High Air Flow and Long Life Fan "San Ace 60L", "San Ace 80L", "San Ace 92L"

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1. Introduction

In recent years, much longer life and environment-conscious product are required while market of information/communication device and recyclable energy are increasingly expanded. At the same time, in line with demand for products to have higher performance and be more compact, there is also requirement for equipment to be higher-density and have more efficient internal cooling. Moreover, there is growing demand for fans installed in these products to be maintenance-free and have high air flow by having even longer life.

Here we introduce features and abilities of three kinds of high air flow and long life fans "San Ace 60L", "San Ace 80L" and "San Ace 92L" 9LG, developed in response to this kind of market demand.

2. Background of the Development

Sanyo Denki has produced and sold long life fan, L-type so far. However, as already mentioned, according to the longer life of communication devices, reusable energy devices and environmental business devices, the higher equipment impedance due to high density equipment and the greater heat generation, a demand has emerged for replaceable parts such as the cooling fan to have much longer life and higher air flow in order to enable the maintenance-free of long-term use devices.

However, it was impossible to increase air flow of the conventional long life fans in order to respond to these demands, therefore Sanyo Denki developed the three kinds of new 9LG fans which achieve both long life and high air flow.

3. Product Features

Fig. 1, 2, and 3 show photographs of three new models. The features of these new models are as follows:

(1) High air flow
(2) Long life
(3) PWM control function

As for new models, high air flow and long life have been achieved maintaining compatibility with the fan size and mounting hole positions of conventional models.

Fig. 1 Profile of new "San Ace 60L" model

Fig. 2 Profile of new "San Ace 80L" model

Fig. 3 Profile of new "San Ace 92L" model

4. Product Overview

4.1 Dimensions

The dimensions of three new models are shown in Fig. 4, 5 and 6. Fan size and mounting dimensions are compatible with ones of conventional long life fan.

4.2 Expected life

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

4.3 Characteristics

4.3.1 General characteristics

The general characteristics of three new models are shown in Tables 1, 2 and 3.

4.3.2 Air flow vs. static pressure characteristics

The air flow vs. static pressure characteristics of three new models are shown in Fig. 7, 8 and 9.

4.3.3 PWM control function

The air flow vs. static pressure characteristics at individual PWM duty cycle of three new models are shown in Fig. 10, 11 and 12.

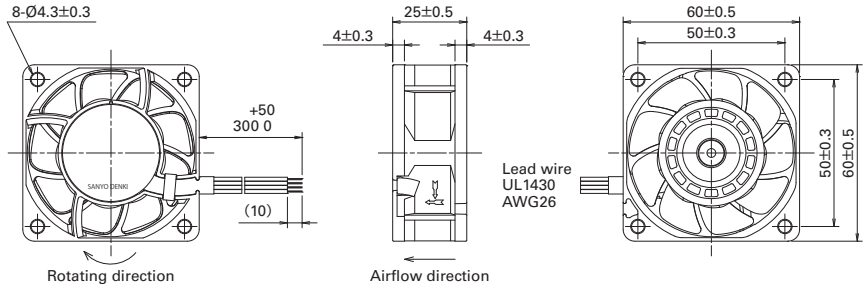


Fig. 4: Dimensions of new model “San Ace 60L” (unit: mm)

Table 1: General characteristics of new model “San Ace 60L”

Model No.	Rated voltage [V]	Operating voltage [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. air flow [m^3/min]	Max. air flow [CFM]	Max. static pressure [Pa]	Max. static pressure [inchH$_2$O]	SPL [dB(A)]	Operating temperature [˚C]	Expected life [h]
9LG0612P4S001	12	10.8 to 13.2	100	0.67	8.04	11000	1.40	49.4	300	1.204	53	-10 to +70	180,000
			20	0.06	0.72	2900	0.36	12.7	20.8	0.083	20		
9LG0612P4J001			100	0.39	4.68	8650	1.10	38.8	182	0.730	47		
			20	0.03	0.36	850	0.10	3.5	1.8	0.007	14		
9LG0612P4H001			100	0.17	2.04	6150	0.78	27.5	97	0.389	35		
			20	0.03	0.36	1350	0.17	6.0	4.7	0.018	14		
9LG0612P4M001			100	0.09	1.08	4200	0.53	18.7	45.0	0.180	24		
			20	0.03	0.36	900	0.11	3.8	2.0	0.008	14		
9LG0624P4S001	24	21.6 to 26.4	100	0.34	8.16	11000	1.40	49.1	300	1.204	53		
			20	0.03	0.72	2900	0.36	12.7	20.8	0.083	20		
9LG0624P4J001			100	0.19	4.56	8650	1.10	38.8	182	0.730	47		
			20	0.02	0.48	2200	0.28	9.8	12.0	0.048	17		
9LG0624P4H001			100	0.08	1.92	6150	0.78	27.5	97	0.389	35		
			20	0.02	0.48	1300	0.16	5.6	4.3	0.017	14		
9LG0624P4M001			100	0.04	0.96	4200	0.53	18.7	45	0.180	24		
			25	0.01	0.24	800	0.10	3.5	1.6	0.006	14		
9LG0648P4S001	48	36 to 72	100	0.18	8.64	11000	1.40	49.4	305	1.224	53		
			20	0.02	0.96	2900	0.36	12.7	20.8	0.083	20		
9LG0648P4J001			100	0.10	4.80	8650	1.10	38.8	182	0.730	47		
			20	0.02	0.96	2100	0.26	9.1	10.7	0.042	17		
9LG0648P4H001			100	0.06	2.88	6150	0.78	27.5	97	0.389	35		
			20	0.02	0.96	1000	0.12	4.2	2.5	0.010	14		
9LG0648P4M001			100	0.04	1.92	4200	0.53	18.7	45	0.180	24		
			20	0.02	0.96	650	0.08	2.8	1.0	0.004	14		

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

*Input PWM frequency: 25 kHz

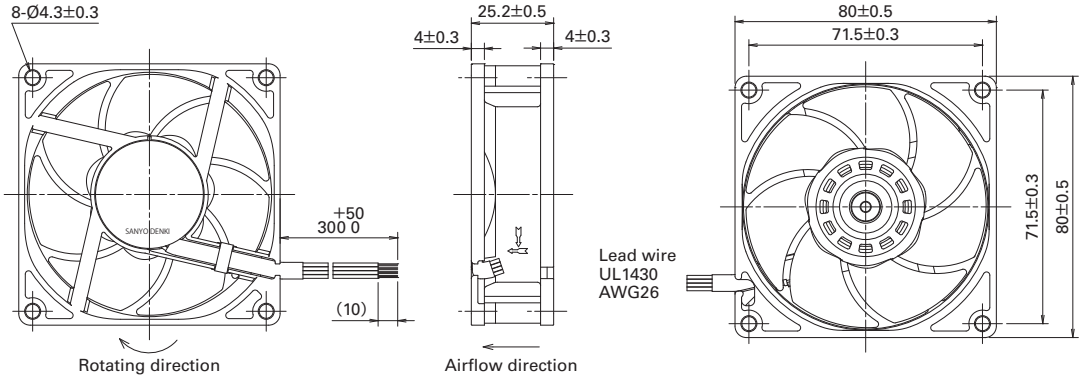


Fig. 5: Dimensions of new model "San Ace 80L" (unit: mm)

Table 2: General characteristics of new model "San Ace 80L"

Model No.	Rated voltage [V]	Operating voltage [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. air flow [m^3/min]	Max. air flow [CFM]	Max. static pressure [Pa]	Max. static pressure [inchH$_2$O]	SPL [dB(A)]	Operating temperature [°C]	Expected life [h]
9LG0812P4H001	12	10.8 to 13.2	100	0.12	1.44	3,700	1.03	36.3	44	0.17	31	-10 to +70	180,000
			25	0.04	0.48	1,100	0.30	10.5	3.9	0.01	13		
9LG0812P4G001			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		
9LG0812P4J001			100	0.6	7.2	7,400	2.07	73.0	177	0.71	49		
			20	0.06	0.72	1,800	0.50	17.6	10.4	0.04	16		
9LG0824P4H001	24	21.6 to 26.4	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		
9LG0824P4G001			100	0.14	3.36	5,500	1.54	54.3	98	0.4	43		
			20	0.02	0.48	1,200	0.33	11.6	4.6	0.01	13		
9LG0824P4J001			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		

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

*Input PWM frequency: 25 kHz

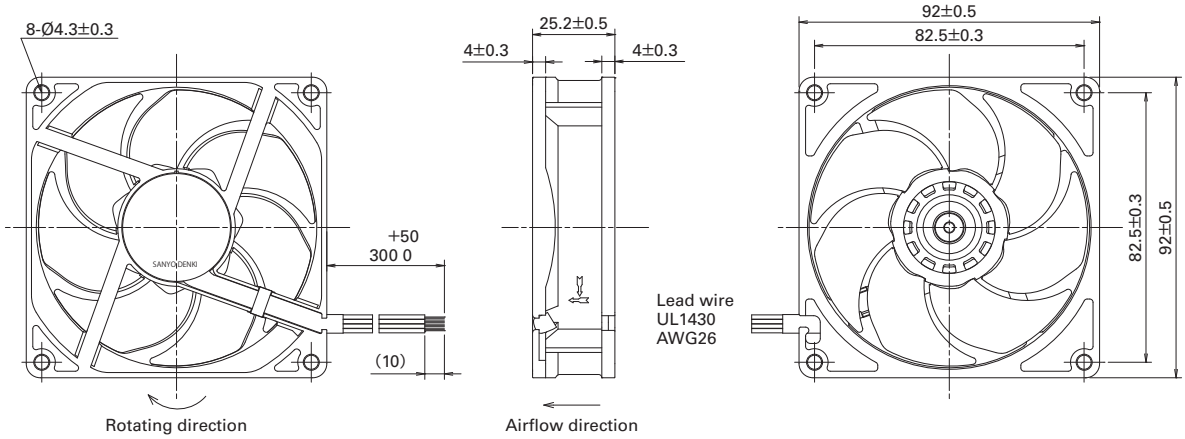


Fig. 6: Dimensions of new model "San Ace 92L" (unit: mm)

Table 3: General characteristics of new model "San Ace 92L"

Model No.	Rated voltage [V]	Operating voltage [V]	PWM duty cycle [%]	Rated current [A]	Rated input [W]	Rated speed [min^{-1}]	Max. air flow [m^3/min]	Max. air flow [CFM]	Max. static pressure [Pa]	Max. static pressure [inchH$_2$O]	SPL [dB(A)]	Operating temperature [°C]	Expected life [h]
9LG0912P4J001	12	10.8 to 13.2	100	0.42	5.04	5000	2.2	77.7	105	0.42	44	-10 to +70	180,000
9LG0912P4G001			100	0.30	3.60	4400	1.93	68.2	81	0.33	40		
9LG0912P4S001			100	0.22	2.64	3850	1.69	59.7	62.1	0.25	37		
9LG0912P4H001			100	0.15	1.80	3150	1.38	48.7	41.6	0.17	32		
9LG0924P4J001	24	21.6 to 26.4	100	0.21	5.04	5000	2.2	77.7	105	0.42	44		
9LG0924P4G001			100	0.15	3.60	4400	1.93	68.2	81	0.33	40		
9LG0924P4S001			100	0.11	2.64	3850	1.69	59.7	62.1	0.25	37		
9LG0924P4H001			100	0.07	1.68	3150	1.38	48.7	41.6	0.17	32		

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

*Input PWM frequency: 25 kHz

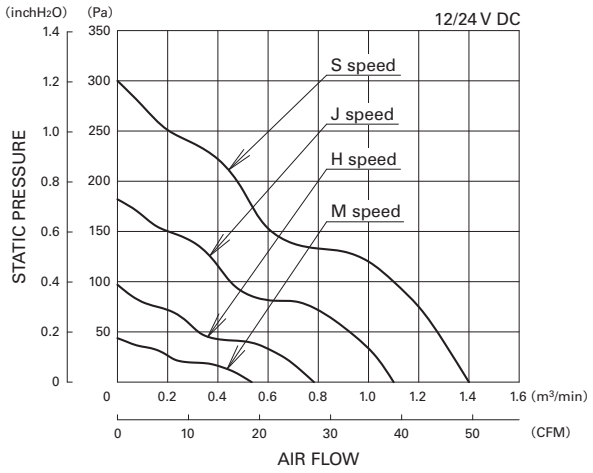


Fig. 7: Air flow vs. static pressure characteristics of new model “San Ace 60L”

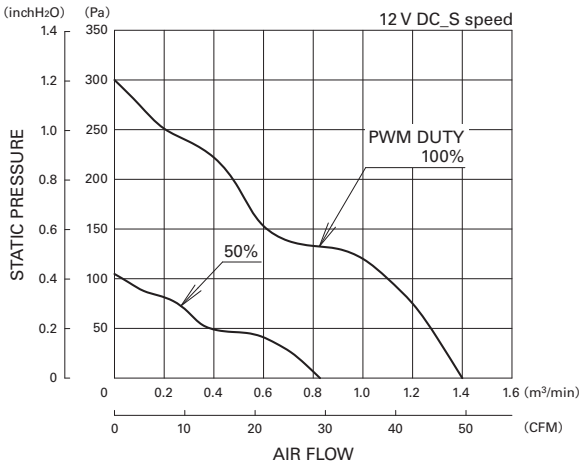


Fig. 10: Air flow vs. static pressure characteristics of new model “San Ace 60L” at individual PWM duty cycle

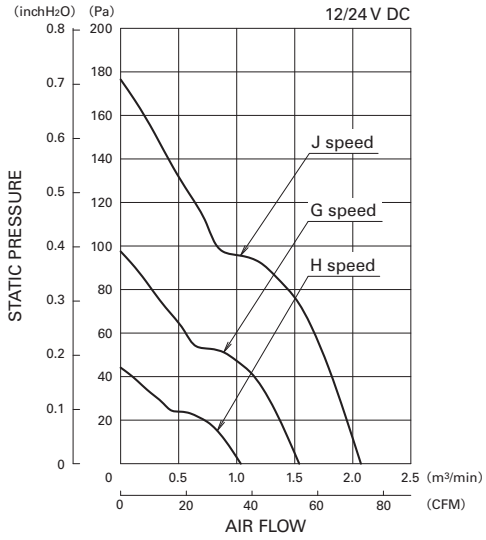


Fig. 8: Air flow vs. static pressure characteristics of new model “San Ace 80L”

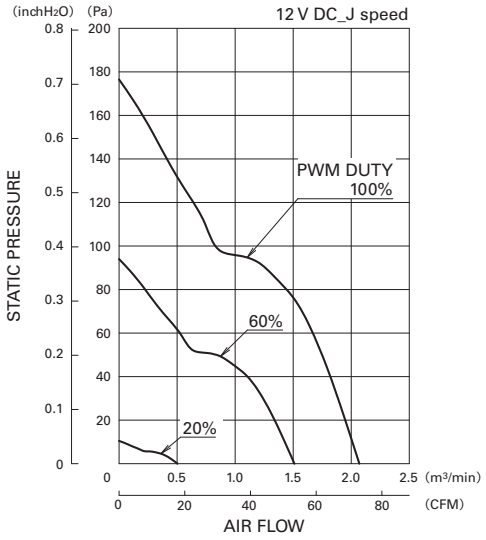


Fig. 11: Air flow vs. static pressure characteristics of new model “San Ace 80L” at individual PWM duty cycle

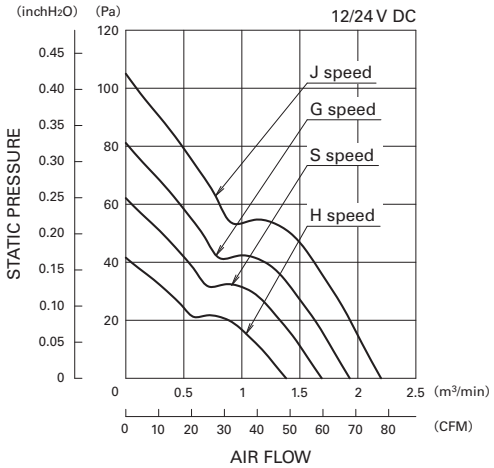


Fig. 9: Air flow vs. static pressure characteristics of new model “San Ace 92L”

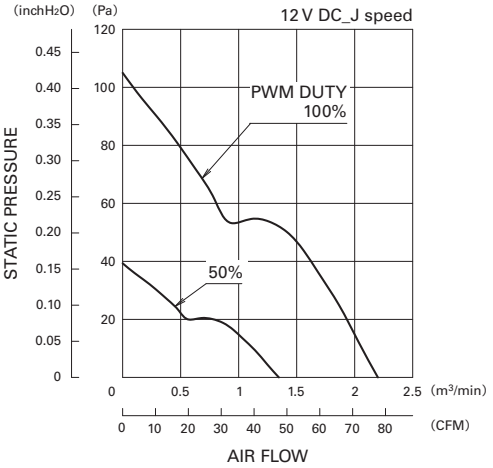


Fig. 12: Air flow vs. static pressure characteristics of new model “San Ace 92L” at individual PWM duty cycle

5. Comparisons with Conventional Models

Here we introduce characteristic differences between new models and conventional models.

5.1 Comparison of expected life

Tables 4, 5 and 6 show comparison of expected life and general characteristics about new models versus conventional models. Values are ones of the highest performing products for each models.

Table 4: "San Ace 60L" Comparison of new model and conventional model

	Expected life [h]	Max. air flow [m^3/min]	Max. static pressure [Pa]	Rated input [W]
New model 9LG0612P4S001	180,000	1.40	300	8.04
Conventional model 109L0612G401	100,000	0.78	87.3	2.88

Table 5: "San Ace 80L" Comparison of new model and conventional model

	Expected life [h]	Max. air flow [m^3/min]	Max. static pressure [Pa]	Rated input [W]
New model 9LG0812P4J001	180,000	2.07	177	7.2
Conventional model 109L0812S401	100,000	1.20	50	3.12

Table 6: "San Ace 92L" Comparison of new model and conventional model

	Expected life [h]	Max. air flow [m^3/min]	Max. static pressure [Pa]	Rated input [W]
New model 9LG0912P4J001	180,000	2.20	105	5.04
Conventional model 109L0912S401	100,000	1.69	66.6	3.84

The new models have significantly higher cooling performance. In addition, compared to conventional model life of 100,000 hours (approx. 11 years), the life of new models is 1.8 times longer at 180,000 hours (approx. 20 years) (ambient temperature: 60°C, survival rate: 90%, rated voltage continuous operation, free-air state, normal humidity).

5.2 Comparison of air flow versus static pressure

Fig. 13, 14, and 15 show air flow versus static pressure characteristics for conventional model and new model.

The new models have higher cooling performance with 1.3 to 1.8 times higher maximum air flow and 1.5 to 3.5 times higher maximum static pressure than conventional models.

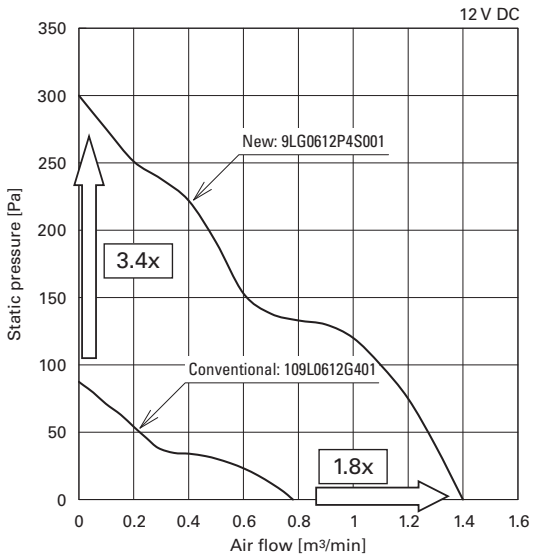


Fig. 13: Air flow vs. static pressure characteristics of "San Ace 60L"
Comparison of new and conventional models

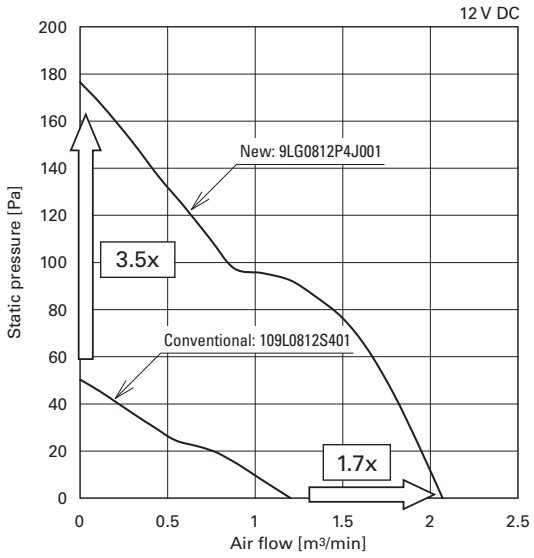


Fig. 14: Air flow vs. static pressure characteristics of "San Ace 80L"
Comparison of new and conventional models

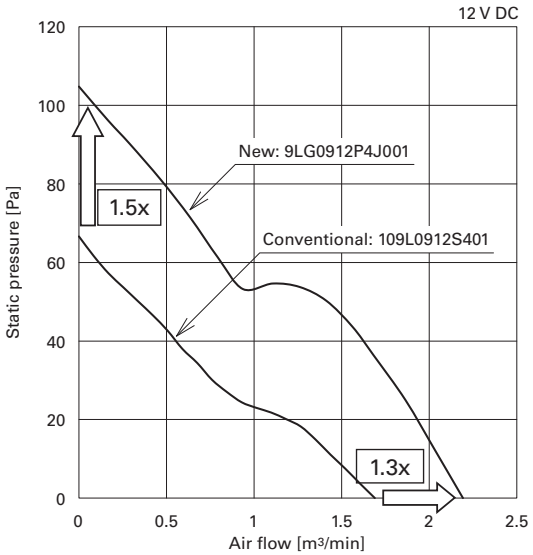


Fig. 15: Air flow vs. static pressure characteristics of “San Ace 92L”
Comparison of new and conventional models

6. Technology achieving both high air flow and long life

The new models were designed with achieving high air flow and long life exceeding those of conventional models.

The three elements achieving higher air flow of fan are as follows;

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

The three elements achieving longer life of fan are as follows;

(4) Selection of material with minimal aged deterioration
(5) Motor drive circuit derating
(6) Reduction of effects on bearing life

The new model was designed with particular consideration towards reducing effects on bearing life, with mainly paying much attention to reducing load on bearings and suppressing bearing temperature rise. In summary, at the same time as achieving higher air flow through optimization of impeller shape, attention was paid to reducing bearing load and high speed motor was adopted while suppressing motor heat generation and bearing temperature rise through higher efficiency.

Here we briefly introduce the key things of part/structure design contributing to the high air flow and long life of the new models, which achieve both reduced effects on bearing life and improved cooling performance at the same time as having significantly improved performance compared with conventional models.

6.1 Impeller

In order to reduce load on bearings, the impeller was made lighter than conventional models by reducing rotor diameter, etc. Also, air flow efficiency was improved by modifying impeller shape in order to reduce bearing temperature rise, and as a result, power consumption was also reduced. In addition to these measures, it was impossible for conventional models to increase air flow according to recent demand, therefore impeller shape was modified for higher air flow at the same time. Fig. 16 shows comparison of rotor diameter and impeller shape of the conventional and new models regarding “San Ace 92L” .

Fig. 16: Profile of “San Ace 92L”
Comparison of rotor diameter and impeller shape of conventional (left) and new (right) models

6.2 Frame

In the same way as conventional model, aluminum die cast frame integrated bearing house was adopted on new model. This type of frame has high heat conductivity and high heat dissipation compared to resin frame, enabling heat of motor to dissioate more efficiently and reduce bearing temperature rise.

Also, shape of frame’s intake and exhaust apertures were optimized in order to achieve higher air flow, adopting spoke shape with minimal air flow loss. By developing optimal frame shape as well as modifying impeller shape, air flow efficiency was further improved.

6.3 Motor and circuit

A higher efficiency motor was achieved by modifying stator shape and increasing winding space factor, while drive IC and electronic parts of circuit were also reviewed. By taking these measures in addition to lightening rotor (mentioned in 6.1) and reducing rotor diameter, it was possible to make the motor smaller. Moreover, lower power consumption was achieved by adopting a highly efficient drive circuit and winding temperature rise was successfully reduced.

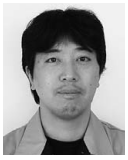
By taking these measures, high speed motor and low power consumption were achieved, and it was possible to reduce amount of heat transmitted from the motor winding to bearing, thereby succeeded to reduce bearing temperature rise.

7. Conclusion

Here we introduced some features and performances of three newly developed high air flow, long life fans “San Ace 60L”, “San Ace 80L”, and “San Ace 92L”.

The new models have achieved significantly higher air flow and longer life while maintaining mounting compatibility with conventional model (L type). This means that, although less number of fans and less equipment space are required, these products can contribute to maintenance-free or reduction in the frequency of fan replacement. Particularly in regards to equipment with life spans of approximately 20 years such as power conditioner of recyclable energy market, adoption of these fan models with approximately 20 years expected life makes it possible to achieve maintenance-free.

Sanyo Denki believes these high air flow, long life fans will greatly contribute to the recyclable energy and environmental business markets.



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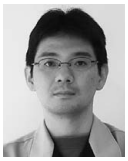

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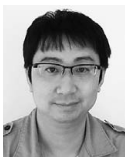

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