Testing of Mixed Flow Vertical Turbine Pump

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Abstract - *Centrifugal pumps is a mechanical device that is used to deliver liquid by converting the rotary kinetic energy of liquid flow into dynamic energy. The motor or turbine is used to deliver rotary energy. normally the liquid enter through the impeller from to rotating axis and the impeller accelerate the liquid to outward radially to diffuser or casing through which the liquid exist. The impeller used in centrifugal pumps are made from Aluminum or Steel. The centrifugal is designed using Computer Aided Design (CAD) software by using various metal alloys and Non-Metallic by testing its to check the composite materials, strength and deformation analyze by simulation software. Centrifugal pumps are a sub-type of dynamic axis symmetric work absorbing turbo machinery. The reverse function of the centrifugal pump is a water turbine converting the Potential Energy of water pressure into mechanical rotatory energy.*

***Key Words*: Centrifugal Pump, Vertical Turbine Pump, Performance Testing, Proto type Pump Testing,**

1. INTRODUCTION

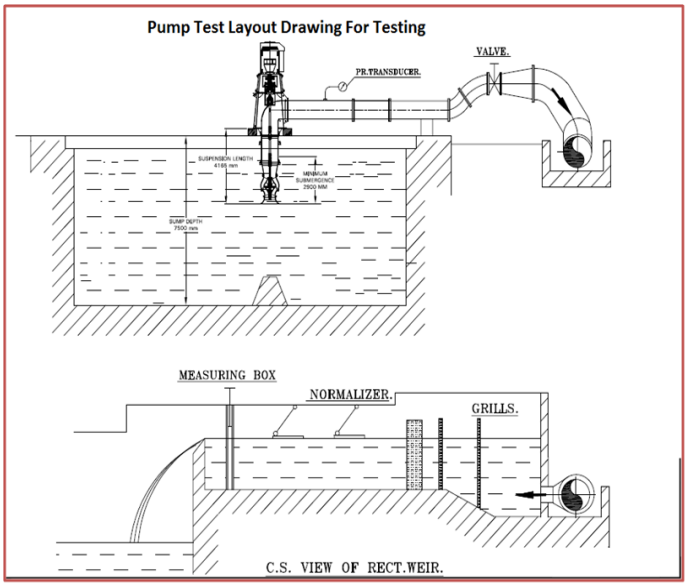
This paper is a part of my ME Dissertation work, In that I took testing part of pump from dissertation work. Kirloskar Brothers Limited, Kirloskarvadi where Performance testing is completed at HRC (Hydraulic Research Center). The test facility built under the guidance and of British Hydraulic Research Association. Test is carried out for power absorbed, efficiency, Discharge, and Head. During pump testing Noise level and vibration level of the pump is recorded. There are 4 test beds which has a depth of 7.5 m. for the discharge and flow we use butter butterfly valve for pumps testing in each well. With the help of short intermediate pipes between flange of discharge and butterfly valve with reduction ratios and diameters checking the flexibility of pump testing discharge flange connected to the butterfly valves. Only Pump unit will be tested. Standard Column pipes and Discharge Head of required size will be used from HRC for testing purpose only. The liquid used in testing will be water at ambient temperature.

1.1 Testing Arrangement of VT Pump

Test bed used for testing was decided based on discharge of pump and total head developed in the pump. According to the discharge of pump and head test bed selected. Line shaft pump has to be selected for design to study. Setup of motor used to drive the pump. Reduced suspension length pump was placed on test bed for testing. Accordingly, further piping controlling valve and flow meter was placed in between piping for measuring the flow of the pump. All necessary instruments like RTD, Digital Flow meter, tacho meter was installed on pump for taking reading of pump during pump operation.

a) Front view of testing arrangement of pump

b) Side view of testing arrangement of Pump



Test-Rig Layout for Mixed Flow Vertical Turbine Pump.

1.2 Instruments used for Performance Testing-

The instruments used during tests are periodically calibrated from NABL laboratory. The read the data input and output of real value is taken from calibration result, which is stated in calibration report. The details of instruments used in testing are as follows.

Discharge Measurement: The discharge is measured by sharp crested rectangular weir.

Head Measurement: Delivery head is measured by delivery pressure transducer mounted on the delivery pipeline.

Power Input Measurement: The power input is measured by power meter.

Measurement of Speed: A digital tachometer is used to measure the speed. It gives the direct reading in rpm.

Vibration Measurement: Vibration is measured as per Hydraulic institute standard by 'Vibration meter' at thrust bearing housing and motor and motor stool holding joint.

Digital Tachometer

Digital sound level meter

Vibration meter

Digital Temp Gun

2. Observations and Sample Calculation-

Total six readings are taken from zero discharge i.e. closed valve condition to maximum discharge of the pump. Specific gravity is considering 1.0 because pumping liquid is water. Table shows the observations during pump testing at specific gravity of 1.0.

Test Conditions-

Atmospheric pressure (mlc) = 9.70 m

Water temperature = 26.50 C

Bearing temperature after test = 36.50 C

Bearing temperature rise =110 C

Duration of pump running = 60 minutes.

$$\text{Pump output} = \frac{(\text{Total Head} \times \text{Discharge} \times \text{sp. Gravity})}{102}$$

$$= \frac{(20.50 \times 611.1 \times 1.00)}{102}$$

$$= 122.82 \text{ kW}$$

$$\text{Pump efficiency} = \frac{(\text{Pump Output})}{(\text{Pump Input})} \times 100$$

$$= \frac{122.82}{140.35} \times 100$$

$$= 87.5\ \%$$

Table -1: Observation Table of Pump Testing

Reading No.	Pump Flow (lps)	Motor Speed (rpm)	Efficiency (n %)	Power (kW)
1	0	983	0	148.40
2	277.8	985	51.50	132.72
3	444.4	983	73.50	138.13
4	611.1	984	87.50	147.74
5	680.6	984	82.50	138.29
6	750	985	66.80	123.28

Reading No.	Head (mtr)				
	*WL to GL Distance (mtr)	Transducer reading (mlc)	Del. Gauge (mlc)	Velocity Head	Total Head
1	0.27	28.53	1.2	0	30.0
2	0.37	23.49	1.2	0.026	25.09
3	0.4	21.66	1.2	0.067	23.33
4	0.47	18.70	1.2	0.128	20.50
5	0.48	15.26	1.2	0.16	17.10
6	0.5	9.31	1.2	0.19	11.20

NOTE: -WL - WATER LEVEL, GL-GROUND LEVEL

Sample Calculation-

Taking Reading No: 4 for sample calculation it is (Close to Duty Point)

Speed measured = 984 rpm

Discharge (Capacity) = 611.11 lps (Converted flow meter reading)

Total head = Water level to ground level distance + Delivery gauge reading (Transducer reading) + Delivery Gauge position with respect to ground + Velocity head correction.

a) Water level to Ground level distance – 0.47 m.

b) Delivery gauge reading – 18.13 m

c) Delivery Gauge position with respect o ground – 1.20 m

Velocity head correction is calculated as follows.

Velocity head correction,

$$\left\{\frac{(V^2)}{2g}\right\} = (Q)^2 \times c'$$

$$= (611.11)^2 \times 0.0000003440$$

$$= 0.128 \text{ m}$$

Where- Q – in lps

C' – 0.0000003440 is constant multiplier for calculations.

Total Head = 0.47+18.70+1.20+0.128

= 20.50 m

Motor Input = 147.74 kW

Pump input = Motor Input x Motor efficiency

= 147.74 X 0.95

= 140.35 kW

$$\text{Pump output} = \frac{(\text{Total Head} \times \text{Discharge} \times \text{Sp. Gravity})}{102}$$

$$= \frac{(20.25 \times 611.11 \times 1.0)}{102}$$

= 122.82 kW

$$\text{Pump efficiency} = \left\{\frac{\text{Pump Output}}{\text{Pump Input}}\right\} \times 100$$

$$\text{Pump Efficiency} = \frac{(122.82)}{140.35} \times 100$$

= 87.5 %

Noise Measurement:

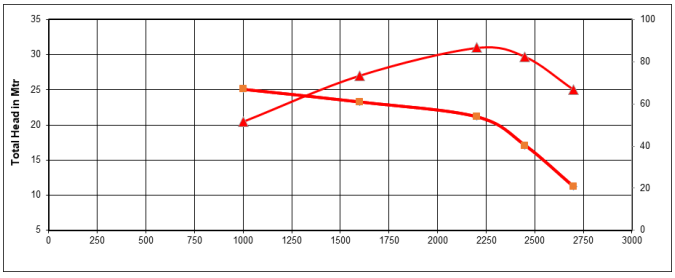
Noise is be measured by 'sound level meter'. Noise level recorded at a distance of 1.0 m from the pump set is 85 dBA.

Vibration Measurement:

Vibration is measured as per Hydraulic institute standard (HIS 14.6) by 'Vibration meter' at thrust bearing housing and motor and motor stool holding joint. Recorded values at motor and motor stool holding joint are as follows.

X =3.8 mm/sec, Y=4.2 mm/sec, Z= 4.3 mm/sec.

After experimental test and reading calculations characteristics performance curve is plotted for as per the test readings. Figure 5.4 shows the tested performance curve



Performance Curve of Tested Pump

CONCLUSIONS

Pump Performance test is taken at pump test lab of Kirloskar Brothers limited factory. These observation readings are used to plot performance characteristic cure. The tested

performance curve is very well matched with required performance curve.

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REFERENCES

[1] Charles M. Burt, "Improving Pump Performance", IA Technical Conference — Anaheim, CA. (2008).

[2] H Chen, W Liu, W Jian, and P Wei, "Impellers of Low Specific Speed Centrifugal Pump Based on Draughting Technology", 25th IAHR Symposium on Hydraulic Machinery & Systems. IOP Publishing

[3] World Pumps, "Advance Design Software for Pumps", www.worldpumps.com (2007)

[4] Kirloskar Brothers Limited, "Rotodymanic Pumps", Engineering Data Book.

[5] Ed Butts, "Vertical Turbine Pumps: Basic Design Features", Water Well Journal (2003)

[6] American National Standard for Vertical Pump for Nomenclature and Definitions (ANSI/HI 2.1-2.2-2000), Hydraulic Institute

[7] Kirloskar Brothers Limited, "Kirloskar Vertical Pump", Vertical Turbine Product Catalogue

[8] Personal communication with engineers from Product Engineering Division, Pump testing lab, Manufacturing Department, assembly shop of Vertical Turbine Pump.

[9] "American National Standard for Vertical Pumps for Nomenclature and Definitions", ANSI/HIS 2.1-2.2, 2000

[10] "American National Standard for Centrifugal Pump Tests", ANSI/HIS 1.6, 2000

BIOGRAPHIES

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