Expand into Wider Markets in Depth

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1. Introduction

SANYO DENKI's Cooling Systems Division has been developing and offering fans chiefly for the purpose of cooling the inside of equipment. Starting with AC fans, we developed brushless DC fans responding to changing market trends, and now we also offer ACDC fans, which are brushless DC fans that can be powered by AC power by internally converting AC power to DC power.

Conventionally, our fans have mainly been used in information and communication equipment such as in servers and ICT equipment. As this equipment has become smaller in size and higher in performance, cooling fans have been required to offer better performance—high airflow, high static pressure, and low power consumption. In response to this, we have developed new products using new technology.

These products have come to be used in various fields and applications in which fans had not previously been used. Also, new demands started to emerge, requiring new kinds of fans that support recent social and environmental trends, which we have not offered previously.

This article discusses the markets in which our cooling fans and related products have conventionally been used, as well as potential new markets into which we expect to expand in the future.

2. Our Conventional Markets

Here we introduce the conventional target markets for and the technology used in our Cooling Systems products.

2.1 Markets for high-performance fans

Conventionally, our fans have mainly been used in information and communication equipment such as in servers and ICT equipment. The popularization of technologies such as the Internet and mobile phones has led to an increase in capacity and speed of ICT equipment. As a result, this equipment has become sophisticated and smaller in size, becoming denser and generating more heat. In the early days of this market, high airflow of cooling fans had been in strong demand. However, as the heat generation of equipment increased, it has become increasingly necessary to develop "high-performance fans" featuring not only high airflow but also high static pressure to cool equipment more efficiently. Moreover, fans with less power consumption had also been demanded for preserving the global environment and lowering equipment running costs.

For example, 1U servers are the mainstream in the server market. Because of their small size, 1U (44.45 mm) servers typically use 40 × 40 mm brushless DC fans. Today's 1U servers are extremely dense inside and generate high heat, requiring fans with high airflow and high static pressure performance.

In response, we used to meet the required performance by using our old product developed in 1990s as a base and improving its speed by revising its drive circuit. However, simply increasing the fan speed was not enough to achieve the required airflow performance nor was it optimal power consumption-wise.

Fan performance is determined by (1) aerodynamic performance of the impeller and frame, (2) motor performance, and (3) drive circuit performance. It is therefore important to optimize each fan component so that these three performance parameters are increased with the overall balance of parameters also optimized.

To achieve higher static pressure, we formed the frame spokes (parts securing the motor to frame) located behind the impeller (rotor blades) into a blade-like shape (stator blades), which proved to be effective. With 40 × 40 × 28 mm axial fans, for example, we have offered the 9GV type (2008), 9GA type (2012), 9HV type (2015), and 9HVA type (2020) with progressive improvements in performance responding to the market demand at the time. Figure 1 shows the

change in product performance. Our latest 9HVA type fan delivers approximately 3.3 times higher maximum airflow of 1.05 m³/min and approximately 22.4 times higher maximum static pressure of 2300 Pa compared to our first product for 1U servers (9P type: 109P0412H3013).

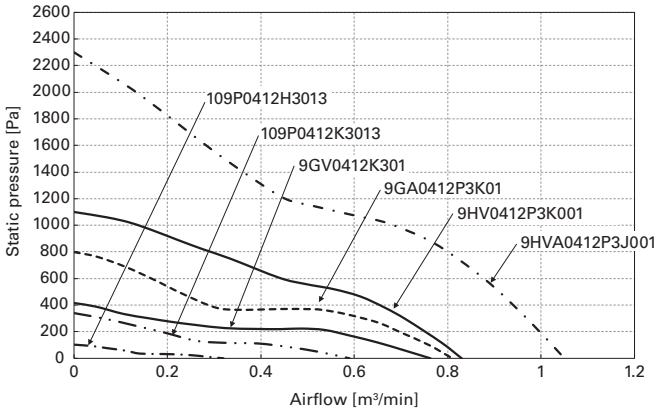

Fig. 1 Airflow vs. static pressure characteristics of our 40 × 40 × 28 fans

One way of achieving even higher static pressure is placing two fans in series, but the impact of the airflow discharged by the inlet fan with the rotor blades of the outlet fan causes a great loss, and therefore static pressure cannot be increased effectively. To resolve this issue, we newly developed a Counter Rotating Fan, where two fans rotating in opposite directions to each other are combined in series. This enabled us to significantly improve airflow characteristics. We have developed and offered 40 × 40 × 56 mm Counter Rotating Fans: the first one is the 9CR type in 2004, and followed by a few models, the 9CRH type in 2017 and 9CRJ type in 2020. Figure 2 shows a Counter Rotating Fan and its impellers. The 9CRJ type fan delivers approximately 1.5 times higher maximum airflow of 1.06 m³/min, and approximately 4.7 times higher maximum static pressure of 2400 Pa compared to the 9CR type, the first of the Counter Rotating Fan series.

As stated above, we have met high airflow and high static pressure requirements for information and communication equipment such as servers and ICT equipment, contributing to the development of this equipment. In short, we have pursued higher fan performance for use in relatively limited markets and applications, and therefore our fans have been used in and focused on a narrow range of markets.

Recent years, however, the use of such high-performance fans featuring high airflow, high static pressure, and low power consumption is not limited only to the ICT equipment market, and they are now being used in various applications where strong winds need to be sent in tight spaces.

The use of such fans has been growing particularly in the energy field, such as in solar power generation systems, storage batteries, fuel cells, fast EV chargers, and lithium-ion battery charge/discharge test equipment, expanding from the conventional narrow markets to wider markets.

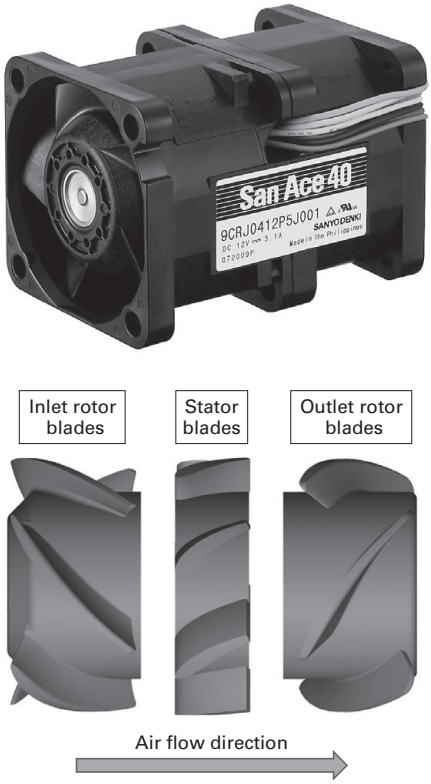

Fig. 2 Structure of our 40 × 40 × 56 mm Counter Rotating Fan

2.2 Markets for Splash Proof Fans

The first Splash Proof Fans were developed for cooling cellular base stations and launched in 1996. Cellular base stations are installed outdoors, and fans for cooling them require not only cooling performance (high airflow and high static pressure) but also environmental durability (water and temperature resistance) and long-term reliability. In response to these requirements, we have developed a series of Splash Proof Fans, which have contributed to the development of 3G, 4G, and 5G mobile communication networks.

Our Splash Proof Fans feature IP55, IP56, or IP68-rated water protection* as standard. As shown in Figure 3, protection from water intrusion is ensured by completely covering electrical live parts including the coil and circuit with highly water-resistant material. Moreover, components exposed to outside air including the magnet and frame employ highly water-resistant materials, and antirust treatment is done on the surface.

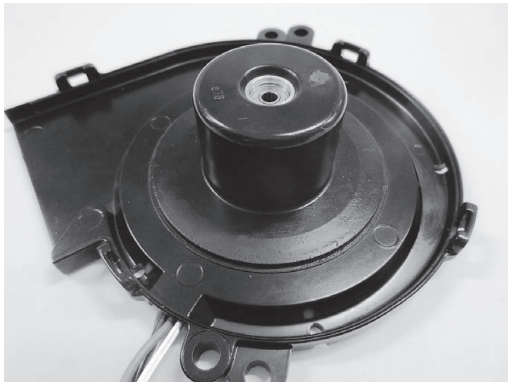

Fig. 3 Our Splash Proof Fan's live parts protection

* IP55/IP56/IP68 ingress protection rating
The degree of protection (IP code) is defined by IEC (International Electrotechnical Commission) 60529 "Degrees of Protection Provided by Enclosures (IP Code)."

Since around 2010, Splash Proof Fans have been adopted not only in conventional cellular base stations but also in new applications such as PV inverters, fast EV chargers, and digital signage. As with cellular base stations, these devices are installed outdoors and therefore require both cooling performance and environmental durability. We have met this demand by developing cooling fans featuring high airflow, high static pressure, and water protection, which contributed to the environment as high-performance fans are high-efficiency energy converting devices and environmentally friendly.

As described above, with water protection added to high airflow and high static pressure, our Splash Proof Fans have previously been employed mainly in applications for cooling equipment installed outdoors. They have pursued the high performance required in these limited applications, and their use has been limited to and focused on the narrow markets.

Recently, however, their use has been increasing in equipment installed indoors and also for non-cooling purposes as follows. The following applications use Splash Proof Fans because exposure to water is inevitable, but as they are non-cooling applications, high airflow or high static pressure is not necessarily required.

(1) Food manufacturing equipment:
This equipment needs to be kept clean, and fans are exposed to water when washing it. Therefore, Splash Proof Fans are required.
During a food processing using flour, fans are used to shake off excess flour or batter, which requires appropriate airflow and control of air direction.

(2) Plant cultivation equipment:
Splash Proof Fans are used as continuous operability in high humidity environments is required.
Appropriate airflow and control of air direction are required to circulate air uniformly inside equipment.

In this way, the application range of our Splash Proof Fan is not limited to outdoor equipment but has been expanding.

3. Expected Future Markets and Required Technology

Moving forward, companies are and will be expected to offer products and services that take environmental aspects into consideration, and achieving carbon neutrality is now a major challenge for the entire world.

The following sections will be introducing IoT-based preventive equipment maintenance and air purifier markets, which are expected to grow in the future.

3.1 For achieving carbon neutrality

Like many countries, Japan has declared its intention to "achieve carbon neutrality (net-zero emissions of greenhouse gases) by 2050."

To make our Cooling Systems products compliant with carbon neutrality, we currently believe that pursuing low power consumption is the most effective way to go regardless of the application. It is expected that demand for low power consumption will be more and more strong in the future. For our fans, we intend to achieve even higher-performance fans with lower power consumption by improving the three performance metrics mentioned in section 2.1.

Moreover, we will help customers achieve low power consumption by expanding our fan lineup with the addition of PWM control models enabling optimum control of fan speed according to the amount of heat generated by equipment, we are helping customers reduce the amount of power consumed by their equipment by expanding our lineup of fans equipped with a speed control function using PWM control.

3.2 Markets for IoT-based preventive facility maintenance

There has been a market demand for a device featuring remote control and status monitoring of fans for preventive equipment maintenance and efficient cooling and ventilation with various sensors combined. In response to this, we developed and launched the *San Ace Controller*, an

IoT-based product.

Figure 4 shows an example system configuration of the *San Ace Controller*.

It enables remote control of fans for efficient cooling of equipment, contributing to the aforementioned reduced equipment power consumption. Moreover, measurement data and alarm history generated during status monitoring can be downloaded to a computer, and this data can be used not only for equipment preventive maintenance but also for new product development and defect analysis. This can contribute to stable equipment operation, helping make equipment even safer and more reliable.

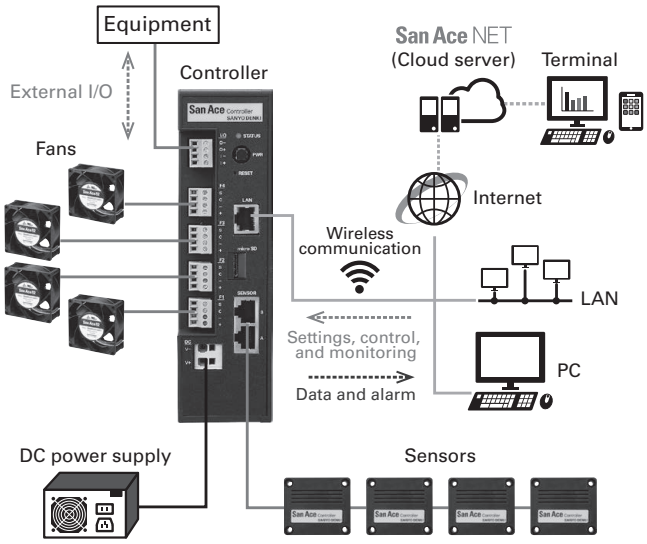

Fig. 4 *San Ace Controller* system configuration example

3.3 Markets for air purifiers

In recent years, demand for air purifiers has been growing in response to worsening air pollution and the spread of COVID-19, and the market for these products has been booming.

Conventionally, SANYO DENKI had had only limited involvement with this market by only providing fans to some air purifier manufacturers. However, by leveraging our expertise in fan technology and know-how in high-efficiency air flow channel design, we made the decision to develop and commercialize our own air purifiers for this market.

The air purifier we developed is shown in Figure 5. This air purifier is capable of delivering high airflow of 16.5 m^3/min and cleaning a large 127 m^2 space in only 30 minutes. Noise produced during operation is a mere 54 dB(A), and only 90 W of power is consumed.

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

Fig. 5 *San Ace Clean Air* 9AP type air purifier

4. Conclusion

This article introduced past and current target markets for our cooling fans and related products, and discussed our expected future markets and technologies.

We have conventionally focused on increasing the performance demanded by the information and communication equipment markets. In recent years, however, the high-performance products we've developed have found new opportunities in a variety of fields and applications: such as in the energy field, typified by solar power generation, and for non-cooling purposes in food manufacturing equipment.

We have also released new kinds of products leveraging our specialty technology and know-how, such as IoT-based products for equipment preventive maintenance and the air purifier that use our fans.

Applications for our fans have expanded from the previous "narrow markets in depth" where we pursued high performance in specific markets to "wider markets in depth" by targeting a wide variety of fields leveraging our technical expertise, as well as new fields where demand for fans is emerging.

We intend to continue identifying more new market needs for our products and contributing to solving our customers' problems in wider markets by developing new technologies and new products.

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