

INVESTIGATION OF GTE COMPRESSOR BLADES VIBRATION DUE TO BLADE–CASING RUBBING

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The constant desire to improve aerodynamic efficiency of modern compressors for aviation gas turbine engine (GTE), inevitably leads to decrease radial clearance between blade tips and casing, thereby increased the probability of blade rub problems during operation. The special abrasible coating is applied to the inside of the case, to avoid dangerous effects of rubbing contact of rotor blade with the casing. However, despite these coating, due rubbing contact may occur high blade's stress levels and/or decrease a fatigue strength of the material with subsequent fatigue failure.

To solve the problem of prevent the GTE blades fatigue failure due to blade-casing rubbing this paper provides analysis of experimental data obtained from special laboratory's investigations with simulations of blades rubbing and experimental data obtained from compressors tests in test facility under atmospheric conditions and stationary conditions of operation. The paper further present calculated studies of changes in the radial clearance between the rotor blades and the casing when oscillations occur. This investigates fails to take the influence of non-stationary thermal modes of operation on the change in radial clearances into account.

Based on the results of computational studies, it was shown that in some cases the main influence on the change in the radial clearance is not static deformations, but large displacement amplitude of the blades during intense vibrations. The analysis of the results of experimental studies showed that oscillations of the rotor blades when they rub the abrasible coating have much in common with forced vibration from the input circumferential flow irregularity. In certain cases, individual blades may experience strong vibration excitation as they touch the abrasible coating, while the vibration stresses amplitude may increase over time. This increase in the vibration stress level is because at a constant frequency of rotation, the periodic impact on the blade from its contact on the coating is in-phase with the oscillatory movement of the blade itself, which, ultimately, ensures a constant increase in the oscillations amplitude after each turn of the rotor. Obviously, the above case demonstrates the danger of the blades touching the abrasible coating, since in a very short period of time the vibration stresses level can reach fatigue limits, which will lead to a failure of the blade.

As a result of the research, features of the blade oscillations mechanisms occurring when they rub the case are identified, diagnostic signs of the blades contact on the abrasible coating during testing of compressors are determined, the influence of blades vibration stresses on the change of the radial clearance is estimated by a calculation method, and recommendations are made to ensure the vibration strength of the blades when they are rub on abrasible coating in the process of conducting bench tests.

Keywords: blades, resonant vibrations, bench testing, spectral analysis, abrasible coating, casing vibration, the radial clearance.