World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:10, No:04, 2016

Numerical Simulation of Aeroelastic Influence Exerted by Kinematic and Geometrical Parameters on Oscillations' Frequencies and Phase Shift Angles in a Simulated Compressor of Gas Transmittal Unit

Authors : Liliia N. Butymova, Vladimir Y. Modorsky, Nikolai A. Shevelev

Abstract : Prediction of vibration processes in gas transmittal units (GTU) is an urgent problem. Despite numerous scientific publications on the problem of vibrations in general, there are not enough works concerning FSI-modeling interaction processes between several deformable blades in gas-dynamic flow. Since it is very difficult to solve the problem in full scope, with all factors considered, a unidirectional dynamic coupled 1FSI model is suggested for use at the first stage, which would include, from symmetry considerations, two blades, which might be considered as the first stage of solving more general bidirectional problem. ANSYS CFX programmed multi-processor was chosen as a numerical computation tool. The problem was solved on PNRPU high-capacity computer complex. At the first stage of the study, blades were believed oscillating with the same frequency, although oscillation phases could be equal and could be different. At that non-stationary gas-dynamic forces distribution over the blades surfaces is calculated in run of simulation experiment. Oscillations in the “gas — structure” dynamic system are assumed to increase if the resultant of these gas-dynamic forces is in-phase with blade oscillation, and phase shift (φ=0). Provided these oscillation occur with phase shift, then oscillations might increase or decrease, depending on the phase shift value. The most important results are as follows: the angle of phase shift in inter-blade oscillation and the gas-dynamic force depends on the flow velocity, the specific inter-blade gap, and the shaft rotation speed; a phase shift in oscillation of adjacent blades does not always correspond to phase shift of gas-dynamic forces affecting the blades. Thus, it was discovered, that asynchronous oscillation of blades might cause either attenuation or intensification of oscillation. It was revealed that clocking effect might depend not only on the mutual circumferential displacement of blade rows and the gap between the blades, but also on the blade dynamic deformation nature.

Keywords : aeroelasticity, ANSYS CFX, oscillation, phase shift, clocking effect, vibrations
Conference Title : ICCFDM 2016 : International Conference on Computational Fluid Dynamics and Mechanics
Conference Location : Venice, Italy
Conference Dates : April 11-12, 2016