

Model CB Double Suction Pump for the Global Market

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Abstract

As key products for the global market, Ebara has released model CB double suction pumps. This model can be used in a wide variety of industries, such as public water supply, general water supply and conveyance, cold/hot water circulation, building facilities, general industries, power plants, petroleum plants, and gas plants. Thanks to the new, high-efficiency flow passage, which Ebara developed through DOE (design of experiments) and sensitivity analyses, the pumps meet an energy efficiency value of η_3 in China's GB standards. In addition, the optimal design of their casing and rotor parts has reduced their pump weights.

Keywords: Double suction, Centrifugal pump, High efficiency, Weight saving, GB standards, Energy saving, Stress analysis, Contact analysis, Through bore, Shortening bearing span

1. Introduction

Regulations concerning energy conservation have been expanding in global markets. Especially in China where markets continue to grow, the efficiency regulation of pumps is stipulated in China's GB standards (hereafter GB standards)¹⁾. GB standards are divided into mandatory standards (GB), which are enforceable by law, and recommended standards (GB/T). In terms of land centrifugal pumps, GB standards not only request that manufacturers produce products with a specified level of efficiency, but also encourage them to develop products that satisfy stricter energy conservation standards according to "the minimum allowable values of energy efficiency and evaluating values of energy conservation of centrifugal pump for fresh water" (GB19762-2007).

For land pumps, fluid is limited to fresh water. Three types of centrifugal pumps (end suction single stage, double suction single stage, and multi-stage) are classified according to flow rate and specific speed. By

using a correction coefficient, the required efficiency is determined for each classified pump. There are three levels of required efficiency: η_1 , minimum allowable value of energy; η_2 , target minimum allowable value of energy; and η_3 , evaluating value of energy conservation. η_1 represented the required efficiency until the end of June 2011. η_2 has represented it since the beginning of July 2011.

η_3 presents the highest efficiency. If a product meets η_3 , it can obtain certification as an energy conservation product in China. Thus, users can select highly efficient products more easily.

Unfortunately, conventional model CNC pumps that are sold in China have not yet met η_3 . It is very challenging for these products to improve their efficiency enough to attain η_3 .

Ebara Corporation and Ebara Machinery (China) Co., Ltd. (hereafter EMC) have jointly developed model CB pumps by fully remodeling conventional models (**Figure 1**). Thanks to the new, high-efficiency flow passage²⁾, all model CB pumps meet η_3 . In addition, the optimal design of their casing and rotor parts has reduced their pump weights.

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Fig. 1 Model CB double suction pump

This paper will provide an overview and introduce features of model CB double suction pump for the Global Market.

2. Features

Figure 1 shows the model CB double suction pump.

In this chapter, we compare features of conventional model CNC with those of new model CB.

2.1 High efficiency

In order to meet η_s , an evaluating value of energy conservation, the new, high-efficiency flow passage has been employed. The impeller, discharge volute, and suction flow passage, which make up the flow passage, were designed with optimal design parameters obtained through design of experiments and sensitivity analysis, to achieve high pump efficiency.

Figure 2 shows results of steady flow analysis of discharge volutes. The contours in Figure 2 shows the all pressure loss distribution of the discharged volutes, where increases in red indicate greater pressure loss, while increases in blue indicate smaller pressure loss. When the conventional model and the optimized shape model were compared, it was found that the pressure loss was reduced in the volute of the optimized shape model because the volute had more blue areas than that of the conventional model.

The three-dimensional streamlines (the solid lines in Figure 2) were drawn from where the pressure loss at the cross section indicated by an arrow was large. In the optimized shape model, the deviation of the

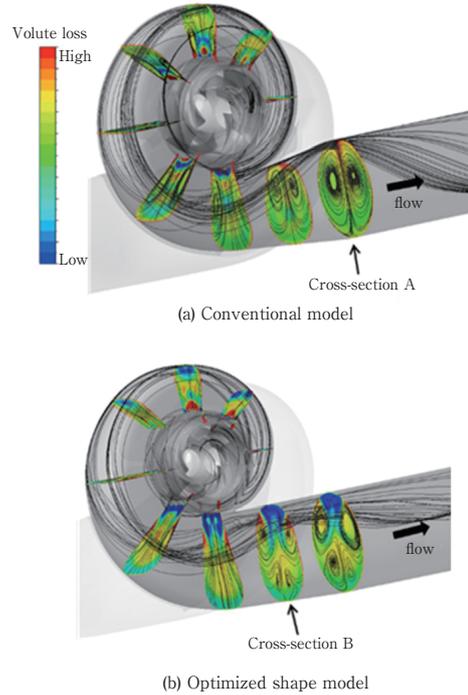


Fig. 2 Examples of flow analysis

streamlines was reduced. Also, since the secondary flow was smaller than that at cross section A of the conventional model, the loss was smaller.

2.2 Weight saving

In order to reduce costs, the weight of the casing was reduced and the rotor parts were optimized, compared with those of the conventional model. Details are shown below.

2.2.1 Casing weight reduction

Since the casing accounts for about 50 % of the mass of a pump, we focused on optimizing the wall thickness. A pressure test with water is usually carried out before a performance test. The casing must maintain pressure as a pressure vessel without leakage and plastic deformation.

Figure 3 shows the result of stress analysis at a pressure of 2.4 MPa (1.5 times the maximum operating pressure of 1.6 MPa). An optimal wall thickness was determined so that the maximum principal stress of the casing was smaller than the yield stress.

Figure 4 shows the results of surface contact analysis. The red parts represent contact surfaces, and the green parts indicate the gap between the upper and lower casings. We learned that there was no

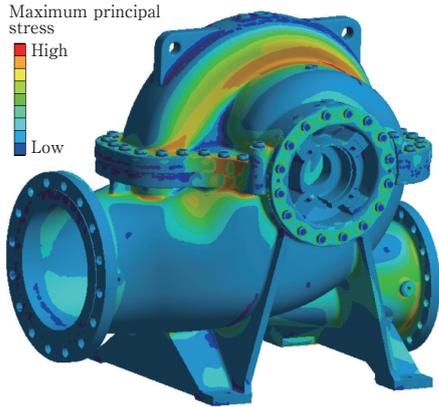


Fig. 3 Example of stress analysis of model CB casing



Fig. 4 Example of surface contact analysis of model CB casing

leakage because the gap did not reach any bolt hole.

Plastic deformation and leakage did not occur, even in a pressure test with an actual machine. Accordingly, concerns about insufficient strength and leakage in a pressure test were dispelled. Compared with conventional pumps, the weight of the new pump has been reduced by about 4 %.

2.2.2 Optimal design of the rotor parts

In order to reduce the sizes of the bearings, mechanical seals, and impeller nut at the same time, the shaft diameter has been optimized.

As shown in **Figure 5**, stress analysis was carried out, simulating a state in which torque is applied to the shaft. It was found that high stress was generated at the key insertion section where the shaft diameter is small.

For this reason, strength evaluation by an inching test shown in **Figure 6** was conducted, and it was confirmed that there was no problem in strength.

Based on the above test results, by optimizing the sizes of the shaft, bearings, mechanical seals, and impeller nut, the pump weight was reduced by 3 %, compared with conventional pumps.

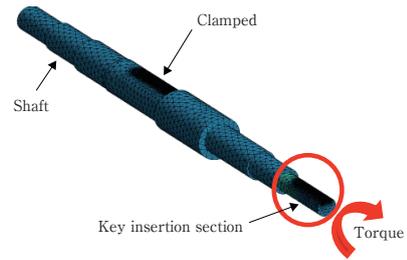


Fig. 5 Example of stress analysis of shaft

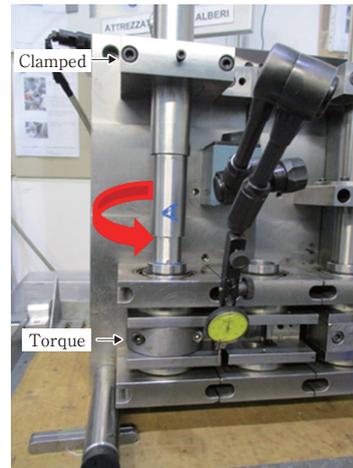


Fig. 6 Shaft inching test

3. Product Overview

The product overview is shown below.

3.1 Specifications

The **table** below shows the main specifications of a model CB pump. Its flange meets JIS, GB, and ASME standards. Mechanical seals are used as shaft seals. **Figure 7** shows the comparison of the pump efficiency with η_3 (evaluating value of energy conservation) between the representative model CNC and CB pumps. The pump efficiency of model CB pumps has been increased by 4 % on average, compared with model CNC pumps, and all 40 models meet η_3 .

3.2 Performance ranges

Figures 8 and **Figures 9** show performance ranges of model CB pumps.

- Suction diameter: 125 to 400 mm
- Flow rate: 0.75 to 45 m³/min (50 Hz)
- 0.85 to 48 m³/min (60 Hz)

They met the performance ranges of the conventional models.

Table Specifications

Item	Specification
Fluid	Fresh water, industrial water
Pump efficiency	η_s (GB standard) min.
Flange rating	JIS, GB, ASME
Max. operating pressure	16 Bar
Temperature	0 to 80 °C
Frequency	50, 60 Hz
No. of poles	4P
Flow rate	48 m ³ /min max.
Total pump head	160 m max.
Casing material	FC250, FCD450 (JIS standard)
Shaft seal	Mechanical seal
Bearing	Grease lubrication

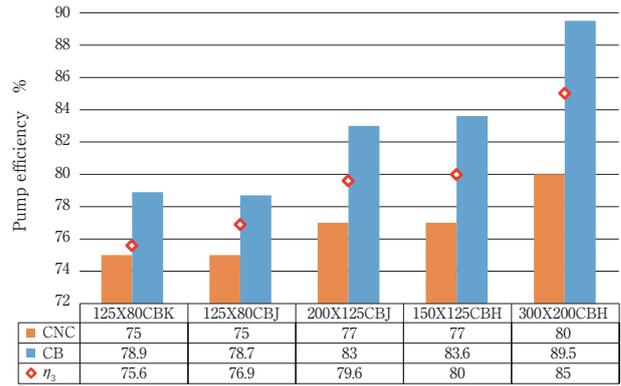


Fig. 7 Comparison of pump efficiency

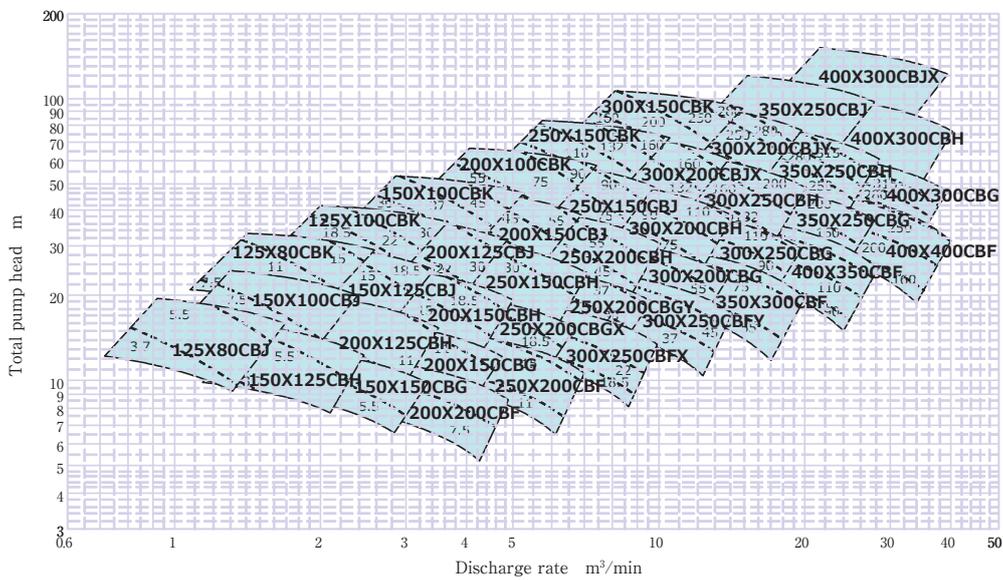


Fig. 8 Performance ranges (50 Hz)

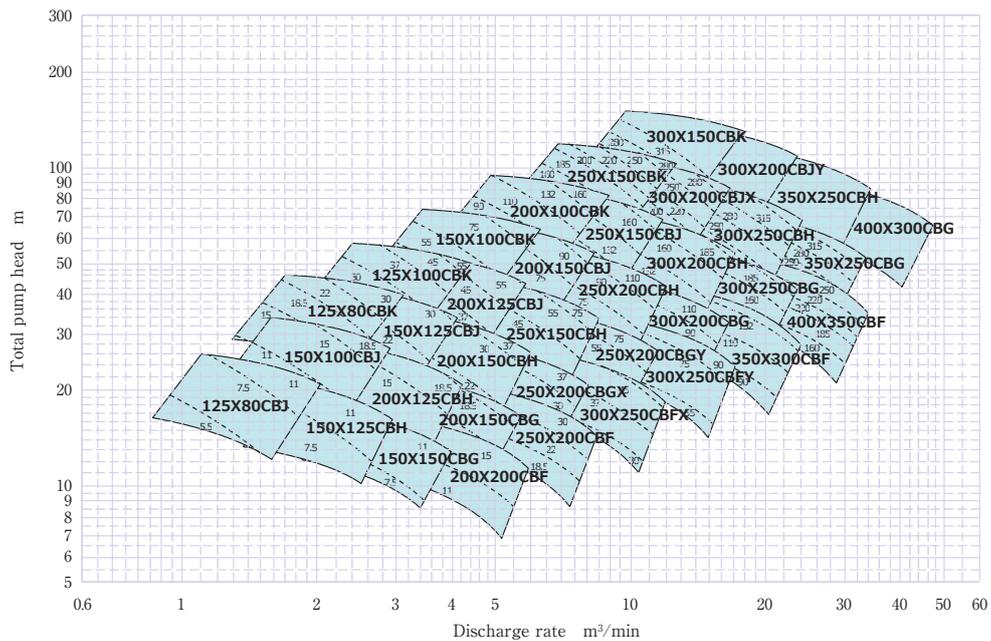


Fig. 9 Performance ranges (60 Hz)

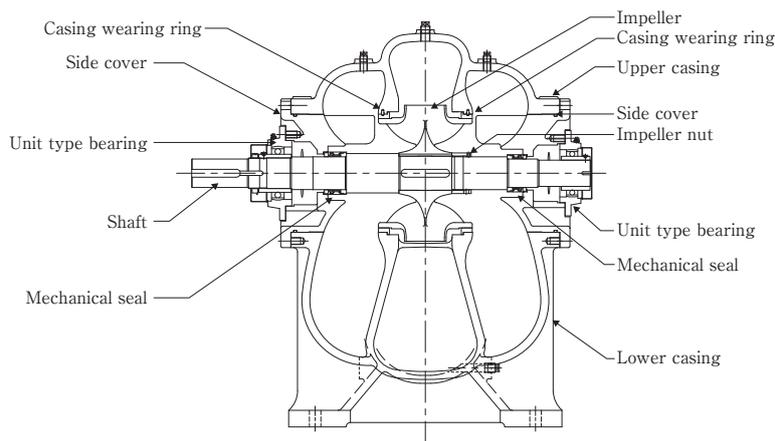


Fig. 10 Structural drawing

3.3 Structure

Figure 10 shows the structural drawing. A model CB pump mainly consists of upper and lower split casings, side covers, a double suction impeller, a shaft, unit type bearings, and mechanical seals.

Thanks to a casing with a through-bore structure (machined from the motor side to the opposite side with the same inner diameter), bearings can be inserted inside the casing, resulting in a shorter bearing span. Furthermore, the unit type bearing that combines a bearing and a bearing cover is easy to install and handle. Since the bearing cover has high rigidity and high strength, no abnormal load can apply to the bearing, resulting in a longer bearing life. Also, since the bearing outer surface and the bearing housing inner surface make spherical contact with each other, the misalignment of the rotor parts is automatically corrected.

The impeller is easy to install because it is directly fit to the shaft and is fastened with an impeller nut.

Since the bearing span of the shaft is shortened, the shaft deflection and the clearance between the impeller and the casing wearing ring can be minimized so that leakage loss is prevented and pump efficiency is improved.

Compared to conventional model CN pumps³⁾ for the Japanese market, the model CB pumps are compact, thanks to the through bore structure and unit type bearings.

4. Conclusion

We have provided an overview and introduced the features of model CB double suction pump for the global market.

By employing the optimal design parameters of the impeller, discharge volute, and suction flow passage, which were obtained through DOE (design of experiments) and sensitivity analyses, we have developed pumps that meet η_s , an evaluating value of energy conservation in GB standards.

In the future, Ebara will improve model CB pumps by increasing the number of motor poles from two to six, achieving the compatibility with high suction pressure, and so on, to promote the pumps globally from Asia, centering on the Chinese market where the production base of the pumps is located. Energy conservation is necessary worldwide, and we will strive to contribute to building a sustainable society, which is a challenge facing not only China, but also the whole world.

Lastly, we would like to express our deep appreciation to all the people who have provided their cooperation in this development.

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