 Proceedings of ICCES'08, pp.755-755

Experimental Study on the Three-Dimensional Unsteady Flow Characteristics for the Rotor-Rotor Interaction of the Counter-Rotating Axial Flow Fan

Leesang Cho[1], Seawook Lee[1], Jinsoo Cho[1,2] and Chuntaek Kim[3]

Summary

Counter-rotating axial flow fan, which is a kind of two-stage axial-flow fan, has been a good solution for applications where high static pressure rise and volumetric flow rate are required. Counter-rotating axial flow fan consists of two counter-rotating rotors, which are a front rotor and a rear rotor, without stator blades. Compared with commercial single-rotating axial flow fan, the counter-rotating axial flow fan has higher efficiency and higher performance characteristics because the swirl velocity generated by the front rotor, which causes the energy loss, is recovered in the form of the static pressure by the rear rotor. Counter-rotating axial flow fan shows that the complex flow characteristics with the three-dimensional, viscous, and unsteady flow fields. Therefore, the aerodynamic noise level of the counter-rotating axial flow fan is increased due to rotor-rotor interaction by the two rotors with opposite directional rotation. For the understanding of the entire core flow in counter-rotating axial flow fan, it is necessary to investigate the three-dimensional unsteady flow field between the rotors. This information is also essential for the improvement of the aerodynamic characteristics, the reduction of the aerodynamic noise level and vibration characteristics of the counter-rotating axial flow fan.

Experimental study on the three-dimensional unsteady flow for the rotor-rotor interaction of the counter-rotating axial flow fan is carried out at the design point (operating point) and the off-design point(stalling onset point). Flow fields in a counter-rotating axial flow fan are measured at the cross-sectional planes of the upstream and downstream of each rotor by the 45° inclined hot-wire. The phase-locked averaged hot-wire technique utilizes the 45° inclined single sensor, rotated successively through 120 degree increments about its own axis. In this technique, the hot-wire signal is triggered by a revolution frequency pulse in successive wave forms are then averaged with one another so that only components repeating every rotor revolution are retained. Three-dimensional unsteady flow characteristics such as tip vortex, secondary flow and tip leakage flow are shown by the form of the axial, radial and tangential velocity vector plot and velocity contour.

[1]School of Mechanical Engineering, Hanyang University, 17 Haengdang-Dong, Sungdong-Ku, Seoul 133-791, Korea

[2]Corresponding author. Email: jscho@hanyang.ac.kr

[3]KHP Development Division, Korea Aerospace Research Institute, 45 Eoeun-Dong, Yuseong-Gu, Daejeon,305-806, Korea