Pilot study for the reliability evaluation of double suction volute pump

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ABSTRACT

In this paper, the study of test methods for the reliable assessment of the amount of suction pumps which bees root fluid is sucked into both around the impeller. Bee root amount suction pump is usually used for the purpose of discharging a large flow rate, such as water supply plant equipment and buildings. Centrifugal pumps are currently in production in the country is the trend in the exchange according to Chapter mode changes to improve the level of technology leaks due to wear of the mechanical seal from the existing impeller wear. When the mode is changed to give chapter and developed appropriate test method for evaluating the reliability of centrifugal pumps life testing time because the calculation method differs with these failure modes.

1. INTRODUCTION

Both suction vortex pumps are a kind of centrifugal pump and are suitable for medium and low heading, and have a long service life and a stable operation, so the range of use is wide. Therefore, it is mainly used for water and sewage, industrial and pumping water, and circulation of large buildings. Domestic centrifugal pump production technology has been improved close to that of foreign advanced companies and many studies have been carried out in terms of materials and design in order to improve the efficiency which is the main performance of the pump. In this study, we have studied the reliability test method which can confirm the leakage due to the wear of the mechanical seal which is the main cause of the system failure in addition to the existing test method for the centrifugal pump.

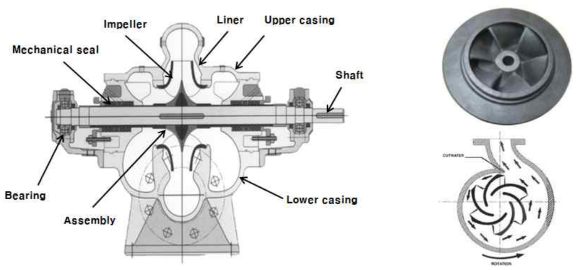

Fig. 1 Structure of the Double suction volute pump

Table 1. Grid coupling sample Specification

Primary components	Failure modes	Failure mechanisms
Assembly	Pressure, Flowrate Decrease	Internal leakage
	External leakage	Oil shortage
Casing	External leakage	Lack of strength
	Corrosion and lifting	Poor surface treatment
Impeller Liner	Pressure, Flowrate Decrease	Deterioration
	Inability to rotate	Seizure
Shaft	Wear	Wear due to vibration
Mechanical Seal	Wear	deterioration
Bearing	damage	Heat, deterioration

2. FAILURE ANALYSIS

Both suction vortex pumps consist largely of main components, impeller and liner, which set a series of reliability test items that gave impulse and liner deterioration in the actual field, giving the impulse to the long mode. In addition, the test equipment is constructed to be able to be realized in the laboratory environment. The slurry pump is water containing the desulfurization slurry because the applied fluid is m echanically frictioned with the impeller and the liner.

2.1. Failure mode and mechanism analysis

Both of the suction vortex pumps consist of main components, impeller, casing, and mechanical seal, which set a series of reliability test items that give deterioration of the mechanical seal, which is the actual delivery mode in the field, and put it into the long mode. In the laboratory environment, the test equipments were constructed tosimulate the operating conditions in the field. Both of the suction and vacuum pumps are water applied, so that the pressure formed inside the pump is lower than the impeller, liner and mechanical friction phenomenon, The maximum flow test, the maximum head test, and the efficiency test were added because the seal could be a failure factor.

2.2. Quality Function Development Phase

Based on the results of QFD analysis, the representative performance test was determined as an efficiency test. In the environmental test, operational test, low temperature test, high temperature test, and humidity test items were selected.

3. TEST METHOD

Based on field failure, we derive comprehensive performance test, environmental test, and life test through failure mode analysis and QFD. In the QFD, the importance score according to the major components is calculated, the test validity score and the ranking are determined for each test item, and the high-ranking test is set as the representative performance test. Since the life test is a test to derive the feeding mode, the test method and the test equipment should be configured so that the influence of all the parts is large.

Table 2 Quality Function Deployment level

Primary components	Importance score	Test Items									
		Rated discharge head - Discharge flow test	Maximum discharge flow rate test	Maximum discharge head test	Efficiency test	External leakage test	Test with operation	Low temperature test	High temperature test	Humidity test	Life test
Assembly	15	◎	◎	◎	◎	▲	▲	▲	▲		◎
	16	●	●	●	◎	◎	▲				◎
Casing	17	●	●	●	●	◎	▲				◎
	8				▲		▲	●	●	◎	●
Impeller Liner	19	◎	◎	◎	◎		●	▲	▲		◎
	14	●	●	●	◎	▲	▲	▲	▲		●
Shaft	10	▲	◎	●	●	◎	▲	▲	▲		◎
Mechanical Seal	22	▲	◎	●	◎	◎	●	●	●	▲	◎
Bearing	13	▲	●	●	◎		●	▲	▲	▲	◎
Test validity score and ranking		356	510	446	584	354	242	161	161	75	626
		5	3	4	2	6	7	8	9	10	1

Table 3 Overall performance test

Test Type	Test Items
Comprehensive performance test	Rated discharge head - Discharge flow test
	Maximum discharge flow rate test
	Maximum discharge head test
	Efficiency test (Representative performance test)
	External leakage test

3.1. Comprehensive performance test

We have established comprehensive performance test of 5 items by consultation with reference standards, manufacturers, demand companies, and experts. Based on the analysis in QFD, the efficiency test was selected as the representative performance test according to the importance score. The comprehensive performance test is performed before and after the life test, and the efficiency test, which is a representative performance test, is performed before, during, and after the life test.

3.2. Environmental test

The environmental resistance test is determined by the environmental conditions under which the actual product operates. Both suction type vacuum pumps are used for water supply and drainage, and are usually installed indoors. Both suction vortex pumps are transported by a rotating impeller and a vane impeller, so it is necessary to consider the environmental conditions for the operating exciter and to test the low temperature and high temperature in an indoor condition. If the next test is carried out within 72 hours after the end of the previous test in the environmental resistance test, the post test of the previous test item shall be replaced by the pre-test of the next test.

3.3. Life test time calculation

As a result of the survey on the domestic industry, the lifetime of both suction and ventilating pumps is assumed to be 9000 hours (average equivalent life of 3 years) with a confidence level of 70% considering the field use conditions. In addition, the delivery mode of both suction tubing pumps is equivalent to the wear referred to in Machinery Failure Analysis and Troubleshooting as leakage due to mechanical seal wear, so the shape parameter (β) follows a Weibull distribution of 3.0.

- Lifetime distribution: Weibull distribution with shape parameter (β) of 3.0
- Warranty life: 9000 hours of life

- Confidence Level: 70%
- Number of samples: 2
- No breakdown test time (t_n):

$$t_n = B_{100P} \cdot \left[\frac{\ln(1-CL)}{n \cdot \ln(1-P)}\right]^{\frac{1}{\beta}} \quad (1)$$

$$= 9000 \cdot \left[\frac{\ln(1-0.7)}{2 \cdot \ln(1-0.1)}\right]^{\frac{1}{3.0}} = 16090 \text{ test time}$$

From here t_n : Non-failure test time

B_{100P} : Warranty life

CL : confidence level

n : Number of samples

p : Unreliability (B_{10}, p= 0.1)

β : Shape parameter

For accelerated life test of deterioration of mechanical seal, which is the feed mode of both suction vortex pumps, the acceleration factor is selected by pressure and speed. The accelerated model is selected as the advance model. The pressure of the operating conditions is 50% of the rated discharge pressure, and the acceleration condition is the accelerated life test at 95% of the rated discharge pressure. The acceleration index m for the pressure acceleration factor is 2, and the acceleration index for the speed acceleration factor is 1. Refer to "Handbook of reliability prediction procedures for machanical equipment", NSWC-07, 2007.

- AccelerationFactor(AF)

$$AF = \left(\frac{P_{test}}{P_{field}}\right)^m \times \left(\frac{\omega_{test}}{\omega_{field}}\right)^1 \quad (2)$$

$$= \left(\frac{0.95P_{max}}{0.5P_{max}}\right)^{2.0} \times \left(\frac{2200}{1750}\right)^1 = 4.583$$

From here

AF : Acceleration factor

P_{test} : Pressure under acceleration conditions

P_{field} : Operating pressure

w_{test} : Test speed (r / min)

w_{field} : Cumulative equivalent use speed (r / min)

P_{max} : Rated discharge pressure

m, l : Acceleration index (m =2, l=1)

- Accelerated life test time (t_{na})

$$t_{na} = \frac{t_n}{AF} = \frac{16090}{4.5383} = 3545.3 \approx 3550 \text{ test time} \quad (3)$$

If two samples are subjected to an accelerated life test up to 3550 hours and satisfied without failure, the B10 life of 9000 hours is guaranteed at a confidence level of 70%.

4. CONCLUSION

In the present study, the performance test was carried out using the rated discharge head-discharge flow test, the maximum discharge flow test, the maximum discharge head test, the efficiency test, the external leakage test, the environmental test, the low temperature test, the high temperature test and the humidity test . Also, the accelerated test time was derived from the pressure failure as an acceleration factor based on the non - failure test time. Based on this test method, it is expected that it can be widely used for the reliability verification test of both suction and vacuum pumps.

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