Development of radial turbines in low-power gas turbine engines

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Today low-power gas turbine engines, especially micro gas turbine installations (MGTI), are one of the most modern types of power generation equipment, which exceed other ones in such consumer properties as: environmental friendliness, efficiency, profitability and integrity. Microturbines are an innovative technology of independent power plant development. They find themselves in different fields of economy with an increasing quantity of consumers: industrial plants, medical centres, oil and gas industry, rural sector, recycling, electrification of autonomous regions, geological prospecting, transportable sources of power for EMERCOM, strategic and military assets.

There are advantages of micro gas turbine installations: an opportunity of performance with small load during a long period of time; a low level of polluting emissions, vibratory actions and noise; low exploitation cost, an opportunity of performance with different types of fuel excluding lubricants; high level of integrity. The main disadvantage is high cost of MGTI.

Development of new microturbines is related to high input requirements, which affect on cost of a complete installation. Cost reduction can be achieved by using of already designed turbines as prototypes and their improvements with an appliance of modern physical process modeling complex. Designers make efforts to create high-speed microturbines. Also problems, connected with supply of gasdynamic (efficiency and power values) and strength (minimal value of efficiency) parameters, are being solved simultaneously. The most frequently a design of impellers, which supply required gasdynamic parameters, is unacceptable because of strength factors in operating performance. Circumference-curved turbine blades bend back because of centrifugal forces, producing high stresses. That's why it's necessary to improve turbine impellers' geometric models, which are achieved after gasdynamic CFD-modeling or they are based on already existed prototype, considering properties of chosen material and operating performances. It's offered to organize a complex of investigational and design researches, which will allow to reduce stresses in the impeller and keep gasdynamic parameters especially coefficient of efficiency as good as possible.

First of all it's necessary to evaluate blade profile and its deviation from radial direction. Analysis of a blade radiality is realized by splitting in several cylindric sections and determination of a deflection angle. Based on received angles, geometric blade model rebuilds by turning of cylindric sections around the axis of rotation. Further, modeling of a turbine loads complex is implemented. Hazardous locations are places of blades joints with a wheel in circumference. Coefficient of efficiency is close to minimum allowed one there. Different connections are considered, which allow to reduce stresses: blades' supports based on extended fillet, triangular form, parabolical form. The most effective joint is parabolical wheel thickening towards to connections with blades in circumference. It is got by means of changing back blade surface. Using of this joint permits to achieve increment of minimum safety factor to 1.3, keeping gasdynamic efficiency parameters of the impeller.

Presented method radial turbine's design related to low-power gas turbine engines, which is based on CFD-modeling and strength analysis, allows to minimize time period and costs of new microturbines' developing process. This fact permits to make independent power engineering more accessible for consumers and profitable for the producer.