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Influence of Porous Filter on Performance of Compact Axial-flow Fan with Upstream Obstacle

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Extended Abstract

Compact axial-flow fans are often used to cool heating elements inside desktop PCs and server machines because their simple structure and light weight characteristics make them relatively inexpensive to fabricate compared to other types of turbomachinery. Since these electronic devices are usually installed indoors in a tightly packed environment and filters are installed for dust prevention, their performance is known to be degraded compared to the case where there are no obstacles on the fan intake and exhaust sides, as in the performance test environment specified in the pre-shipment specifications. Many studies have been conducted on the influence of obstacles on fan performance [1-3]. The influence of the presence or absence of an obstacle on the flow field near the fan exhaust has also been investigated both experimentally and numerically [1]. When an obstacle is located at the intake side, a significant performance degradation is observed when the distance between the obstacle and fan is shorter than a certain threshold. Moreover, flow instability occurs at low flow rates where disturbances with pressure fluctuations propagate in the circumferential direction [2]. To control this flow instability, Shinohara et al. [3] proposed installing of a cross plate between a circular obstacle and the fan and succeeded in suppressing the pressure fluctuation induced by the disturbance propagation. However, the fan performance has not recovered to that without the obstruct.

Recently, improvement of the stall margin by lining the gap between the fan blades and casing with a porous material has been reported [4]. Inspired by this study, this research proposes installing a porous filter at the fan intake to suppress the performance degradation and unstable flow caused by the presence of obstacles on the intake side. Specifically, the influence of different porosity of the filter used for dust prevention on the fan performance curve, efficiency, the propagation velocity of the disturbance, and the amplitude of the pressure fluctuation was investigated experimentally. As a supplement to the experimental results, a steady-state simulation using computational fluid dynamics with Reynolds-averaged Navier-Stokes as the governing equation was performed to observe the flow field in the gap between the obstacle and filter. The obtained results show that when the filter porosity is below a certain level, the flow instability is eliminated or suppressed under the present experimental conditions and differential pressure at the same flow rate is decreased.

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