RESEARCH ARTICLE OPEN ACCESS

Characteristic Curves of Chemical Pump

Munther Ibrahim Almatouq
Section Head of Chemical Process department, Higher Institute of energy– (PAAET) Public Authority for Applied Education and Training – State of Kuwait.

ABSTRACT
The paper reports investigation variable speed Chemical pump Characteristic which includes flow, pressure, power consumed and pump efficiency under condition of atmospheric pressure and temperature in ShuwaikhKuwait.
The experimental procedure will run on G.U.N.T Water systemwhich permits the determination of characteristic curves – of a centrifugal pump by change the flow rate using aglobe 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.

Date of Submission: 25-02-2020 Date Of Acceptance: 05-03-2020

I. INTRODUCTION

Centrifugal chemical pumps are used for pumping acidsand alkalis and other low-viscosity, aggressive liquidsand neutral media.

Chemical centrifugal pumps are available in an enormous range of designs in terms of materials, seals, types of construction and installation sizes. Fig(1). Generally centrifugal pumps are one of the most common types of pumps. Centrifugal pumpsare characterized byacompact designand are relatively simple structure and donot include anymoving components which are readily subject to wear.

Fig (1) Chemical centrifugal pumps

II. LITERATURE SURVEY

1.1 A Review On Improvement Of Efficiency Of Centrifugal Pump Through Modifications In Suction Manifold

A centrifugal pump operated at constant speed delivers any capacity from zero to maximum depending on the head, design and suction conditions. The operating pressure of the system is a function of the flow through the system and the arrangement of the system in terms of pipe length, fittings, pipe size, the change in liquid elevation, pressure on the liquid surface. Every unit of power saved in the application contributes towards conservation for the environment and towards Green Earth. Every inch of enhancement in the `head' at the output side adds to the efficiency of the pumping system. This work aims at improving the performance of the system with a focus on the suction side while contributing to the global effort in upgrading the performance. This work is relevant in the context of lowering power consumption or improving the effective head of the pumping system[1].

1.2 PreImproving the Hydraulic Efficiency of Centrifugal Pumps through Computational Fluid Dynamics Based Design optimization.

THECOMPUTATIONAL TECHNIQUE In this section, we shall describe the general structure of the computational technique used in the optimization that we apply to a specific system in section III. We shall present this general case first and then indicate briefly how the results will simplify for our special cases [2].

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

Centrifugal pump is one of the basic and a superb piece of equipment possessing numerous benefits over its contemporaries. The main advantages of a centrifugal pump includes its higher discharging capacity, higher operating speeds , lifting highly viscous liquids such as oils, muddyand sewage water, paper pulp, sugar molasses, chemicals etc. against the reciprocating pumps which can handle relatively small quantity of liquid operating at comparative slower range of speeds that is limited to pure water or less viscous liquids free from impurities limited from the considerations of separation ,cavitation and frequent choking troubles. The overall maintenance cost of a centrifugal pump is also comparatively lesser due to less wear and tear. While major disadvantage includes vulnerability to a complexities of eddies formations, noise and vibrations and inability to generate higher pressures as executed by the reciprocating pumps [3].

1- 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 acceleratedintocircularpath 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 Kineticenergy stored in the fast-flowingfluidis converted into static pressure energy. The fluid leaves the pump at high pressure via the pressure fitting.This high pressureistheso-called pump head. The fluidis taken in at the in take fitting. As thefluid 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.

2- Test Rig

The pump and valve test rig Fig (2) permits the determination of characteristic curves of a centrifugal pump by using of a motorized control valve to regulate the flow rate. Four digital displays show:

- Position of electrical control valve (2)
- speed (4)
- electrical power (6)
- Flow rate (7).

The unit is equipped with four pressure gauges:

- Differential pressure gauge measuring range: 0...2.5 bar (9).
- Differential pressure gauge measuring range: 0...4 bar(10).
- Deliverypressure gauge measuring range: 0...4 bar(28).
- Suctionpressure gauge measuring range: -1...+0.6 bar(30).

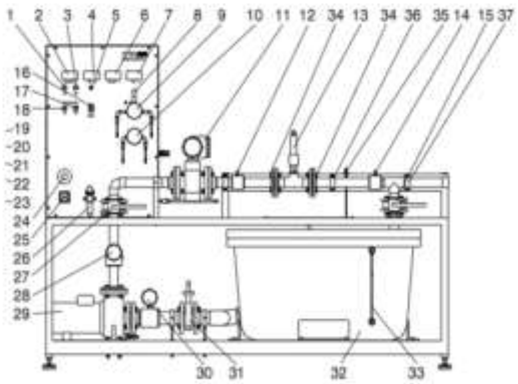


Fig (3) Test rig [2]

3- 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/m^3) and specific gravity (□ = 9810 N/m^3). The totalhead TH is measured as the increase in the usablemechanicalenergyof water pumped between the inlet and outlet of the pump. The unit of thetotal 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.

Symbols:

TH Total head in m

h_d Height level of outlet cross-section of pump in m

h_sHeight level of inlet cross-section of pump in m

p_dStatic pressure in outlet cross-section of pump in Pa

p_sStatic pressure in inlet cross-section of pump in Pa

v_dFlow speed in outlet cross-section of pump in m/s

v_sFlow speed in inlet cross-section of pump in m/s

ρDensity of fluid in kg/m^3= 1000 kg/m^3 for water

g Acceleration due to gravity = 9.81 m/s^2

Q Volumetric flow rate m^3/s

Total head TH consists of:

$h_d - h_s$: 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 pumpedmediumbetweeninletandoutlet

$\frac{v_d^2 - v_s^2}{2 \times g}$: Difference in speed levels of pumpedmediumbetweeninletandoutlet

These yield the Total head equation for a pump as:

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

$h_d - h_s$= 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).

$\eta = \frac{HP}{EP} \times 100$ % (2)Thedegreeofefficiencyisdefinedhereasthe ratio of the hydraulic power of the pump HP to the electrical power consumption EP.

Hydraulic power in HP w is calculated using:

$HP = \rho \times g \times Q \times TH$ (w) (3)

4- Experimental Procedure

7-**1 startup;**

1. Switch on the electric power.
2. Adjust the pump speed to 2700 rpm.
3. Start with the motorized control valve full open, record each of flow rate, electrical power, suction pressure and delivery pressure.
4. Repeat step 3 at different valve opens.

7-2 **Measured values**

Measured values will record in table (1)

Flow .m^3/hr	Suction pressure bar	Delivery pressure bar	Electric Power w
8	- 0.3	1.3	4020
7	- 0.3	1.3	4033
6	- 0.3	1.4	3990
5	- O.2	1.6	3850
4	- 0.1	1.9	3470
3	- 0.0 5	2.1	2750
2	0	2.2	2000
1	0	2.25	1857
0	0	2.3	1800

Table (1) Measured values

7-3 calculations

Calculations and are shown in table (2)

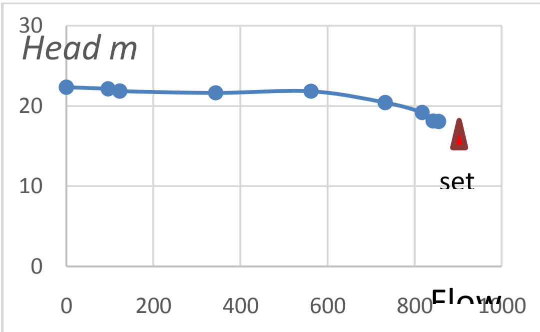
Flow .m^3/hr	Head m	Hydraulic Power w	Efficiency %
8	18.03	2516	62.6
7	18.1	2491	61.8
6	19.15	2558	64.1
5	20.4	2442	63.4
4	21.8	2003	57.7
3	21.6	1211	44
2	21.83	439	22
1	22.1	347	18.7
0	22.31	0	0

Table (2) Calculated values

III. RESULTS

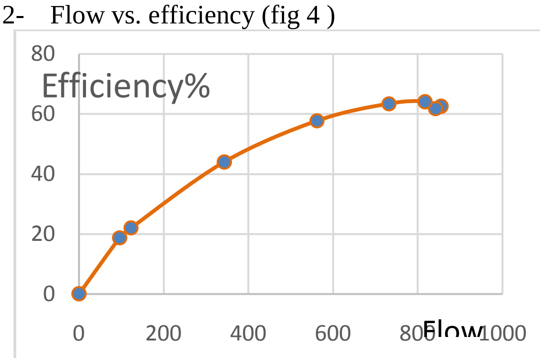
From previous calculation we get three relations:

1- Flow v.s Head (Fig 3)



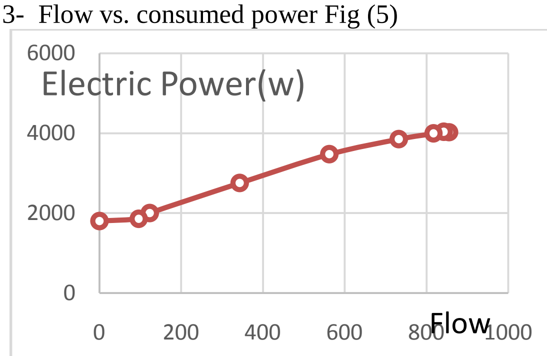
Flow v.s Head (Fig 3)

2- Flow vs. efficiency (fig 4)



Flow v.sefficiency (Fig 4)

3- Flow vs. consumed power Fig (5)



Flow vs. electric power (Fig5)

IV. CONCLUSION

- 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.

RECOMMENDATION

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.

REFERENCES

[1]. Mr. Amitkumar Bhimrao Salunkhe Vice Principal, Shree Shivajirao Deshmukh Institute of Technology, Red-Shirala, Maharashtra, India
[2]. Mr. Ranjit Ganaptrao Todkar Professor, Department of Mechanical Engineering/ ADCET, Shivaji University, Maharashtra, India
[3]. Mr. Kedar Madanrao Relekar HOD, Shree Shivajirao Deshmukh Institute of Technology, Red-Shirala, Maharashtra, India
[4]. Abdallah Ait Moussa*, Lin Yunhao* *(Department of Engineering and Physics, University of central Oklahoma, 100 University Drive, Edmond, Oklahoma, USA 73034.)
[5]. Amit Suhane Assistant Professor, Mechanical Engineering Department, M.A.N.I.T., Bhopal, M.P. India-462051
[6]. G.U.N.T (PUMP AND VALVE) manual and test rig.
[7]. Frank D. Graham Audels pumps hydraulics air compressors Theo. AUDEL & CO. New York 1943
[8]. GRUNDFOS RESEARCH AND TECHNOLOGY (The Centrifugal Pump). AND TECHNOLOGY

Munther Ibrahim Almatouq, " Characteristic Curves of Chemical Pump " *International Journal of Engineering Research and Applications (IJERA*), vol.10 (03), 2020, pp 32-35.