Cooling Fans Contributing to Effective Use of Power

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1. Introduction

In recent years, effective use of limited energy resources has become important topic in attempt to control global warming. In Japan, motors likely account for 60% to 70% of the total power consumption for industrial use[(1)]. In addition, high efficiency of fans used for various applications and providing products equipped with high cooling performance with low power is a continuing issue. Regarding IT equipment and communication equipment, power is especially consumed a lot according to high performance and high efficient parts are required. Fans are no exception. Furthermore, for power generating devices including residential use fuel cells, high efficiency component parts, including fans, are demanded to keep the power consumed by the devices themselves to a minimum.

Sanyo Denki develops fans along a strategy of providing top performance in the industry. Since 2009, Sanyo Denki has led the industry with the development of the "San Ace" GA type, which was designed to have dramatically lower power consumption compared to conventional models, and we have supplied to market with a lineup of 12 products from 40 mm sq., 15 mm thick models to 92 mm sq., 38 mm thick models.

Sanyo Denki also has a lineup of 12 counter rotating fans to cover high air flow and high static pressure areas, which are supplied to markets for IT equipment and communications equipment.

This document first introduces low power consumption fans and counter rotating fans as cooling fans that contribute to effective use of power. Then, this document introduces variable speed fans that incorporate speed control function that make further effective use of power possible.

2. Effective Use of Power in Low Power Consumption Fans

When developing a product, minimizing the energy required for the entire lifecycle of the product, from supplying parts to manufacture, distribution, use, and disposal, must be taken into consideration from the perspective of reducing global warming. Fig. 1 shows the calculation of the required energy[(Note 1)] for each processes from purchasing parts to disposal for one fan using the 80 mm sq., 38 mm thick GA type model[(2)] as an example, based on Sanyo Denki's environmentally compatible product design standards. The energy required for each processes, including purchasing, manufacture, distribution, and disposal, is 10Mcal or less, but the necessary energy when using the product is more than 1000Mcal, a significantly large value. This indicates that reducing the power consumed when using the product can minimize the energy required over the fan's entire lifecycle. In other words, developing products that achieve high cooling performance with low power is very important.

With the development of the low power consumption fan GA type, the goal was to reduce the power consumption even further when the fans are mounted into customers' devices.

Normally, as motors become bigger, manufacturers gain freedom degree for the dimensions of each parts and it becomes easier to improve efficiency, but for fans, as the motors become bigger, manufacturers lose freedom degree in terms of the dimensions of the fans and optimal shapes are limited. Furthermore, as the external diameter of the motor become bigger, airflow pass area in the frame become smaller and the air flow through the airflow pass is bigger, which is disadvantage to low SPL (Sound Pressure Level). With these issues in mind, the optimal impeller and frame shape was discovered in order to achieve the air flow versus static pressure characteristics demanded by customers, and the motor and electric circuit conditions

to improve efficiency as much as possible when rotating the impeller was also discovered. By repeating numerical simulations using magnetic field analysis software and fluid analysis software, prototypes, and performance verification, we discovered the combination that achieves the highest performance.

This document introduces the results of comparing the power consumption between the conventional G type / GV type and the low power consumption GA type in the operating range, using the 80 mm sq., 38 mm thick size fans as an example. Fig. 2 shows the air flow versus static pressure characteristics and the air flow versus power consumption characteristics with each fan running at the same air flow. As described in Table 1, assuming that the GA type has power consumption of 100% the G type has power consumption of 125% to 150% and the GV type has 117% to 146%. From this, the low power consumption GA type model has lower power consumption compared to the conventional model in the operating range and therefore it can be said to be a cooling fan that contributes to the effective use of power.

We currently have lineup of 12 products, all of which have achieved low power consumption that is top of the industry: 40 mm sq., 15 mm thick; 40 mm sq., 20 mm thick; 40 mm sq., 28 mm thick; 52 mm sq., 15 mm thick; 60 mm sq., 15 mm thick; 60 mm sq., 20 mm thick; 60 mm sq., 38 mm thick; 80 mm sq., 32 mm thick; 80 mm sq., 20 mm thick; 80 mm sq., 38 mm thick; 92 mm sq., 25 mm thick; 92 mm sq., 38 mm thick.[Note 2) (3)] Fig. 3 shows the appearance of the low power consumption series.

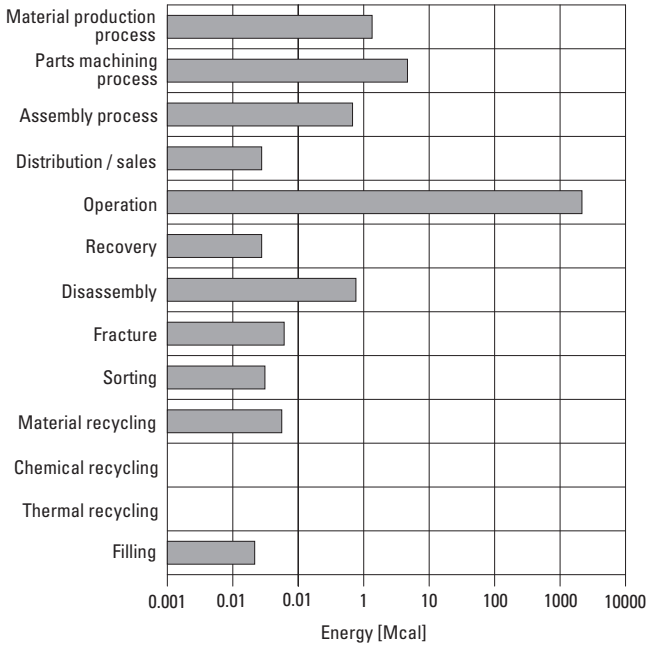
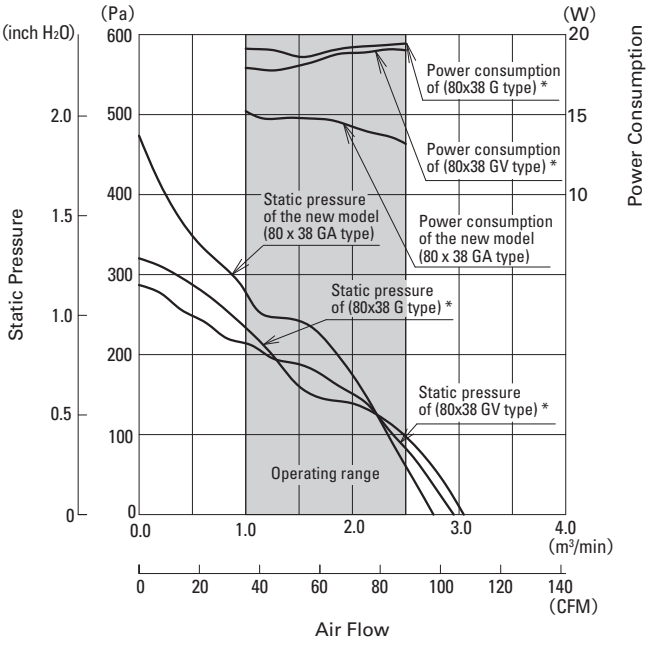


Fig. 1: Energy consumption for the product lifecycle (80 mm sq., 38 mm thick GA type model 9GA0812P1H61)



* When fan is running at the same performance as the new model.

Fig. 2: Comparison of consumption power in the operating range (80 mm sq., 38 mm thick fan)

Table 1: Comparison of power consumption in the operating range (80 mm sq., 38 mm thick fan)

	Power [W]	Ratio [%]
Conventional model G type	19.1 to 19.5	125 to 150
Conventional model GV type	17.9 to 19.0	117 to 146
Low power consumption GA type	15.3 to 13.0	100

Fig. 3: Low power consumption fan series

3. Effective Use of Power in Counter Rotating Fans

If one fan has insufficient cooling performance, one method used to compensate for the insufficient performance is operating fans in tandem.

However, for IT equipment such as 1U servers, the heat grows dramatically and there were cases where even two fans operated in series could not produce the necessary air flow.

For this situation, Sanyo Denki developed counter rotating fans that combine two axial flow fans and use a method where the front and back driving blades rotate in opposite directions[4]. As a first stage, in 2003, the 40 mm sq., 56 mm thick CR type[5] was provided to the market. This later developed into a lineup of 12 counter rotating fans to meet market demands: 38 mm sq., 48 mm thick, 40 mm sq., 48 mm thick, 40 mm sq., 56 mm thick, 60 mm sq., 51 mm thick, 60 mm sq., 76 mm thick, 80 mm sq., 80 mm thick, 120 mm sq., 76 mm thick, and ϕ 172 x 150 x 102 mm thick models. These products have been continuously used in servers and communication equipment as essential parts. Fig. 4 shows a photograph of the counter rotating fan series.

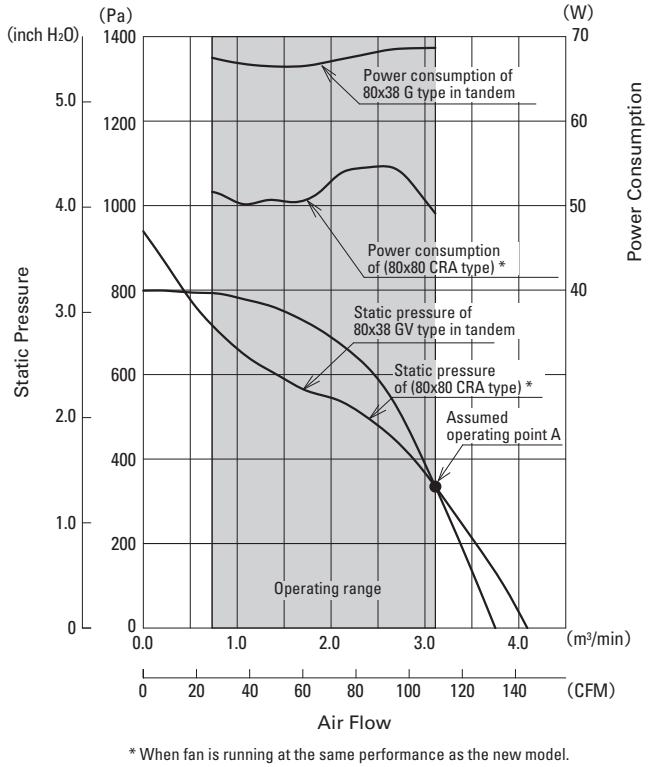
Fig. 5 shows the air flow versus static pressure characteristics and air flow versus power consumption characteristics when the 80 mm sq., 38 mm thick GV type is operated in tandem and when the 80 mm sq., 80 mm thick CRA type counter rotating fan is operated at the same air flow. As shown in Table 2, the power consumption in the operating range is approximately 30% to 44% lower for the counter rotating fan compared to the tandem operations.

If the fan was operated at the operation point A in Fig. 5, the power consumption for tandem operations would be 68.6 W. On the other hand, operating one counter rotating fan at the same air flow would be 47.6 W. If the fans were run continuously for one year in these states, the difference in power consumption would be 183 kWh. When calculated in terms of electricity costs, the conventional fans would cost approximately 3,660 yen.

- Difference in power consumption when run continuously for one year
  (68.6-47.6)(W) × 24(h) × 365(days) = 183 (kWh)
- Difference in electricity costs for one year
  183(kWh) × 20(yen/kWh) = 3,660 (yen)
- Assuming electricity costs of 20 JPY per 1 kWh

From this, it can be said that counter rotating fans contribute to greater effective use of power compared to two fans operated in tandem.

Fig. 4: Counter rotating fan series



* When fan is running at the same performance as the new model.

Fig. 5: Comparison of power consumption in the operating range
(80 mm sq., 38 mm thick in tandem, 80 mm sq. counter rotating fan)

Table 2: Comparison of power consumption in the operating range
(80 mm sq., 38 mm thick GV tandem, 80 mm sq., 80 mm thick counter rotating CRA fan)

	Power consumption [W] (within the operating range)	Ratio of power consumption [%]
80 mm sq., 38 mm thick GV type tandem	67.2 to 68.6	130 to 144
80 mm sq., 80 mm thick counter rotating CRA type (when running at the same air flow)	51.4 to 47.6	100

4. Effective Use of Power with Speed Control Technology

As for BLDC fan generally, when the rotating speed decreases, the air flow decreases in proportion to the rotating speed and the power consumption decreases with the cube of voting speed. When there is surplus cooling performance, lowering the air flow by reducing the rotating speed can simultaneously reduce power consumption. Sanyo Denki developed and provided to market fans equipped with temperature sensors that can adjust the rotation speed depending on the temperature with thermally speed controlled fans or fans that can control the rotating speed through control lines from the equipment.

Table 3 shows the types and characteristics of typical variable speed fans. In recent years, customers have wished for more detailed air flow controls depending on heat generation, so demand has grown for PWM control fans that can provide detailed speed controls. Sanyo Denki includes this feature as a standard specification in many new models.

By using these variable speed fans to obtain only necessary air flow depended on the situation, the fans can contribute to effective use of power.

Table 3: Typical variable speed fan types and characteristics

Types	Overview	Characteristics	Example fan models
Dual speed fan	Controls low speed or high speed with the L or H signal input to the control line from the equipment	Useful to control two speeds: low speed and high speed	9G1212EG101 (Standard)
Thermally speed controlled fan	Controls speed depending on the detected temperature from temperature sensors in the interior or on the exterior of the fan	No need to use temperature sensors or control circuits on the equipment	9G1212T4Gxx (Custom product)
Voltage control fan	Controls speed depending on the size of the voltage input into the control line from the equipment	Controls speed with analog input (voltage)	9G1224V1G01 (Standard)
PWM control fan	Controls speed depending on duty from the PWM signal input into the control line from the equipment	Can provide detailed control due to the digital input (PWM signal)	9GV1212P1J01 (Standard)

5. Conclusion

This document introduced how fans developed by Sanyo Denki contribute to effective use of power, using the low power consumption fan and counter rotating fan as examples. Furthermore, it introduced variable speed fans that can contribute to further effective use of power by using speed control technology that can control the fan rotating speed as necessary.

By using these fans and technologies developed by Sanyo Denki, customers' equipment can not only save energy, but also contribute to suppressing global warming. We will continue to pursue high efficiency technologies for fans and develop products that deliver low power consumption and high performance.

Note 1: Conditions for example of required energy calculations during a product's lifecycle
- Fan model number: 9GA0812P1H61
- Operating conditions: Rated input, free air, continuous operations, room temperature
- Running conditions: Running 24 hours a day, 365 days a year
- Assumed total run time: 40,000 hours (4.56 years)
- Transportation method: Two ton truck

Note 2: When each fans were released

Documentation

(1) The Institute of Applied Energy:
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(3) Katsumichi Ishihara: "Cooling Fans that Contribute to Energy Conservation Products"
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(4) Yoshihiko Aizawa: "Cooling System Technology That Changes The Conventional Trend"
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(5) Honami Oosawa and Others: "'San Ace 40' Counter Rotating Fan"
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