DEVELOPMENT OF BREAKTHROUGH TECHNOLOGIES FOR CREATING NODES AND DETAILS FROM CERAMIC AND POLYMER COMPOSITE MATERIALS FOR SMALL-SIZED AIRCRAFT ENGINES

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The increase working and economic characteristics of small-sized gas turbine aircraft engines (SSGT) for promising unmanned aerial vehicles and helicopter engines in the near future largely depends on the fact,
- polymer composite materials,
- composite materials on a metal matrix or intermetallic matrix,
- ceramic composite materials,
- carbon-carbon composite materials with coatings;

The objectives of the work were:
- Development of constructive and breakthrough technologies for the creation of SSGT with detailed and components from domestic composite materials (polymer composite materials, composites on metal and / or intermetallic matrix, ceramic composite materials, carbon-carbon composite materials) for promising unmanned aerial vehicles and helicopters
- Decrease in weight and content of elements by 40% or more, raising the gas temperature in front of the turbine by 20-25%, improving environmental performance and other technical and economic indicators;
- Demonstration of the performance of engine components from ceramic and composite materials by means of details development and experimental studies of parts in the operating mode of the engine;
- Creation of prototypes of rotor and stator engine elements from ceramic and polymer composite materials;
- Creation of a scientific and technical background on the use of composite and / or ceramic materials in engine designs for various purposes.

New design solutions and breakthrough technologies for the use of ceramic and composite materials with the realization of their characteristics in engine designs have been developed. Experimental studies of both samples and experimental details and assemblies from new ceramic and composite materials have been carried out. Information has been obtained on the physicomechanical properties of new ceramic and composite materials at normal and high temperatures (up to 1500 °C) associated with the use of these materials in promising SSGT. The models of stator (Fig. 1) and rotor (Fig. 2) units of SSGT with ceramic and polymer composite materials are manufactured and assembled.

Fig. 1 - Stator unit with a flame tube and nozzle apparatus made of ceramic material
Fig. 2 - Rotary assembly with low-pressure, high-pressure impellers and composite turbines
In particular, the manufacturing technology has been worked out, the elements of SSGT have been manufactured and tested:

- Impeller of a low-pressure compressor made of polymer composite material;
- Impeller compressor of high pressure from high-temperature KM at 320 °C [1];
- Impeller high-pressure turbines from CMC for heat treatment in ceramic material [2];
- A flame tube made of ceramic composite material C/SiC [3];
- Ceramic rolling elements made of SiC material and a carbon fiber separator for rolling bearings [4];
- Nozzle apparatus made from a dispersed-hardened ceramic material with diamond particles [5].

The weight reduction of the nodes was ~ 49.5% compared to the metal prototypes. The flame tube, nozzle apparatus and turbine, made of ceramic composite materials, can increase the efficiency of the engine by 1.5-2% by cooling and raising the temperature of the gas in front of the turbine. Developed and manufactured assemblies of ceramic and composite materials correspond to world achievements in the field of promising SSGT, and some details do not have foreign analogues.

Developments allow improving the tactical and technical characteristics of SSGT and can be used in various engines.

The results of the work will be used when finalizing the details and assemblies of SSGT from ceramic and composite materials to the VI technological readiness level (TRL), as well as for the development of perspective engines for various applications with wide application of parts and assemblies of ceramic and composite materials.


3 T.D. Karimbayev, MA Mezentsev - "Ceramic flame tube and nozzle apparatus integrated into the one design of the SSGT", XXXII All-Russian Conference on Science and Technology, 12-14 June 2012 in Miass, Chelyabinsk Region;
