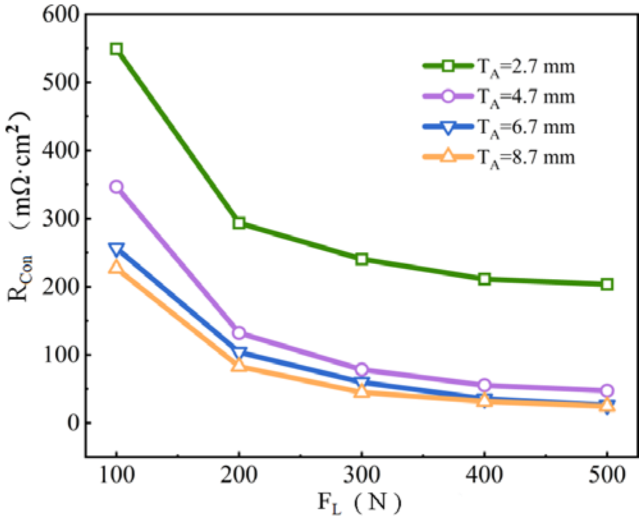

Fig. 3 Influence of the thickness of anode support layer on contact resistance (Unit: mΩ·cm²)

Fig. 3 shows the influence of different thickness of anode support layer on the average contact resistance of cathode. When the bolt preload is 500 N, the contact resistance of the cathode decreases by 156.16 mΩ $\cdot cm^2$ when the thickness of the anode support layer increases from 2.7 mm to 4.7 mm, but decreases by 1.26 mΩ $\cdot cm^2$ when the thickness of the anode support layer increases from 6.7 mm to 8.7 mm. Thus, the thickness of the anode support layer is recommended to be 6.7 mm to save cost.

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DESIGN OF GAS TURBINE UNIT WITH EJECTION OVER-EXPANSION OF GAS IN THE TURBINE

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The paper deals with the development of the design of a gas turbine unit with ejection over-expansion of gas in the turbine. The influence of the air-jet ejector on the dimensions, weight and efficiency of the GTU, as well as on the features of its design and operation, has been analyzed.

Keywords: gas turbine unit; air-jet ejector; gas over-expansion; design features; heat drop.

One of the possible ways to increase the efficiency and useful power of gas turbine units is the use of gas over-expansion in the turbine part of these units.

It is known that the power of the turbine part is directly proportional to the heat drop in it, which is the difference of the enthalpies of the gas before and after the turbine part. Enthalpy, as a characteristic of potential energy, is functionally dependent on pressure and temperature. The greater the pressure and temperature, the greater the enthalpy of the working fluid. Therefore, to increase the heat drop, it is necessary to strive, on the one hand, to increase the parameters of the gas (pressure and temperature) in front of the turbine, and on the other – to reduce them behind the turbine.

The increase in the parameters of the gas in front of the turbine is provided by the structural parts of the GTU, located earlier. The pressure increases in the compressor part during air compression; the temperature rises mainly in the combustion chamber due to fuel combustion.

Consider what depends on the parameters of the gas at the outlet of the turbine. In open thermodynamic cycle gas turbine plants, in which the emission of exhaust gases is carried out into the atmosphere, the pressure at the outlet of the turbine part of the GTU is set approximately equal to atmospheric pressure. It is only slightly larger than this value by the amount of pressure loss in the exhaust tract. Open-cycle gas turbine units, in which the pressure at the outlet of the turbine in order to increase the heat drop is organized less than atmospheric, are called "units with gas over-expansion in the turbine".

GTU with gas over-expansion has much larger heat drop in the turbine, but they need additional structural elements for the emission of exhaust gas into the atmosphere, because independently, without these elements, the gas can no longer enter it. These additional elements should increase the gas pressure to atmospheric (taking into account the pressure loss in the exhaust tract).

As such additional pressure devices it is possible to use:

a) special compressors (exhausters);

b) air-jet ejectors.

It should be noted that in both cases the mechanical energy of the turbine part of the GTU will be spent on the operation of the pressure device, which significantly reduces the positive effect of gas over-expansion. Since the use of over-expansion in this way will affect the efficiency of GTU ambiguously (on the one hand to increase the power of the turbine due to greater heat drop, and on the other hand to reduce it due to the power take-off to the pressure device), the choice of parameters of the gas turbine unit of this type should be made by a series of optimization calculations taking into account specific features of its design.

This paper research the possibility of creating a gas turbine unit with gas over-expansion, which uses an air-jet ejector as a pressure device. The role of the working substance involves the use of air, which is extracted from the intermediate stages of the compressor part of the GTU. As already mentioned, the operation of this device will consume the mechanical energy of the turbine part of the GTU, as the ejection will be extracted for air, the compression of which has already been spent mechanical energy.

The general structure of the gas turbine unit with ejection over-expansion of the gas in the turbine part is shown in Fig. 1.

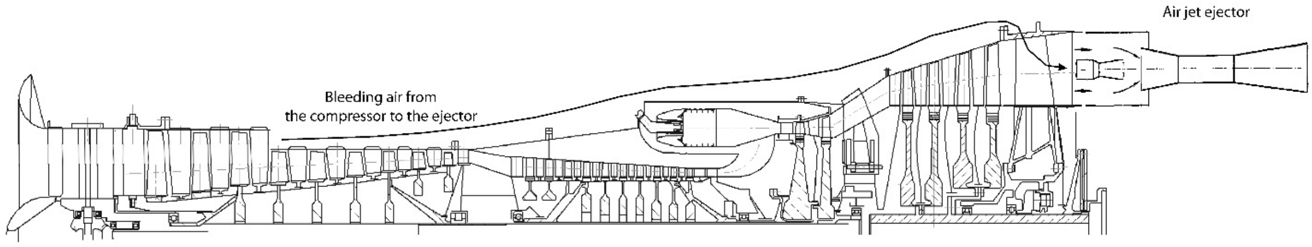

Fig. 1. Design of gas turbine unit with ejection over-expansion of gas

Creation of this GTU took place by modifying the design of the gas turbine unit of the simple thermodynamic cycle UGT 25000 (DG80), which is mass-produced by the state enterprise NVKG "Zorya" - "Mashproekt" (Mykolaiv, Ukraine) [1].

The extraction of air for the ejector is carried out from the intermediate stages of the compressor part of the GTU (in the figure – from the intermediate stages of the low pressure compressor). The ring-shaped air-jet ejector is located directly behind the power turbine of the unit after the rear support.

It should be noted that structurally such a gas turbine unit somewhat resembles aircraft turbofan engines with mixing flows in the jet nozzle [2]. The first stages of the compressor part, which are located before the extraction of air, in the turbofan engines are traditionally called "fans" and their structure is largely similar to the structure of the same stages of the projected gas turbine unit. The organization of the movement of air extraction from the place of intake to the ejector will also be similar to the movement of air of the outer circuit in the turbofan engines with mixing flows.

In comparison with GTU of a simple cycle the gas turbine unit with ejection gas over-expansion [3]:

– will have more length;

– his work will be more noisy;

– fan compressor blades, due to their longer length, will experience large loads from centrifugal forces;

– the surging phenomena in the compressor at partial power modes is not entirely clear;

– the air moving to the ejector along the annular space will cool the outer casing of the gas turbine unit, which will make it possible not to use traditional means of this cooling.

When calculating, it will be necessary to take into account the significant pressure loss of the ejection air on the way from the extraction point to the ejection point.

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UDC 539.3

GAS TURBINE ENGINE ROTORS FORCED VIBRATION STUDY ON THE BASE OF REFINED FEM MODEL

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Abstract. The method of the highly loaded gas turbine non-cooled impeller with damping links vibration research is described. Using the finite element method, a refined mathematical model was developed for the impeller's section, consisting of a disk sector and a bandaged blade. The developed mathematical model takes into consideration the structural heterogeneity of the blade itself and the disk. The results of the impeller vibration frequencies calculation, caused by the influence of non-stationary gas flow, can be used for the rotor stress-strain state calculation.

Key words: gas turbine rotor, impeller, forced vibration, vibration frequency, non-stationary gas flow.