

Airflow uniformity improvement technology for Compact High-Efficiency Blower Fan



Masaharu Sakai *1
(1970)



Toshinori Ochiai *2
(1976)



Yasushi Mitsuishi *3
(1968)

1. Outline

The air-conditioning system for vehicles (HVAC) consists of various components such as blower fan, heat exchanger and air control doors. Due to increasing demand for compact and energy-saving cars in recent years, HVAC is required to be more smaller and more energy-saving efficient accordingly. For a blower fan in HVAC, Sirocco fan has been often adopted because of its compact size and sufficiency to supply high pressure. However, when furthermore size reduction of blower fan is demanded, the most concerned issue is increase of airflow velocity between fan blades, which may cause decrease in fan efficiency and increase in noise level. In order to solve the issue, we have developed an innovative device, “Dynamic PIV device with image-derotator system” for precise observation of the rotating airflow characteristics between the Sirocco fan blades. As a result, the technologies to make airflow distribution between the blades uniform were found, and it brought us successful development and productization of the compact and high efficient blower fan.

2. Description of Technologies

The “Dynamic PIV device with image-derotator system” is, as shown in Fig. 1, to set an image-rotation prism on the fan axis, then to make it rotate with a half speed of the fan rotate speed. This system is capable to obtain the still images of the fan movements. Accordingly, it made possible to perform continuous velocity field measurement of the airflow between Sirocco fan blades. The observation results are shown in Fig. 2. The flow separated at the blade leading edge is fluctuating with the rotation, and some generations and extinctions of the small-scale vortices are observed near the nose area. On the basis of those results, we have projected three technologies to make flow conditions uniform, aiming to suppress the separations or the vortices. Fig. 3 is the newly developed compact high-efficiency blower fan, which is applied our 3 airflow uniformity improvement technologies.

Here are the descriptions of the technologies. First, the blade leading edge to be thinner with sharp shape in order to reduce the separating airflow velocity and to fix the separation point at the edge (Fig. 4). The middle portion of the blade to be thicker than the edge, which facilitates re-attaching movements of the separated flow and reduces the area of the separation. Second, the air inlet portion, bell mouth, to form a guide-shape, which makes the flow distribution uniform in the axial direction (Fig. 5). Third, partial enlargement of “nose gap” of a scroll casing to make the flow uniform in the rotational direction (Fig. 6). These airflow uniformity improvement technologies made the new blower fan able to be compact and more efficient, because the flow loss and the fluid noise were suppressed.

3. Summary

As a HVAC component, the new blower fan we have developed has launched in November 2008, and it has been in the market since then. Our next target is to launch more new products with use of the airflow uniformity improvement

technologies, which are not only for regular vehicles but hybrid vehicles with battery cooling system, aiming to address the needs, further power saving, low noise level features.

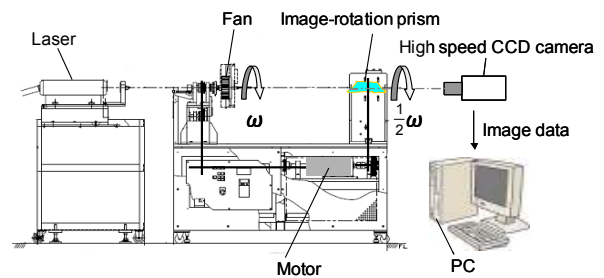


Fig. 1 Dynamic PIV device with image-derotator system

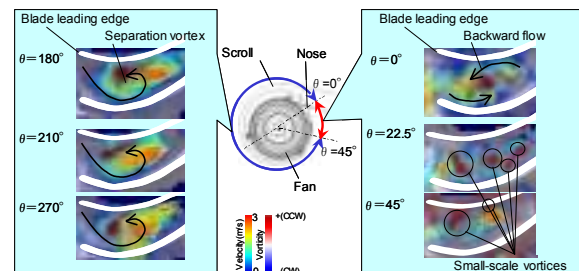


Fig. 2 PIV analysis result

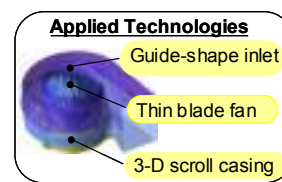


Fig. 3 Compact high-efficiency blower fan

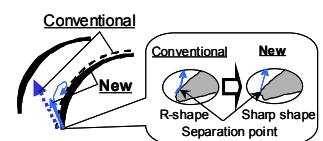


Fig. 4 Thin blade fan

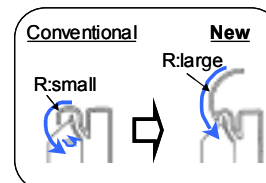


Fig. 5 Guide-shape inlet

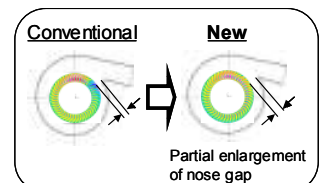


Fig. 6 3-D scroll casing

*1 Member, DENSO CORPORATION (〒448-8661, 1-1, Showa, Kariya)

*2 DENSO CORPORATION (〒448-8661, 1-1, Showa, Kariya)

*3 Member, NIPPON SOKEN, INC(〒445-0012, 14, Iwaya, Shimohasumi, Nishio)