ISSN 2347 - 3983
Volume 9. No. 7, July 2021
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter06972021.pdf
https://doi.org/10.30534/ijeter/2021/06972021

Characteristic Curves of Chemical Pump

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ABSTRACT

The paper reports investigation variable speed Chemical pump Characteristic which includes flow, pressure, and power consumed and pump efficiency under condition of atmospheric pressure and temperature in Shuwaikh Kuwait. The experimental procedure will run on G.U.N.T Water system which permits the determination of characteristic curves – of a centrifugal pump by change the flow rate using a globe control valve. Digital displays show the speed and the electrical power consumption of the pump, the volumetric flow is shown by Rota meter the pressure reading from the suction and delivery pressure gauges. The results from the water system are compatible with that from experimental calculations with 5 % deviation, which mean that the system is appropriateness.

Key words: Chemistry, pumps, characteristics curve, flow, pressure, power consumption.

1. INTRODUCTION

Chemical centrifugal pumps are used to pump acids, alkalis and other corrosive liquids with low viscosity and neutral media. Chemical centrifugal pumps have a variety of designs to choose from in terms of materials, seals, and design and installation dimensions. The most common type of pump. Centrifugal pumps are compact and relatively simple in design, and contain no moving parts that are easily subjected to wear.

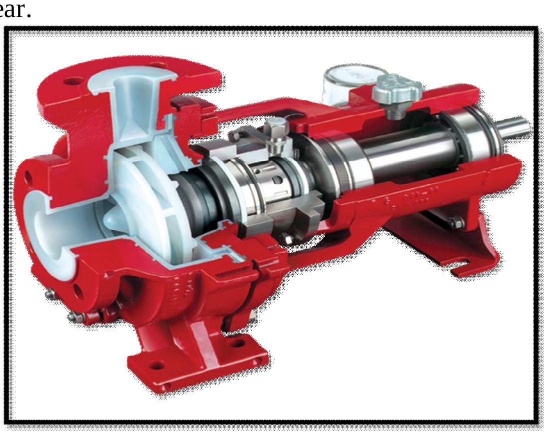

Figure 1: Chemical centrifugal pumps

2. LITERATURE SURVEY

A review on improvement of efficiency of centrifugal pump through modifications in suction manifold

Constant-speed centrifugal pumps can provide from zero to maximum capacity, depending on the delivery head, design and suction conditions. The working pressure in the system depends on the flow rate in the system and the position of the system in terms of pipe length, fittings and pipes. Changes in size, height of the liquid, pressure on the surface of the liquid. Every unit of energy saved in the app helps protect the environment and achieve a green earth. In Output added Pump system efficiency: the work aims to improve system performance, focusing on the suction side, while making overall efforts to improve performance related to lower energy consumption or increased effective lift height. Pumping system [1].

Pre Improving the Hydraulic Efficiency of Centrifugal Pumps through Computational Fluid Dynamics Based Design optimization.

Calculation In this part, we will describe the general calculation structure used in optimization and apply it to the specific system in Section III. We will first introduce the general situation and then briefly outline how to simplify the results for our particular situation [2].

An Experimental Study on Centrifugal Pump to Determine the Effect of Radial Clearance on Pressure Pulsations, Vibrations and Noise.

The centrifugal pump is one of the advanced basic equipment and has many advantages over its contemporaries. The main advantages of centrifugal pumps are their higher flow rates, higher operating speeds and the ability to lift high-viscosity liquids such as oil, mud and water. Waste, pulp, molasses, chemicals, etc. Compared with piston pumps, piston pumps can handle a relatively small amount of liquid and operate at a relatively low speed range. The speed range is limited to pure water or liquids with low viscosity and does not Limited amount of pollutants. The overall maintenance, delamination, cavitation and common suffocation problems. Due to lower wear, the total maintenance cost of centrifugal pumps is also relatively low. The main disadvantage is that it is susceptible to complex vortex formation, noise and vibration, and cannot generate higher pressures, such as those operated by piston pumps [3].

In [7], a feasible way to improve pump performance is to redesign or modify the radial pump impeller. The purpose of vane pump modification is to improve pump efficiency, reduce cross flow, reduce secondary incident flow and reduce the return area at the exit of the impeller. There are three cutting blades on the impeller. The exit blade angle is 20°, and the impeller rotates at 2400 rpm. The added separator page variants are 0.25, 0.375, and 0.5 times the original page length. The separating blade is located on the outside of the impeller. Adding some vanes to the outside of the 0.5L impeller will increase the pump head to 22%, and the number of pumps will be 38.Hydraulic efficiency is 66%. The best pump efficiency (Q_{bep}) was 3.02 x 10^{-3} m^3/s.
The influence of gas-water two-phase mixing on the characteristic curve of centrifugal pump was discussed in [8], the inoperability of pump vibration at different flow rates under these conditions is considered. The ability to use experimental research results for numerical modeling for design and training, as well as the ability to use vibration and sound analysis to capture changes in equipment operating conditions. The results show that vibration analysis can provide accurate information about the functional status of the pump and the pumping process. In addition, the sound emission can also assess the state of the pump. However, further improvements are needed to better capture useful sound and isolate it from the surrounding environment.

Chemical centrifugal pumps working principal
Centrifugal pumps have a spiral-shaped housing containing an impeller fitted with blades. With caned pumps the impeller is mounted directly on the motor shaft. The fluid enters the impeller via the intake fitting and is accelerated in to circular path by a rotating impeller. The centrifugal force spins the fluid outwards in a radial direction so it reaches the spiral housing and then the pressure fitting. The spiral housing acts as a spiral manifold. The fluid is decelerated in this manifold. The Kinetic energy stored in the fast-flowing fluid is converted into static pressure energy. The fluid leaves the pump at high pressure via the pressure fitting. This high pressure is the so-called pump head. The fluid is taken in at the intake fitting. As the fluid is accelerated to a high speed in the impeller, part of the static pressure energy is converted into kinetic energy. The impeller inlet is thus subject to relatively low static pressure, which is transferred to the intake fitting. This low pressure is the so-called suction head.

3.EXPERIMENTAL TEST RIG

The Chemical centrifugal pump test rig Figure 2 permits the determination of characteristic curves of a centrifugal pump by using of a control valve to regulate the flow rate. Four gauges are used for read the pump parameters:

- Electrical power digital gauge.
- Rotameter.
- Suction pressure.
- Delivery pressure.

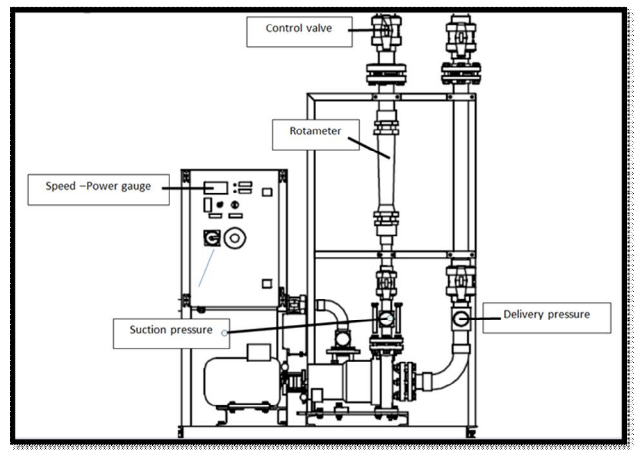

Figure 2: Test rig used in the study

Chemical Pump Characteristic
The total head TH of a pump is the mechanical work transferred by the pump to the medium pumped, normal water density(ρ = *1000kg/m³*) and specific gravity (γ= *9810 N/m³*). The total head TH is measured as the increase in the usable mechanical energy of water pumped between the inlet and outlet of the pump. The unit of the total head is the meter. Despite this unit, the head must never be taken to signify a length, the total head units is energy per unit weight i.e. *j/N*.
Total head TH consists of:

TH= $h_d - h_s$: Difference in height levels of inlet and outlet cross-section of pump.

$\frac{p_d - p_s}{\rho \times g}$: Difference in pump pressure of pumped medium between inlet and outlet

$\frac{v_d^2 - v_s^2}{2 \times g}$: Difference in speed levels of pumped medium between inlet and outlet

These yield the Total head equation for a pump as:

$$TH = h_d - h_s + \frac{p_d - p_s}{\rho \times g} + \frac{v_d^2 - v_s^2}{2 \times g} \quad (1)$$

$h_d - h_s$= 0.36 m for the experiment rig

$v_d = Q \div 0.00196$ in m/s (outlet area = *0.00196 m2, d = 50 mm*).

$v_s = Q \div 0.00332$ in m/s (inlet area = *0.00332* m^2, *d = 65 mm*).

$$\eta = \frac{HP}{EP} * 100\%$$

The degree of efficiency is defined here as the ratio of the hydraulic power of the pump HP to the electrical power consumption EP.

Hydraulic power in HP w is calculated using:

$$HP = \rho \times g \times Q \times TH \quad (w)$$

Where *TH*:Total head in m , h_d : Height level of outlet cross-section of pump in m, h_s Height level of inlet cross-section of pump in m , p_d Static pressure in outlet cross-section of pump in Pa , p_s Static pressure in inlet cross-section of pump in Pa, v_d Flow speed in outlet cross-section of pump in m/s, v_s Flow speed in inlet cross-section of pump in m/s , ρ Density of fluid in kg/m^3 = 1000 kg/m^3 for water , g Acceleration due to gravity = 9.81 m/s^2 and Q Volumetric flow rate m^3/s

Experimental Procedure

-start up;

1. Switch on the electric power.
2. Adjust the pump speed to 2100 rpm.
3. Start control valve full open, record each of flow rate, electrical power, suction pressure and delivery pressure.
4. Repeat step 3 at different valve opens.

-**Measured values**: Measured values will record in Table (1)-Appendix A. **-Calculations:** Calculations of flow rate, head losses and hydraulic power and efficiency are shown in Table (2)

4. RESULTS AND DISCUSSION

Figure 3 shows the relation between total head loss of the pump versus Flowrate, it can be noticed that the relation between total head loss of the pump and the Flowrate is nonlinear and as the Flowrate increases the total head loss (TH) decreases.

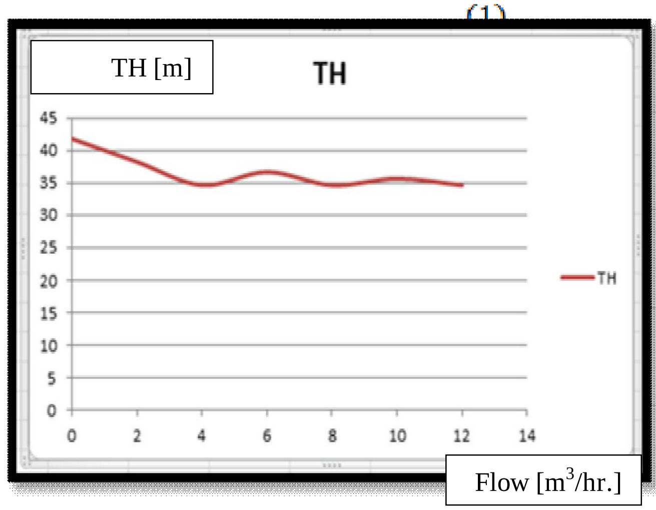

Figure 3: Total Head loss vs. Flowrate

Figure 4 shows the relation between efficiency of the pump and its flow rate, it can be noticed that as the Flowrate of the pump (work done by the pump) increases the efficiency increases (nonlinear relation).

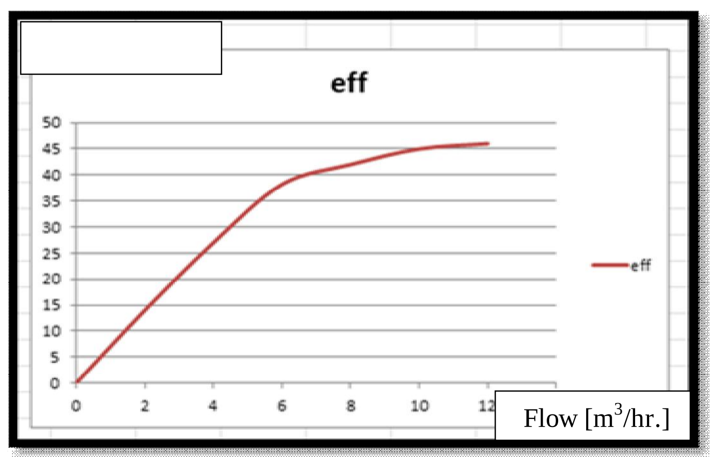

Figure 4: Relation between efficiency of the pump and its flow rate

Figure 5 shows the relation between power consumed by the pump and the Flowrate, it can be noticed that as the Flowrate of the fluid increase, the pump consumed more power, the relation is nonlinear.

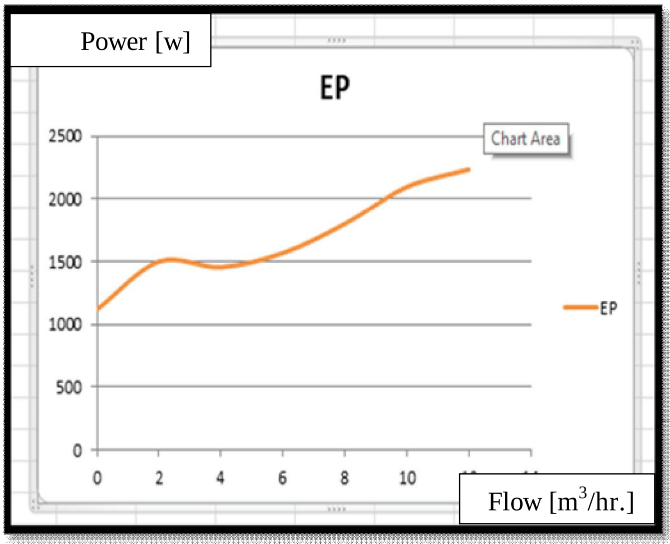

Figure 5. Power consumed by the pump and the Flowrate

5. CONCLUSION

The following conclusions can be carried out from last results and analysis:

-The performance of pump is affected with running out of pump set point, pump should run at recommended back pressure and flow.

-From the graph Fig (4) the set point for the pump at 800 L/min and 18 m Total head that's lead to efficiency around 64 %

-Pump efficiency can increase if run at lower speed (2000 rpm) but it could not cover the flow and pressure demand.

-Three types of problems mostly encounter operation of caned pump: operate out of set point, poor maintenance practices and run out of recommended speed.

-The experiment results typical to pump charts of factory.

Depending on last investigation and results, it's recommended to carry out a lot of medication to increase overall efficiency of pump using (CFD) in pump design, follow the pump operation procedure and apply preventative maintenance according to maintenance schedules.

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APPENDIX A

Table 1: Measured values

Flow (m^3/hr)	Suction pressure (bar)	Delivery pressure (bar)	Electric Power (w)
12	- 0.3	3.1	2285
10	- 0.3	3.2	2013
8	- 0.3	3.1	1855
6	- 0.2	3.4	1586
4	- 0.1	3.5	1490
2	- 0.05	3.8	1587
0	0	4.1	1389

Table 2: Calculated values

Flow (m^3/hr)	Head (m)	Hydraulic Power (w)	Efficiency %
12	34.66	1038.8	46
10	35.68	944.4	45
8	34.65	766.6	42.4
6	36.7	601	38.2
4	34.66	399	27.5
2	38.24	311	14
0	41.79	0	0