High Airflow, Long Life, Splash Proof Fans "San Ace 60W", "San Ace 80W", "San Ace 92W"

Katsumichi Ishihara   Akira Nakayama   Tatsuya Midorikawa   Masato Kakeyama

1. Introduction

From the perspective of protecting the global environment, photovoltaic generation, electric vehicles etc. become rapidly popular in recent years. In line with this, the demand for equipment is installed outdoors has increased and these are installed in a diversity of places over a wide area, therefore achieving maintenance-free is essential. Moreover, emphasis is being placed on higher performance and downsizing of equipment, and enhancing the cooling performance for the equipment interior is necessary due to higher density of components.

Here we introduce the features and performance of 3 models, the "San Ace 60W", "San Ace 80W" and "San Ace 92W" 9WL types, which are high airflow, long life, splash proof fans commercialized in order to satisfy the requirements of this kind of eco-business market.

2. Background of the Development

Sanyo Denki has been producing and selling splash proof fans for many years. Splash proof fans offer water protection suitable for equipment installed outdoors such as photovoltaic inverters and EV rapid chargers. However, regarding the splash proof fan, a reguirement of the high airflow is gradually increased according to increase of the heat generation due to high density system as a result of high performance and down-sizing of the system. In addition to this, there is a strong requirement of maintenance-free and longer life for equipment used for a prolonged period, such as photovoltaic inverters which are used for approx. 20 years.

To fulfill these requirements, Sanyo Denki has commercialized 3 new models of 9WL type splash proof fans which are high airflow, long life (hereinafter "3 new models" or "new models").

3. Product Features

Fig. 1, 2, and 3 show the three new models.

Fig. 1: "San Ace 60W"

Fig. 2: "San Ace 80W"

Fig. 3: "San Ace 92W"

The new models have maintained compatibility with the conventional splash proof fans in regards to fan size and mounting hole position, at the same time as achieving higher airflow and longer life.

The features of the new models are as follows:

(1) Dust proof and splash proof performance: Protection class IP68[*1]
(2) High airflow
(3) Long life
(4) PWM control function

The following indicates the features of a structure that has realized dust proof and splash proof for protection class IP68:

(1) The conductor part (winding, PCB) is protected using a highly resistant material to splash. (Fig. 4)

Fig. 4: Coating of the conductor part

(2) Magnetic materials is also highly resistant to splash compared to that for regular fans
(3) Antirust agent is applied to necessary parts

4. Product Overview

4.1 Dimensions

The new models have maintained compatibility with the conventional splash proof fans in regards to fan external dimensions, mounting hole position and so on.

4.2 Expected life

The new model has an expected life of 180,000 hours (approx. 20 years) at 60˚C (survival rate of 90% with continuous operation at the rated voltage under free air conditions and at normal humidity).

4.3 Characteristics

4.3.1 General characteristics

Tables 1, 2 and 3 give the respective general characteristics of the 3 new models.

4.3.2 Airflow vs. static pressure characteristics

Figures 5, 6 and 7 show the respective airflow vs. static pressure characteristics of the 3 new models.

4.3.3 PWM control function

The 3 new models have a PWM control function and speed control is possible.

Table 1: General characteristics of “San Ace 60W”

Model No.	Rated voltage [V]	Operating voltage [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. airflow		Max. static pressure		SPL [dB(A)]	Operating temperature [˚C]	Expected life [h]
							[m^3/min]	[CFM]	[Pa]	[inchH$_2$O]			
9WL0612P4S001	12	10.8 to 13.2	100	0.67	8.04	11,000	1.40	49.4	300	1.204	53	-20 to +70	180,000
			20	0.06	0.72	2,900	0.36	12.7	20.8	0.083	20		
9WL0612P4J001			100	0.39	4.68	8,650	1.10	38.8	182	0.730	47		
			20	0.03	0.36	1,150	0.13	4.8	3.3	0.013	14		
9WL0612P4H001			100	0.17	2.04	6,150	0.78	27.5	97	0.389	36		
			20	0.03	0.36	1,350	0.17	6.0	4.7	0.018	14		
9WL0624P4S001	24	21.6 to 26.4	100	0.34	8.16	11,000	1.40	49.4	300	1.204	53		
			20	0.03	0.72	2,900	0.36	12.7	20.8	0.083	20		
9WL0624P4J001			100	0.19	4.56	8,650	1.10	38.8	182	0.730	47		
			20	0.02	0.48	2,200	0.28	9.8	12.0	0.048	17		
9WL0624P4H001			100	0.08	1.92	6,150	0.78	27.5	97	0.389	36		
			20	0.02	0.48	1,300	0.16	5.6	4.3	0.017	14		

Note: Speed is 0 min^{-1} at 0% PWM duty cycle

* Input PWM frequency: 25 kHz

Table 2: General characteristics of “San Ace 80W”

Model No.	Rated voltage [V]	Operating voltage [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. airflow		Max. static pressure		SPL [dB(A)]	Operating temperature [°C]	Expected life [h]
							[m^3/min]	[CFM]	[Pa]	[inchH$_2$O]			
9WL0812P4J001	12	10.8 to 13.2	100	0.6	7.2	7,400	2.07	73.0	177	0.71	49	-20 to +70	180,000
			20	0.06	0.72	1,800	0.50	17.6	10.4	0.04	16		
9WL0812P4G001			100	0.30	3.60	5,500	1.54	54.3	98	0.39	43		
			25	0.05	0.60	1,400	0.39	13.7	6.3	0.02	14		
9WL0812P4H001			100	0.12	1.44	3,700	1.03	36.3	44	0.17	31		
			25	0.04	0.48	1,100	0.30	10.5	3.9	0.01	13		
9WL0824P4J001	24	21.6 to 26.4	100	0.28	6.72	7,400	2.07	73.0	177	0.71	49		
			20	0.05	1.20	2,400	0.67	23.6	18.6	0.07	22		
9WL0824P4G001			100	0.14	3.36	5,500	1.54	54.3	98	0.39	43		
			20	0.02	0.48	1,200	0.33	11.6	4.6	0.01	13		
9WL0824P4H001			100	0.05	1.2	3,700	1.03	36.3	44	0.17	31		
			30	0.02	0.48	1,100	0.30	10.5	3.9	0.01	13		

Note: Speed is 0 min^{-1} at 0% when PWM duty cycle

* Input PWM frequency: 25 kHz

Table 3: General characteristics of “San Ace 92W”

Model No.	Rated voltage [V]	Operating voltage [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. airflow		Max. static pressure		SPL [dB(A)]	Operating temperature [°C]	Expected life [h]
							[m^3/min]	[CFM]	[Pa]	[inchH$_2$O]			
9WL0912P4J001	12	10.8 to 13.2	100	0.42	5.04	5,000	2.2	77.7	105	0.42	44	-20 to +70	180,000
			20	0.04	0.48	1,200	0.52	18.4	6.04	0.024	11		
9WL0912P4G001			100	0.30	3.60	4,400	1.93	68.2	81	0.33	40		
			20	0.04	0.48	1,000	0.43	15.1	4.18	0.016	8		
9WL0912P4S001			100	0.22	2.64	3,850	1.69	59.7	62.1	0.25	37		
			30	0.04	0.48	1,400	0.61	21.5	8.21	0.032	13		
9WL0912P4H001			100	0.15	1.80	3,150	1.38	48.7	41.6	0.17	32		
			30	0.04	0.48	1,100	0.48	16.9	5.07	0.020	9		
9WL0924P4J001	24	21.6 to 26.4	100	0.21	5.04	5,000	2.2	77.7	105	0.42	44		
			20	0.02	0.48	1,100	0.48	16.9	5.07	0.020	9		
9WL0924P4S001			100	0.11	2.64	3,850	1.69	59.7	62.1	0.25	37		
			30	0.02	0.48	1,300	0.57	20.1	7.08	0.028	12		
9WL0924P4H001			100	0.07	1.68	3,150	1.38	48.7	41.6	0.17	32		
			30	0.02	0.48	1,000	0.43	15.1	4.18	0.016	8		

Note: Speed is 0 min^{-1} at 0% PWM duty cycle

* Input PWM frequency: 25 kHz

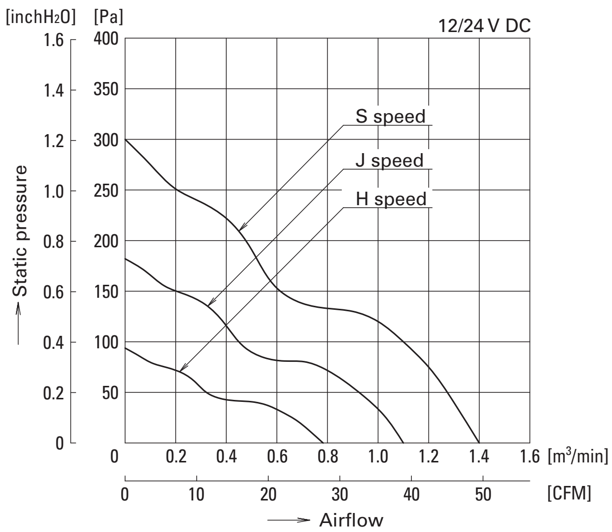

Fig. 5: Airflow vs. static pressure characteristics of “San Ace 60W”

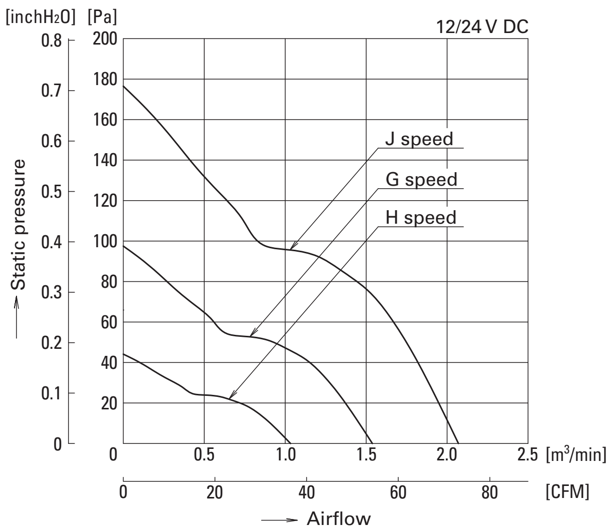

Fig. 6: Airflow vs. static pressure characteristics of “San Ace 80W”

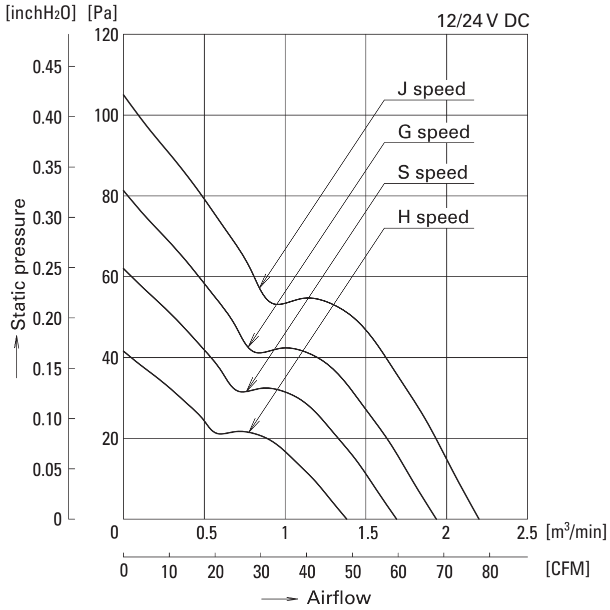

Fig. 7: Airflow vs. static pressure characteristics of “San Ace 92W”

5. Comparisons with our Conventional Models

Here we introduce the characteristic differences between the new model and our conventional model.

5.1 Comparison of expected life

Tables 4, 5, and 6 compare the expected life and other general characteristics between the new model and conventional model. The values shown represent the maximum performance products of each model.

The new models have significantly enhanced cooling performance. Furthermore, the new models have achieved an expected life of 180,000 hours (approx. 20 years) at 60°C (survival rate of 90% with continuous operation at the rated voltage under free air conditions and at normal humidity). Which is 4.5 times life than conventional fans, which was 40,000 hours (approx. 4.5 years).

5.2 Comparison of airflow vs. static pressure

Fig. 8, 9, and 10 show the airflow vs. static pressure characteristics between the conventional model and the new model.

Compared with conventional models, the new models have 1.2 to 1.7 times maximum airflow and 1.5 to 3.4 times maximum static pressure, thus achieving higher cooling performance.

Table 4: Comparison between new model “San Ace 60W” and a conventional model

	Expected life [h]	Max. airflow [m³/min]	Max. static pressure [Pa]	Power consumption [W]
New model 9WL0612P4S001	180,000	1.4	300	8.04
Conventional model 9WP0612G401	40,000	0.78	87.3	2.52

Table 5: Comparison between new model “San Ace 80W” and a conventional model

	Expected life [h]	Max. airflow [m³/min]	Max. static pressure [Pa]	Power consumption [W]
New model 9WL0812P4J001	180,000	2.07	177	7.2
Conventional model 9WP0812G401	40,000	1.5	80.4	4.56

Table 6: Comparison between new model “San Ace 92W” and a conventional model

	Expected life [h]	Max. airflow [m³/min]	Max. static pressure [Pa]	Power consumption [W]
New model 9WL0912P4J001	180,000	2.2	105	5.04
Conventional model 9WP0924G401	40,000	1.76	66.5	4.56

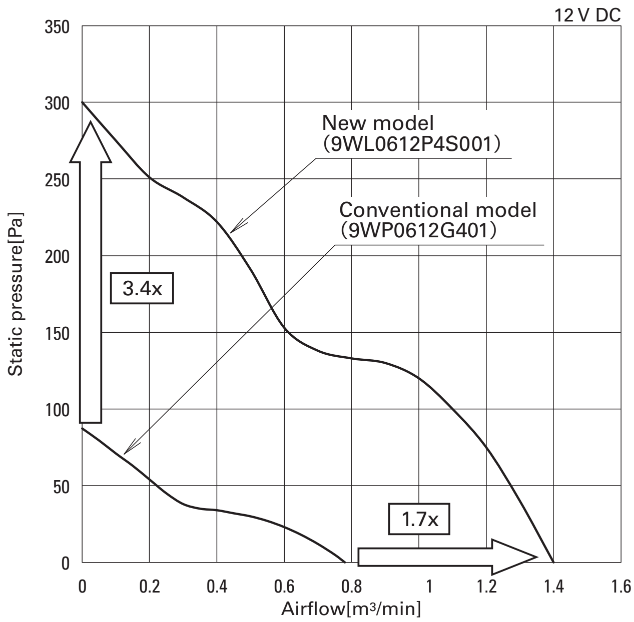

Fig. 8: Airflow vs. static pressure characteristics of “San Ace 60W”New/conventional model comparison

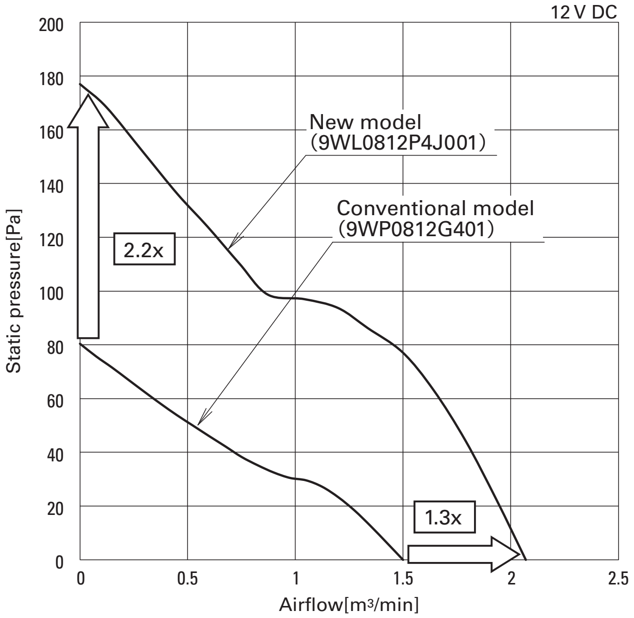

Fig. 9: Airflow vs. static pressure characteristics of "San Ace 80W" New/conventional model comparison

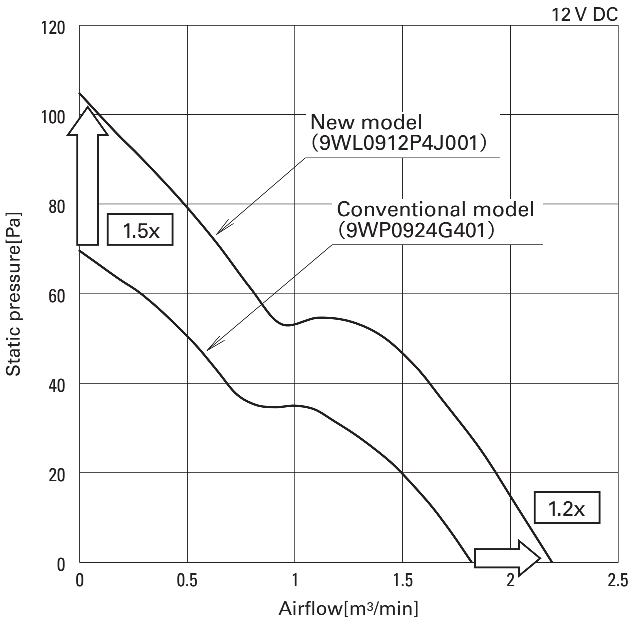

Fig. 10: Airflow vs. static pressure characteristics of "San Ace 92W" New/conventional model comparison

6. Technology Achieving Both Higher Airflow and Longer Life

The new models have been designed to maintain water protection achieving a higher airflow and longer life than conventional models.

The below 3 elements contribute to the fans' higher airflow.

(1) Optimization of impeller shape
(2) Optimization of frame shape
(3) Adoption of a high speed motor

The below 3 elements contribute to the fan's long life.

(1) Selection of components with minimal aging and deterioration
(2) Derating of the motor drive circuit
(3) Reduced impact on bearing life

For the new models, the impeller shape has been optimized in order to achieve higher airflow, and impact on bearing life has been reduced in order to achieve longer life. Bearing life in particular affects the fan's life, therefore the new models were designed with emphasis on reducing the load applied to bearings and minimizing bearing temperature rise. As a result, it was possible to minimize motor heat generation and bearing temperature rise by improving efficiency of the motor and drive circuit, despite use of a high speed motor.

The next section will briefly introduce the components and structural design which contributed to developing a new model that offers water protection while achieving both reduced impact on bearing life and enhanced cooling performance, as well as significantly improved airflow and life compared with conventional models.

6.1 Impeller shape

The new impeller design contributed to improvement of airflow efficiency, achievement of high airflow and reduction of power, thus we succeeded reduction of bearing temperature rise. Fig. 11 gives a comparison of the respective impeller shapes for the conventional and new models.

Conventional model New model

Fig. 11: Comparison of impeller shape between our conventional model and the new model

6.2 Frame

An aluminum die-cast with an integrated bearing house structure was adopted for the frame. Compared with plastic frames, this frame has high heat conductivity and excellent heat dissipation, allowing heat from the motor to dissipate effectively and minimizing the rise in bearing temperature.

Aluminum die-cast is high stiffness than plastic and as such provides better durability.

Moreover, by applying a coat to the surface of the aluminum die-cast frame, it is protected from corrosion such as rust caused by the external environment. This allows it to be used for an extended period of time even in environments where it is exposed to water.

Fig. 12: No coating (left) and with coating (right)

6.3 Motor and circuit

In order to avoid malfunction of conductor part (motor, circuit) due to water ingress, a plastic coating such as that shown in Fig. 4 must be applied. However, applying a coat to conductor part makes it difficult for the heat generation from the winding to dissipate.

In light of this, we developed the stator shape and increased the winding space factor to improve motor efficiency. We also reviewed the drive IC and semiconductor of the circuit. Furthermore, by adopting a highly efficient drive mode, we achieved low power consumption and succeeded in reducing winding temperature rise.

This made it possible to achieve low power consumption despite using a high speed motor and reduce motor winding heat generation a plastic coating on the conductor part, thus successfully suppressing bearing temperature rise.

7. Conclusion

This document introduced some of the features and advantages of the three newly developed high airflow, long life, splash proof fans “San Ace 60W”, “San Ace 80W”, and “San Ace 92W”.

The all 3 new models maintain mounting compatibility with the conventional models while achieving significantly improved high airflow and longer life. This has resulted in a product which contributes to a reduced number of fans per equipment, less installation space, maintenance-free application and fewer fan replacements (no. of units).

Sanyo Denki believes that our high airflow, long life, splash proof fans will also contribute largely in the category of global environment conservation.

Footnotes

*1: Shows the protection class of the “San Ace W” series.
Specified in 60529 “DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP code)” by IEC (International Electrotechnical Commission).
* IEC 60529: 2001
The IP code is defined as “a system that uses codes to indicate the class of protection for the outer framework against water ingression, foreign particle ingression, access to hazardous parts, or other additional items”.
The first digit “6” : Dustproof shape (no dust penetration)
The second digit “8” : Underwater shape (no water penetration causing harmful effect even underwater)

Reference

(1) Akira Nakayama and others: Splash Proof Fan “San Ace 92W” WP Type
SANYO DENKI Technical Report No.24 p17-19 (2007-11)

(2) Kakuhiko Hata and others: High Air Flow, High Static Pressure Splash Proof Fan “San Ace W”
SANYO DENKI Technical Report No.32 p20-24 (2011-11)

Katsumichi Ishihara
Joined Sanyo Denki in 2001.
Cooling Systems Division, Design Dept.
Worked on the development and design of cooling fans.

Akira Nakayama
Joined Sanyo Denki in 2005.
Cooling Systems Division, Design Dept.
Worked on the development and design of cooling fans.

Tatsuya Midorikawa
Joined Sanyo Denki in 2009.
Cooling Systems Division, Design Dept.
Worked on the development and design of cooling fans.

Masato Kakeyama
Joined Sanyo Denki in 2013.
Cooling Systems Division, Design Dept.
Worked on the development and design of cooling fans.