Cooling Systems Division Technologies Offering Value in New Fields

Satoshi Fujimaki

1. Introduction

New products sold in various fields worldwide always come equipped with many new functions with their performance greatly improved. With that in mind, to offer our customers the fans they need now and in the future, SANYO DENKI proactively listens to our customers' requests and problems, while providing technical support, so that we may develop new technologies and products which fulfill customers' needs.

While such technologies and products enjoy demand from typical applications such as ICT equipment, industrial equipment, industrial inverters, and measuring devices, they can also offer value to new applications and new fields.

This article will introduce our achievement in terms of technologies offering value in new fields, using the following recent products as examples: the Reversible Flow Fan that can blow air in both directions, the Airflow Tester to measure the operating airflow and system impedance of equipment, the PWM Controller for controlling the speed of PWM control function fans, and the G Proof Fan that can withstand high levels of G-force.

2. Reversible Flow Fan

The Reversible Flow Fan is designed mainly for use in non-cooling applications. Its unique characteristic is that it can blow air in two switchable directions with equivalent airflow and power consumption performance in both directions. As this product mainly targets the household ventilation market, the new models have circular shape with 136 mm and 92 mm diameters unlike normal square-shaped axial fans in order to match the common size of household ventilation ducts.

Technical Report No. 40 and No. 42 already introduced the first generation ø136 mm sized Reversible Flow Fan, therefore this article will focus on the technology newly adopted in the next-generation ø92 mm model.

For the ø136 mm model, equivalent performance had been achieved in airflow vs. static pressure characteristics and power consumption for both directions. However, there was a sound pressure level (SPL) difference of more than 10 dB(A), which needed to be improved. In order to improve the SPL of the newly-developed ø92 mm model, we incorporated new technology in the blade shape. A concrete explanation is provided below.

Considering its particular application, the aim of the Reversible Flow Fan is to blow air in both forward and reverse directions, therefore there is a need for the airflow vs. static pressure characteristics and SPL to be equal in both airflow directions.

The shape and mounting angle of the blades significantly change the airflow vs. static pressure characteristics as well as impact SPL and power consumption. SPL tends to increase particularly in the reverse airflow direction due to the spokes supporting the motor on the air suction side.

To minimize SPL, the surface area of the blades was increased and the shape designed to optimize pressure distribution on the blade's surface so that the necessary airflow could be obtained without increasing fan speed.

Figure 1 shows an example of pressure distribution on the surface of a blade in the Reversible Flow Fan obtained by performing fluid analysis. Figure 2 is an external view of the blade.

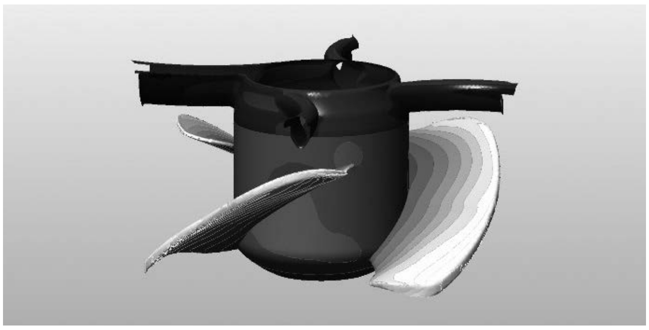

Fig. 1: Example of pressure distribution on the blade surface using fluid analysis

Fig. 2: Blades

By adopting a SANYO DENKI-original shape for the blades, we were able to achieve surface distribution with only moderate pressure change and reduce flow separation. As a result, the airflow vs. static pressure characteristics is equal for the forward and reverse directions and there is minimal difference in SPL.

This technology has reduced the SPL difference between forward and reverse directions from 11 dB(A) of the ø136 model to 4 dB(A) of the ø92 model.

Hence, this technology has proved effective for the Reversible Flow Fan.

3. Airflow Tester

One important element in thermal design is selecting the optimal fan for a device. It requires, however, to know the system impedance and operating airflow of the device. Measurement of these allow you to easily identify the fan's operating point, and select a fan with consideration to the equipment's cooling margin, fan SPL, power consumption, etc.

A measuring instrument known as a "double chamber measuring device" can accurately measure the system impedance of a device. However, they are extremely expensive, large, and require installation, making them difficult to relocate once installed.

Due to this, the majority of users opt to use anemometers and simulations rather than the double chamber measuring device for the thermal design process and select fans accordingly. However, because anemometers and simulations have poor accuracy compared to double chamber measuring devices, thermal design and verification required a great deal of time and effort.

To help solve these problems, SANYO DENKI developed the *San Ace Airflow Tester* to easily measure system impedance and operating airflow and offer value in new fields. The Airflow Tester is a portable measuring device that uses the highly accurate double chamber method.

Figure 3 is an external view of the Airflow Tester.

Fig. 3: Airflow Tester

At L600 mm × H250 mm × W250 mm and 6 kg, the Airflow Tester can be carried and used by a single person.

To make it lighter, the main body of the Airflow Tester is made of high-performance plastics for high strength. Moreover, through strength and fluid analyses, we were able to design a lightweight shape that maintains strength. Finally, by integrating the power source, control components, sensors and other necessary components to the main body of the tester, we have achieved a compact product.

Our measurement method is adapted from the highly-accurate double chamber method as per JIS-B-8330. Due to the nature of the highly accurate double chamber method, there is a need to change the size of the nozzle depending on the airflow being measured. For this reason, multiple nozzles are necessary. However, rather than fixing these nozzles directly to the Airflow Tester's main body, we have made them interchangeable to keep the tester's size to a minimum.

Because the Airflow Tester is small, light, and portable, measurements can be taken easily without moving from the location where the equipment is installed. We have also prepared a special-purpose duct which is mounted to the exhaust port to make measurements more convenient.

Figure 4 shows an example of how the Airflow Tester is connected to equipment.

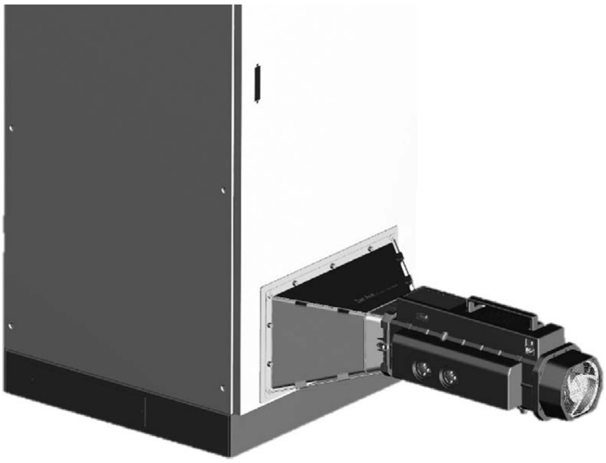

Fig. 4: Example of how an Airflow Tester is connected to equipment

Fig. 5: Box type

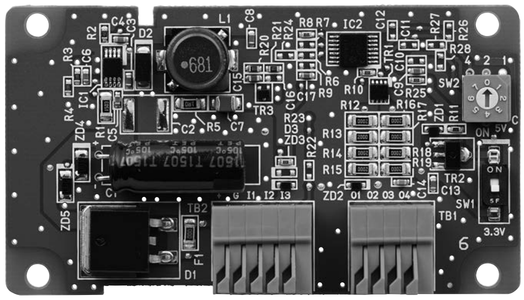

Fig. 6: PCB type

In this way, the Airflow Tester developed using new technology is having a significant impact not only in terms of equipment thermal design, but also in regard to fan selection in new fields such as ventilation.

For details on this product, please read SANYO DENKI Technical Report No. 42 (2016)

"Development of the *San Ace Airflow Tester* - A Measuring Device for System Impedance and Operating Airflow of Equipment."

4. PWM Controller

Many fans in the market use PWM control function to control a fan's airflow and rotational speed. This type of fan controls rotational speed using a PWM signal.

To do this, one must prepare a special-purpose control circuit but this requires specialist knowledge.

For this reason, SANYO DENKI developed and released the *San Ace PWM Controller* in 2016 which can be used together with the PWM controller-inclusive fan as a set.

This product is a standard controller that enables you to easily utilize PWM control function fans without special knowledge.

This product can share a DC power source with the PWM control function fans it is connected to. For this reason, we designed new control circuits and achieved a wide-operating voltage range from 7 to 60 VDC, making it compatible with all the SANYO DENKI fan's standard rated voltages 12 V, 24 V and 48 V.

This product is available in two types to suit our customers' specific application. These are the "box type", shown in Figure 5, and the "PCB type", shown in Figure 6.

For use in a variety of applications, the box type comes with functions to control the PWM signal through four types of inputs: voltage, variable resistor, thermistor, and the adjustment knob on the box. The four control functions are installed in the controller in advance, therefore by switching the control functions and input circuits with the selector switch enable it to output a PWM signal linked to each individual input. Below listed are the four types of control functions.

1) Voltage control:
   This function converts the voltage signal (0 to 5 V) from the customer to PWM output duty signal to control fan speed.
2) Variable resistor control:
   This function controls PWM output duty signal with externally-connected variable resistor.
3) Thermistor control:
   The PWM duty signal is automatically controlled by preset temperature (30 to 50°C) and the detected temperature with an external thermistor.
4) Adjustment knob control
   The PWM output duty signal is controlled by the adjustment knob on the box.

In regard to the PCB type, three models have been produced featuring one of the functions mentioned in 1) through 3) above.

The right *San Ace PWM Controller* to suit the particular application can be used, making it a user-friendly product.

SANYO DENKI is confident that this is an extremely effective solution for customers in a variety of fields that cannot easily design and fabricate controllers.

5. G Proof Fan

Inside CT scanners for medical use, the part which irradiates X-rays into the human body rotates at high speed. For this reason, the fan used to cool this portion is subjected to high levels of G-force.

CT scanners for medical use are expected to have even higher performance in the future, therefore fans that can operate in environments with even higher G-force will be needed.

In order to meet such requirements of the medical industry, SANYO DENKI has developed and commercialized *San Ace 120GP* and *San Ace 172GP* 9GP type G Proof Fans.

Figure 7 is an external view of the G Proof Fan.

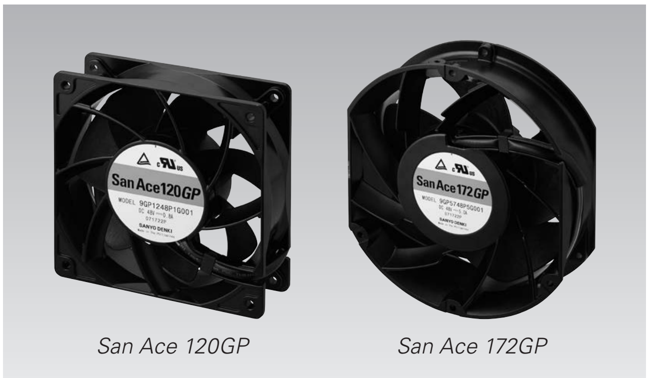

Fig. 7: G Proof Fan

By considering actual operating environment to extract problems when using a fan in environments with G-force and performing strength analysis using simulations, we have successfully produced a fan able to withstand G-force of up to 75G.

Each structures of this fan have been strengthened to withstand the target level of G-force.

An aluminum frame has been adopted. In order to improve the strength of rotating bodies (rotor, blade assembly, etc.), we have achieved a G-force tolerance of 75G by adopting a new structural design whereby each component is fixed, as well as adopted new material and shape.

For details, please read the article on this product in this Technical Report.

6. Conclusion

This article has introduced initiatives related to technologies offering value in new fields using the products developed by SANYO DENKI as examples.

We firmly believe we must continue to swiftly and accurately ascertain our customers' issues and requests, and constantly pursue fan technologies required by our customers. Then, leveraging these technologies, we will engage in the development of products offering value in new fields so that we may, together with our customers, provide products that make dreams come true.

References

(1) Toshiya Nishizawa and 3 others:
"ø136 mm × 28 mm Thick Reversible Flow Fan *San Ace 136RF* 9RF Type"
SANYO DENKI Technical Report No. 40 (2015)

(2) Katsumichi Ishihara and 4 others:
"Development of the *San Ace Airflow Tester*
– A Measuring Device for System Impedance and Operating Airflow of Equipment"
SANYO DENKI Technical Report No. 42 (2016)

Satoshi Fujimaki
Joined SANYO DENKI in 1982.
Cooling Systems Div., Design Dept.
Works on the development and design of cooling fans.