〔New Products & New Techniques〕

Model EVMS Vertical Multistage Pumps for the Global Market

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Abstract

As key products for the global market, new model EVMS stainless vertical multi-stage pumps have been released. This model can be used in a wide range of applications including industrial water, cold and hot water circulation, boiler feed, drinking water feed for building facilities, and water purification equipment. Thanks to the unique shape of its impeller main shroud, the model greatly reduces axial thrust force and can be used with standard motors, which have no special bearings for high axial thrust force. In addition, the model offers increased compatibility with a variety of pipe connections so that it can be connected to various kinds of piping.

Keywords: Vertical, Multistage, Stainless, Impeller, Thrust force, Axial force, Bearing, Motor, Efficiency, Connection, Unique shape

1. Introduction

Our vertical multi-stage pumps are inline pumps that are compact and lightweight. With the advantage that they can be installed in small spaces, they are used in a wide range of applications including industrial water, cold and hot water circulation, boiler feed, drinking water feed for building facilities, and water purification equipment. As a pioneer in the field of vertical multistage pumps, we started in 1998 to manufacture and sell the model VDP for the Japanese market. We subsequently remodeled them as the model EVM for global markets. Since 2003, we have been providing these global models inside and outside Japan.

Our new model EVMS jointly developed with EBARA PUMPS EUROPE S.p.A., an Italy based firm, is a full model change of the previous model EVM stainless steel vertical multi-stage pumps. This new model uses a redesigned impeller, with the objectives of reducing much axial thrust force resulting from the multi-stage impeller, and of achieving improved pump performance. In addition, the new model offers more choices for pipe connections to meet the needs of assembled product manufacturers in particular.

This paper will outline the model EVMS vertical multi-stage pumps for global markets, and describe their features.

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2. Product outline

Figure 1 shows the appearances of some model EVMS vertical multi-stage pumps. The table shows the product specifications. **Figures 2** and **3** show the performance ranges and **Figure 4**, the structure.

2.1 Product specifications

According to the material used for the pump, the EVMS-series pumps are divided into three types: the model EVMSG made of EN 1.4301 (AISI 304) and cast iron, mainly used for pumping industrial water; the model EVMS made of EN 1.4301 (AISI 304), mainly used for supplying drinking water; and the model EVMSL made of EN 1.4401 (AISI 316), mainly used in water purification systems and other equipment.

Fig. 1 Appearances of model EVMS vertical multi-stage pumps for global markets

Table Product specifications

Item		EVMSG	EVMS	EVMSL
Application		Boiler feeding and coolant supply	Supply of drinking and hot water	Use in water purification systems
Fluid	Liquid type	Industrial water	Clean water	Pure water
	Temperature	- 30 to 140 ℃ [- 15 to 120 ℃]		
Bore (mm)		25, 32, 40, and 50		
Total suction head		- 6 m (20 ℃): 25S/25/32/40		
		- 5 m (20 ℃): 50/50L		
Maximum operating pressure		1.4/2.5 MPa		
Standard allowable boost pressure		Maximum operating pressure - shutoff pressure		
Structure	Impeller	Closed type with a single liner		
	Intermediate casing	Ring section type with returning blades		
	Casing ring	Floating type		
	Lower casing	Inline-type		
	Mechanical seal	Cartridge mechanical seal		
	Ball bearing	Sealed ball bearing (inside the motor)		
	Sliding bearing	Submerged sleeve bearing		
Pipe connection		Oval, DIN, and ANSI	Oval, DIN, ANSI, JIS, and grooved pipe couplings.	
Material	Impeller	EN 1.4301 (AISI 304)		EN 1.4401 (AISI 316)
	Intermediate casing	EN 1.4301 (AISI 304)		EN 1.4401 (AISI 316)
	Casing ring	EN 1.4301 (AISI 304) + PPS		
	Lower casing	FC250	EN 1.4301 (AISI 304)	EN 1.4401 (AISI 316)
	Sliding bearing	Tungsten carbide		
	Main shaft	EN 1.4301 (AISI 304)/EN 1.4460 (AISI 329A)		EN 1.4401 (AISI 316)/ EN 1.4460 (AISI 329A)
	Shaft sleeve	EN 1.4301 (AISI 304)		EN 1.4401 (AISI 316)
	Mechanical seal	SiC, carbon, and FPM		
	O-ring	EPDM (standard) or FPM (optional) [FPM]		

Standard motor specifications

Output range	0.37 to 18.5 kW
Numbers of phases and poles	Three phases and two poles
Voltage	200 V, 50 Hz
	200/220 V, 60 Hz
Type and protection scheme	Totally-enclosed fan-cooled type with IP55 protection
Efficiency level **	IE3, premium efficiency
Installation location	Indoor and outdoor

* The data inside [ ] is for the models for the Japanese market.
** Output less than 0.75 kW is regarded as premium efficiency class (our definition)

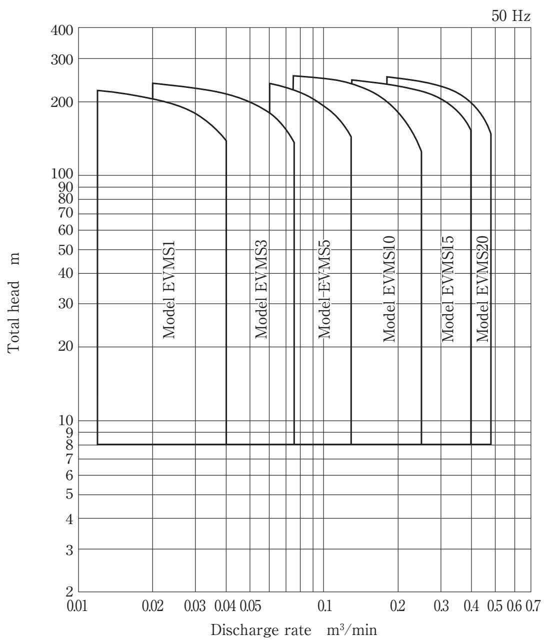


Fig. 2 Performance range (50 Hz)

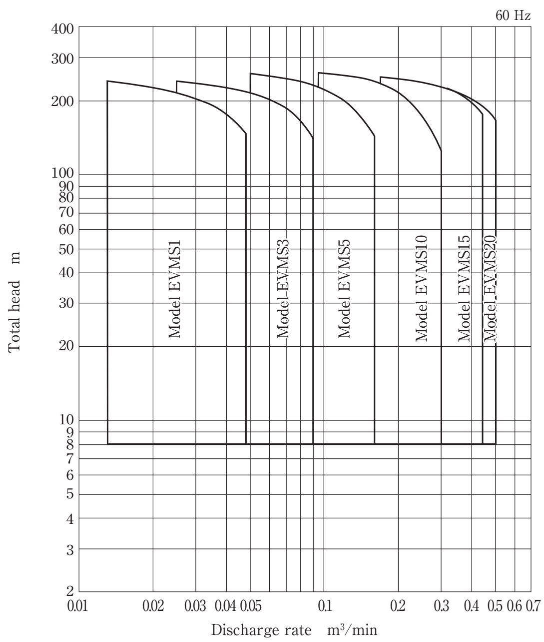
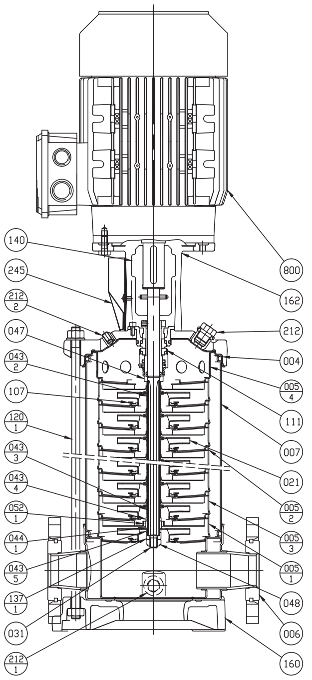


Fig. 3 Performance range (60 Hz)



n : Number of impellers
Bn : Number of sleeve bearings

PART NO.	PART NAME	MATERIAL		NO. FOR 1 UNIT
800	MOTOR			1
245	COUPLING GUARD	SUS304	304 STAINLESS	2
212	PRIMING WATER PLUG	SUS304	304 STAINLESS	1
212-2	AIR VENT PLUG	SUS316L	316L STAINLESS	1
212-1	DRAIN PLUG	SUS304	304 STAINLESS	2
162	MOTOR BRACET	FCD250	CAST IRON	1
160	BASE PLATE	ADC12	DIE CAST ALUMINUM	1
140	COUPLING	ADC12	DIE CAST ALUMINUM	2
137-1	SHAFT END SLEEVE	SUS304	304 STAINLESS	1
120-1	TIE-ROD BOLT	S35C	CARBON STEEL	4
111	MECHANICAL SEAL	SIC/CAR/FP	SIC/CAR/FP	1set
107	WEAR RING	SUS304+PPS	304 STAINLESS+PPS	n
052-1	SLEEVE BEARING	WC	TUNGSTEN CARBAIDE	Bn
048	FRICTION NUT	SUS304	304 STAINLESS	1
047	RING HOLDER	SUS316L	316L STAINLESS	1
044-1	BEARING SLEEVE	WC	TUNGSTEN CARBAIDE	Bn
043-5	SHAFT SLEEVE	SUS304	304 STAINLESS	1
043-4	SHAFT SLEEVE	SUS304	304 STAINLESS	Bn
043-3	SHAFT SLEEVE	SUS304	304 STAINLESS	Bn
043-2	SHAFT SLEEVE	SUS304	304 STAINLESS	2(n-Bn)-1
031	MAIN SHAFT	SUS304	304 STAINLESS	1
021	IMPELLER	SUS304	304 STAINLESS	n
007	OUTER CASING	SUS304	304 STAINLESS	1
006	LOWER CASING	SUS304	304 STAINLESS	1
005-4	INTERMEDIATE CASING	SUS304	304 STAINLESS	1
005-3	INTERMEDIATE CASING	SUS304	304 STAINLESS	Bn
005-2	INTERMEDIATE CASING	SUS304	304 STAINLESS	n-Bn-1
005-1	INTERMEDIATE CASING	SUS304	304 STAINLESS	1
004	CASING COVER	SUS304	304 STAINLESS	1

Fig. 4 Structure of a typical EVMS-series model

2.2 Performance

The previous EVM series consisted of four models (EVM3, EVM5, EVM10, and EVM18). The new EVMS series has included two more models—the EVMS1 with a water volume lower than that of the EVM3, and the EVMS20 with a water volume higher than that of the EVM18—totaling six models (EVMS1, EVMS3, EVMS5, EVMS10, EVMS15, and EVMS20). The number (e.g., 3) included in each model name represents the nominal discharge rate (m^3/h).

Each model supports a variety of pump heads up to 200 m and motors of up to 18.5 kW.

Bore: 25, 32, 40, and 50 mm

Flow rate range: 0.012 to 0.48 m^3/min. (50 Hz)
0.013 to 0.56 m^3/min. (60 Hz)

2.3 Structure

The model EVMS pumps are vertical designs consisting of an inline-type lower casing; a combination of an impeller, intermediate casings, and an outer casing; a combination of a motor bracket and a cartridge mechanical seal; a coupling; and a motor, arranged from the bottom to the top.

The lower casing is made of pressed stainless steel or cast iron. The bracket unit consists of a motor bracket for supporting internal pressure, operation torque, and the weight of the motor, and a casing cover made of pressed stainless steel sheet for preventing rust at the part that contacts liquid. The casing cover is equipped with an air vent plug, in addition to the priming water plug, which was also installed in the previous models, to ensure complete air removal.

All of the impellers are closed type and made of pressed stainless steel. Each of the intermediate casings is equipped with returning blades for guiding the fluid from the impeller to the next stage.

The motor torque is transferred through the coupling to the main shaft. The main shaft is splined, transferring the torque to each impeller. Inside the pump, a submerged bearing made of cemented carbide (tungsten carbide) is arranged as required to control axial runout. The axial thrust force applied to the main shaft during pump operation is absorbed by a sealed ball bearing installed inside the motor. The approach to reducing axial thrust force will be described in detail in the "Features" section that follows.

3. Features

3.1 Development of a new impeller (reduced axial thrust force and improved performance)

A radial impeller rotating in liquid produces a centrifugal effect, which develops a discharge pressure. The difference between the discharge pressure and suction pressure causes axial thrust force to act on the

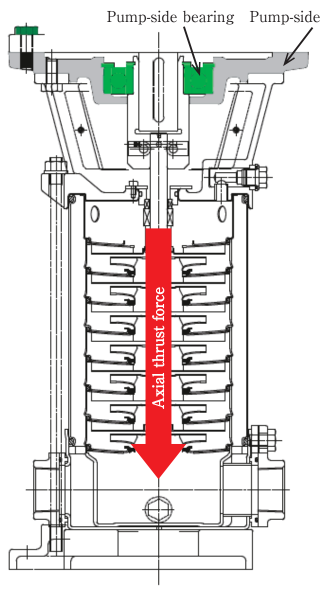


Fig. 5 Countermeasures against axial thrust used in the previous model EVM

impeller. An impeller, if multi-stage, produces axial thrust force that increases in proportion to the number of stages. To absorb this thrust force, the previous model EVM uses a combination of a pump-side bearing for absorbing high axial thrust force and a housing for supporting this bearing, or uses, as the bearing built into the motor, a purpose-built bearing capable of enduring high axial thrust force. **Figure 5** shows the direction in which the axial thrust force acts and the location of the pump-side bearing for countering the thrust force.

For the purpose of explaining how axial thrust force acts on the impeller, **Figure 6** shows the previous impeller used in the model EVM, seen from the main

Fig. 6 Impeller used in the previous model EVM (seen from the main shroud)

Fig. 9 New impeller (seen from the main shroud)

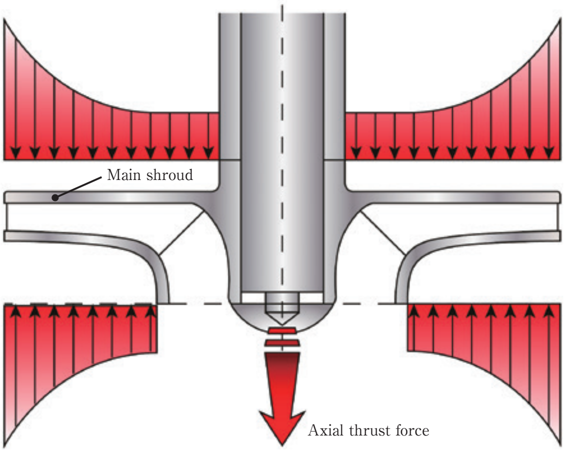


Fig. 7 Axial thrust force acting on the impeller in the previous model EVM

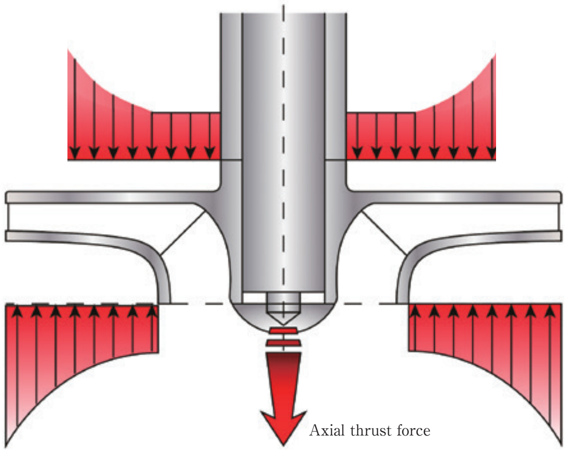


Fig. 10 Axial thrust force acting on the new impeller

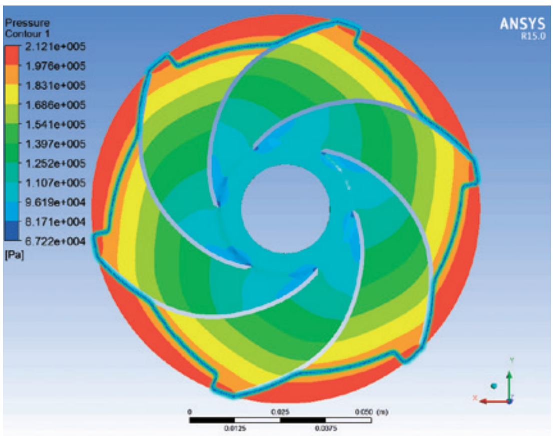


Fig. 8 Pressure distribution in the main shroud of the impeller used in the previous model EVM

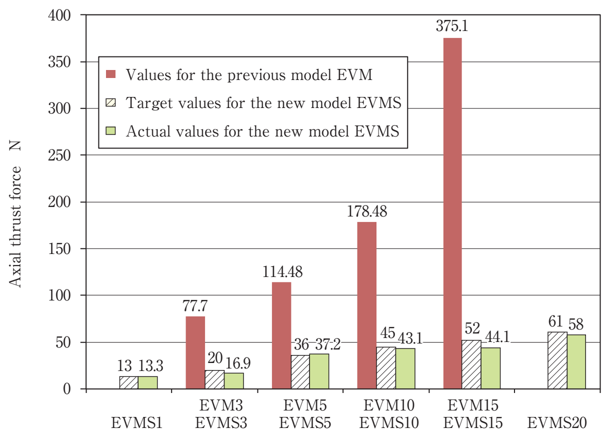


Fig. 11 Comparison of axial thrust force between the previous model EVM and new model EVMS

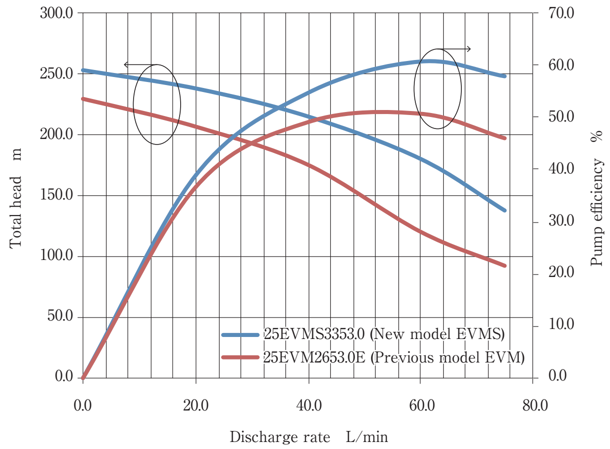


Fig. 12 Performance comparison between the previous model EVM and new model EVMS (50 Hz)

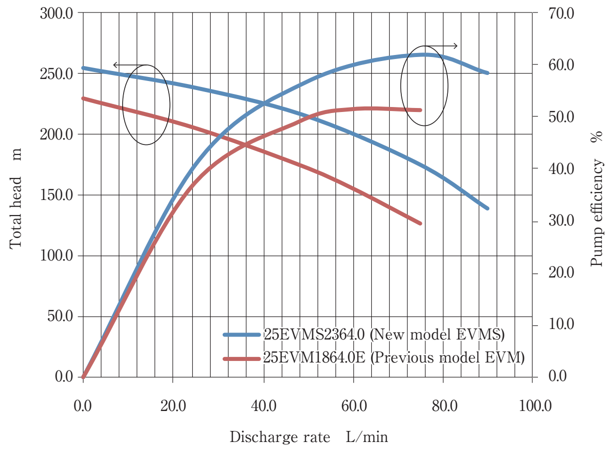


Fig. 13 Performance comparison between the previous model EVM and new model EVMS (60 Hz)

shroud, and **Figure 7**, how axial thrust force acts on the impeller. **Figure 8** shows the distribution of pressure that acts on the main shroud.

As shown in Fig. 8, the pressure is highest at the rim of the shroud.

The new impeller we have developed this time reduces the axial thrust force that acts on the impeller during operation by using a uniquely shaped impeller main shroud with the most pressurized part partially removed. The blue line in the figure represents the unique shape of the main shroud of the new impeller. **Figure 9** shows the new impeller seen from the main shroud, and **Figure 10**, how axial thrust force acts on the new impeller.

Actual measurement results have demonstrated that the axial thrust force is significantly lower than that of the previous model EVM; the measurement results are

Fig. 14 Motor bracket

Fig. 15 Casing cover (made of thin stainless steel plate)

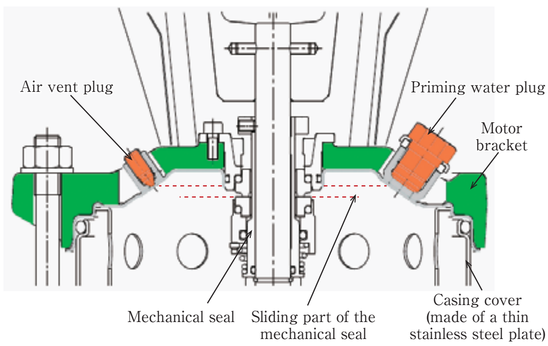


Fig. 16 Structure of the motor bracket

shown in **Figure 11**. The shaded bars in the figure represent the target values of axial thrust forces. If the actual thrust force does not exceed these targets, no pump-side bearing is required and it is possible to use a standard motor without a purpose-built bearing that endures high axial thrust force, offering a wider choice of motors.

Figures 12 and **13** show some of the performance improvements achieved by the new impeller. They indicate that compared with the previous model EVM,

Fig. 17 Connection of DIN, ANSI, and JIS flanges

Fig. 18 Grooved pipe couplings

the new impeller exhibits significantly improved QH performance and efficiency.

3.2 Bracket structure (separate structure of pressed stainless steel)

The bracket itself is made of cast iron and internally has a separate casing cover made of pressed stainless steel (EN 1.4301 or EN 1.4401). The motor bracket made of cast iron is designed to resist pressure. The internal casing cover is in close contact with the part made of cast iron to minimize deformation. **Figures 14** and **15** show the motor bracket and casing cover, respectively. **Figure 16** shows the structure of the motor bracket. The horizontal locations of the priming water plug and air vent plug are higher in the axial direction than the sliding surface of the mechanical seal, to ensure complete air removal. In addition, the priming water plug is provided with an air vent line to prevent mechanical seal breakage caused by sliding in a dry state even if air has entered the mechanical seal.

3.3 Enhanced flexibility of pipe connection

In addition to the flanges conforming to the DIN, ANSI, and JIS standards, used in the previous model EVM, the model EVMS also support grooved pipe couplings. **Figure 17** shows the appearance of a flange conforming to the DIN, ANSI, and JIS standards and **Figure 18**, appearances of grooved pipe couplings. Compared with the conventional flange-based connection, grooved pipe couplings do not require a large connection space and therefore are widely used to connect pipes in devices, in particular, made by assembled product manufacturers, which require space saving.

4. Conclusion

With vertical multi-stage pumps made of stainless steel positioned as our key models, we have been manufacturing and selling this type of pump over many years since the launch of the first generations of models VDP and EVM. Multi-stage pumps are inevitably accompanied by axial thrust force. As a solution to this problem, we have successfully developed an impeller that significantly reduces axial thrust force, after a process of trial and error by making use of leading-edge hydraulic design, press, and welding technologies.

Through cooperation between our production and sales departments from the basic design phase, we developed this impeller in a short time, from the commencement of development activities to market introduction. We will further expand the lineup of the EVMS series to continue to supply high-quality products to global markets.

Finally, we would like to express our deep gratitude to all the people who helped us carry out development activities.