increasing the working gas pressure and for increasing the efficiency of ejector systems. So, when implementing a cyclic low-frequency working process, the outlet gas pressure can be equal to the pressure of the working fluid, and the pressure ratio parameter reaches 1, and this result has been confirmed experimentally during bench tests of a new ejector system in laboratory conditions. With the cyclic operation of the ejector, perspective problems of gas compression to pressures of 10 to 20MPa are considered. Preliminary calculations showed that there is potential for increasing the gas pressure to a level of 20 to 40MPa. At the same time, the cost of the newly developed compressor technology can be reduced 16...20 times compared to modern compressors.

One of the promising directions for the development of this scientific work is associated with the creation of new compressors and pulse turbines for internal combustion engines, in which the combustion of the fuel-air mixture is carried out at a constant volume. At the same time, the creation of cheap and economical compressor technologies will make it possible to solve topical issues of energy supply in remote oil and gas fields. The results of the studies performed can serve as the basis for a promising technology that allows one-stage isothermal compression of gas without restrictions on the degree of pressure increase, including with a 400-fold increase in gas pressure in one stage. On the basis of this technology, there is a prospect to develop other branches of science and technology, including gas turbine plants for various purposes. Some of the results of the research performed can be used to create new pumping, compressor and turbine equipment for various industries, including transport and robotics.

Conclusion

New scientific principles have been developed and patented for the compression of gases and gas-liquid mixtures, using pulse ejectors and pulse turbines. When implementing a cyclic low-frequency working process, it was shown during bench tests that the outlet gas pressure can equal the pressure of the working fluid, and the pressure ratio parameter for the ejector can be increased from 0.15 to 1.0. With the cyclic operation of the ejector, the prospects for gas compression to pressures of 10 to 20MPa are shown. The results of the studies performed can serve as a basis for a promising technology that allows one-stage isothermal gas compression without restrictions on the degree of pressure increase in one stage.

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