Performance investigation on double acting reciprocating pump

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***Abstract*- The present article summarizes the performance of double acting reciprocating pump in laboratory set up. The purpose of the performance testing is to verify the theoretical calculations with the practical performance. A performance testing of the double acting reciprocating pump is used to determine the working condition and analyzing the delivery and suction pressure which plays an important role in maintaining proper heads. Using conventional performance testing methods, efficiency and working of the pump are improved. Various measuring instruments are used to measure flow rate, suction and delivery pressure, power consumption etc. Reciprocating pumps are mostly used where flow is constant and high delivery pressures are required, so they are exposed to more risk of failure when changing the pressure by manually regulating a valve. The obtained result show that the effect of various parameters such as speed, flow rate, pressure etc. on pump performance.**

Index terms- Delivery pressure, Performance testing, Reciprocating pump, Suction pressure

1. INTRODUCTION

Reciprocating pump uses the pumping action to move fluids by a plunger or piston that travels back and forth inside a cylinder. The duplex reciprocating pump model is used for testing which is based on eccentric cam mechanism with a dual cylinder system. These pumps are self-priming which supplies fluids at high pressure and constant flow rates compared to centrifugal pumps. Reciprocating pumps are the most common pumps used where a high delivery pressure is required and minimum quantity is handled, as in order to maintain the process they need a lot of pumps to carry out the process [1-5]. Performance testing of pumps has to be done periodically to avoid any damage to the equipment, as even the strength degradation of the pump can cause it vibrate more rapidly which can lead to the pressure drop and the pump not working in an efficient manner. The main reason behind such inefficient operation is due to gaps and misalignment in the assembly itself. A smart work in the testing can help in process monitoring for degradation of pumps and would also allow the maintenance personals to make a schedule for the checkup of pumps [6-8]. These pumps mainly have a circular profile and have to be performance analyzed at a specific period of time as their flow is little. Even the shape plays an important role in the performance of the pump. Maintenance cost can't be increased for this small quantity of water being displaced [9-10]. The present investigation has been carried out to study an approach for performance testing of pumps by integrating sensors for measuring pressure variations and energy supply for running the pumps and analysis of the output. The present approach can be used for testing the pump at industries or even at households and also similar equipment or product by determining the parameters and their values that affect the performance of the equipment. Reciprocating pumps are widely used due to their ease of use and simple arrangement. In case of this pump, flow is constant but also varies with variation in pressure. Output flow will be decreased when system pressure will be increased.

II. EXPERIMENTAL SETUP

The apparatus consists of a double acting-single cylinder reciprocating pump is operated on closed circuit basis. An AC motor with 3 speeds is provided to regulate the rpm of the pump. Suction and delivery head can be varied by the valves provided and Pressure & Vacuum Gauges can measure it. Flow of water is measured by using measuring tank and stopwatch as shown in Fig. 1.

Fig. 1. Experimental set-up of reciprocating pump

The following are the steps for the performance testing of a double acting reciprocating pump:

1. Clean the apparatus and make tank free from dust and foreign particles.
2. Close the drain valve provided below the auxiliary tank.
3. Fill the sump tank with clean water above the suction level of supply line.
4. Open the flow control valve given on water discharge line and control valve given on suction line.
5. Ensure that power switch given on panel should be on.
6. Set the speed of pump with control knob provided in electric panel board in front section of apparatus.
7. Operate the flow control valve to regulate the flow of water in the discharge by the pump.
8. Record discharge pressure by means of pressure gauge, provided on discharge line.
9. Operate the control valve to regulate the suction of pump.
10. Record the suction pressure by means of vacuum gauge, provided at suction line of the pump.
11. Also note energy input for this time from energy meter.
12. Note down the rpm of the pump in revolution counter provided in the panel board.
13. Measure the flow of water, discharge by the pump, using the stopwatch and measuring tank.
14. Repeat the same procedure for different pressure head.
15. Repeat the same procedure for the different rpm with help of rheostat provided in the panel board.
16. When the experimental measurements are over, properly open the gate valve provided on discharge line.
17. Switch off the pump first.
18. Switch of the main power line supply to panel board.

The following are the precautions taken while carrying out experiments on double acting reciprocating pump.

- Never run the apparatus, if power supply is less than 180 volts and above 230 volts.
- Never fully close, the delivery line and by pass line valves simultaneously.
- To prevent the clogging of moving parts, run pump at least once in fortnight.
- Always use clean water.
- If the apparatus will now use for more than month, drain the apparatus completely.
- Always keep apparatus free from dust.
- If water is not lifted, the revolution of the AC motor may be reverse. Change the electric connection of motor to change the revolutions.
- If the panel is not showing input, check the fuse and main supply electricity.
- Do not run the pump at fully speed for the longer period to avoid leakages of water in discharge lines.

The following are the specifications of the pump:
Stroke length – 16 mm
Piston diameter – 22 mm
DC motor with 1 HP power supply.

III. DATA REDUCTION

The theoretical capacity of pump [11] is given by

$$Qth = 2LAN/60 \quad (1)$$

The actual capacity of pump [12] is given by

$$Qact = [(HF - HI)] * Acstank/Time \quad (2)$$

Slip of pump given by

$$S = Qth - Qact \quad (3)$$

Volumetric efficiency of pump is given by

$$\eta = \frac{Qa}{Qth} * 100 \quad (4)$$

IV. RESULTS AND DISCUSSIONS

The following are the observations obtained for the motor speed 140 rpm.

Table -1. Observation table

Sr. No.	P_s mmHg	P_d Kg/cm^2	HI cm	HF cm	Time sec	Power initial	Power final
1	230	2	2	7	19	0.278	0.282
2	200	1.5	2	7	30	0.247	0.26
3	170	1	2	7	32	0.167	0.18
4	100	0	2	7	33	0.522	0.537

The reciprocating pumps are positive displacements pumps i.e. initially, a small quantity of water is taken into a chamber and is physically displaced and forced out with pressure by a moving mechanical element. The moving mechanical element may be a gear system rotating in the housing or piston moving in a cylinder with the help of external power. Thus, if the chamber is alternatively filled by drawing in the water to be pumped and emptied by forcing it out, the water from the sump can be raised to the required height. Since the volume of water would depend greatly on speed with which the chamber is filled and emptied, the discharge will be propositional to the speed of the moving element as shown in Fig. 2 and Fig. 3.

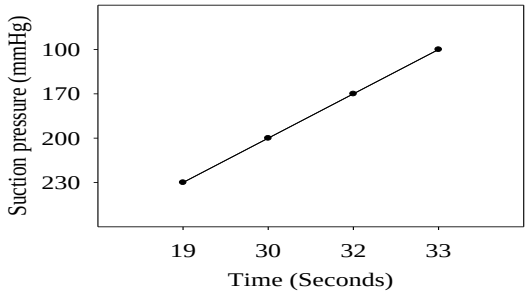

Fig. 2. Variation in suction pressure with time

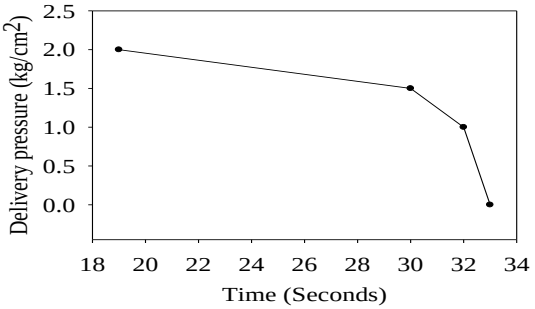

Fig. 3. Variation in delivery pressure with time

V. CONCLUSIONS

The performance of the double acting reciprocating pump has been found by measuring the operational parameters during operation. Duplex reciprocating pumps produce a fixed discharge volume of fluid pumped for each rotation, regardless of the fluid being pumped. Efficiency of the pump is directly related to the energy consumption. The overall efficiency of a duplex reciprocating pump and motor set up is above 14% which is not common in a reciprocating pump (single acting of efficiency below 10% in general). This reciprocating pump can provide fluid at constant flow rates over a wide range of pressure. It is expected that the convenience, efficiency and advantages offered by duplex reciprocating pump will make it commercial for its use. There is likely to be a significant increase in the application due to its energy efficient.

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