Aerodynamic excitation forces in air conditioners with rotating fan-motor system

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ABSTRACT

Many air conditioners use fan systems for heat exchange. Vibratory motion and noise in the air conditioner occur by the aerodynamic excitation forces of the rotating fan blades. Therefore, calculating the aerodynamic excitation forces is a useful solution for reducing the vibration and noise.

Aerodynamic excitation forces in air conditioners having a fan-motor system can be divided into the following two types:

(1) Aerodynamic pressure pulsation acting on the cabinet (the thin metal plate) of the air conditioner (referred to below as "aerodynamic pressure pulsation"),

(2) Reaction forces acting on the base of the motor as a result of aerodynamic pressure pulsation (referred to below as "motor reaction forces").

Ota et al. have measured the aerodynamic pressure pulsation and researched techniques for predicting structural vibration caused by the pressure pulsation [1]. Sato et al. have discussed the relationship between aerodynamic pressure pulsation and motor reaction force experimentally [2]. Furukawa et al. simulated the vertical flow in a propeller fan using large eddy simulation [3]. Watanabe et al. discussed the aerodynamic and noise characteristics of a centrifugal fan [4].

In this report, the aerodynamic pressure pulsation of the rotating blades was measured using the experimental device with fan blades, a motor, pressure gauges, and load cells. The motor, which has four feet at its base, is installed on a high-stiffness block via a load cell. Fan blades are attached to the motor axis by screwing them on through bosses. A measurement board is installed for receiving aerodynamic pressure pulsation, which are measured using a pressure sensor attached to the measurement board.

On the other hand, we calculated the aerodynamic pressure pulsation on the measurement board and fan blades using CFD simulation software. Furthermore, based on CFD results, motor reaction forces were derived. Comparisons were made between calculation results and experimental results of the pressure pulsation and motor reaction forces. Finally, we could get good calculation results.

REFERENCES

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