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Evaluation of thePerformance of Centrifugal PumpType (98-00-000)

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***Abstract**:Experimental study was carried out at the laboratories of the General Company for Automotive and Mechanical Equipment - Alexandria 50 km south of Baghdad in 2016 to evaluate the effect of changing the pumping height (sump) and thehead (delivery head) from the water level and increasing the pressure of the pump type (98-00-000) (4"× 4") Pump. Three levels of delivery head were used(5, 10 and 15 meters) and three section depths included (0.6 , 1.1 and 1.6 m) were used in this study. The speed is 1450 rpm. A laboratory experiment was done using (CRD) Complete Randomize Design in three replicates. The results of the study were as follow:pumping discharge(**Q**) is reduced by increasing the head of the pump and the Sump . Water horsepower(**WHP**) is increase byincreasing the head and reduced the sump .Brake horsepower(**BHP**)is reduced by increasing the head and reduce the sump . Efficiency(**eff**) is increased with increasing head . The pumping efficiency was the best in the interaction between the sump (0.6 m) and the delivery head (15m) was superior in getting higher (**eff**.) of 970.622 %).*

***Keyword:**centrifugal pump, water horsepower, brake horsepower, efficiency*

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I. Introduction

Pumps which have an essential role in irrigation, moving and lifting liquids in general to the high elevations, which are mechanical equipment raise liquids from low to high level. The Pumps are necessary and very important equipment used in large fields and need to study so that appropriate pump can be chosen for a particular performance.The possibility of operating the pumps at different speeds and pressures and their impact on the performance are very important so that the Iraqi farmer can use the pumps efficiently and benefit from increased productivity.

In view of the country's need for irrigation pumps, the General Company for the manufacture of cars and equipment / Mechanical Lab - Alexandria manufactures various types and sizes of irrigation pumps. In order to develop the pumps and improve their performance and solve their manufacturing problems, tests are required for these pumps which are manufactured in the above company and performance evaluation. The centrifugal pump 4 "x 4" type 98-00-000 was chosen. that the centrifugal pump act is the reverse of the turbine's action or action, the turbine converts the hydraulic energy into mechanical energy (Cherkassky 12990). While the pump converts mechanical energy into hydraulic power. Its advantages are simple, cost-effective, stable, discharge, continuous and easy to operate. The disadvantages are the limited height of the suction pipe and the need to fill the suction tube and pump body with water before operating it. The outer head compressor is a vertical head which be needed by pump to left the water to it. The pump is considered as a power transmission device and cannot generate energy. The pump's moving energy, some of which go to generate pressure (rise) in the liquid and a section to give velocity to the liquid and a section loses due to friction between the liquid and the walls of the irrigation group of tubes Valves, inverters, etc., this is expressed by the loss of friction. (Bachus L and Argel 2003) The monomeric compressor given by the pump is reduced by increasing discharge. The compressor, which corresponds to zero discharge, is called the shut-off head. The pumping height is divided into three sections: the height of the fixed suction, the height of the fixed drive and the high friction. The push pressure of the centrifugal pump can be controlled by the push valve. For the purpose of obtaining the required power to withdraw and lift the fluid, the pump gears must be rotated with a number of specific cycles according to the pump design and measured by a Rot. /mint (rpm) and symbolized by the symbol (N) (Bliesner and Keller 1982).

The aim of this study is to evaluate the performance of the pump (98-00-000) for the purpose of determining the best efficiency point by conducting a test with the change of the pressure from low to high and changing the pump height from the water level (sump).

II. Materials and Methods

The study was conducted in the laboratories of the General Company for Automotive Industries and Equipment / Mechanical Lab - Alexandria, located at 50 km south of Baghdad, which belongs to the Ministry of Industry and Minerals, in 2016 to evaluate the effect of different pump level from the water surface and increase the pressure in the performance of centrifugal pumptype (98-00- 000) and determine their efficiency.

Pump Specification: A centrifugal pump type (98-00-000) (4 "x 4") with an electric motor with a capacity of 5.5 kW and a speed of 1450 rpm. The experiment was carried out using CRD design. The study included the following: The pump tests were carried out using a platform for testing the pumps in the laboratories of the General Company for Automotive Industries and Equipment / Mechanical Lab as follows: (Esmaaeil 2001)

1. Assembling the pumping unit with the electric motor on the inspection platform for the purpose of running the pump at a speed of 1450 rpm.
2. Install the pumping crew on the inspection platform designated for this purpose, prepare the pump by dictating the suction tube and the hole of the internal pump with water, and lock the push valve
3. Running the pump from the electric panel and then start to open the valve payment gradually for the purpose of reducing the pressure of the payment until it reaches (15 m)Here began the pump to pump water with a certain discharge.
4. Start taking the readings where the measure was measured in the manner of size and fix the speed of the pump and install reading the negative pressure meter and read the pressure gauge and read the number of amps drawn by the electric motor.

In the same way, the pump is tested on pressure 5m and 10 m and 15m with three replicates.

The studied characteristics and methods of calculation:

The **discharge** was measured by the volumetric method and used the fallowingequation:(Allteef and Alhadeethy 1988)

Q = (vol.) / T

Where:

Discharge=M^3/hr

Vol. = Size M^3

T = Time.hr

Calculation of total pumping height (**TDH**) (Total Dynamic Head).

The value of the total pumping height is included in most of the equations for centrifugal pumps and is calculated from the following equation suggested by (Bhattacharya 1975)

TDH = hgd - hgs + z

Where:

Hgd. = reading the pressure gauge (positive), bar, (1 bar = 10.193 m)

Hgs. = reading a barometer (negative), bar

z. = The difference in height between Zs and Zd, Figure 1:

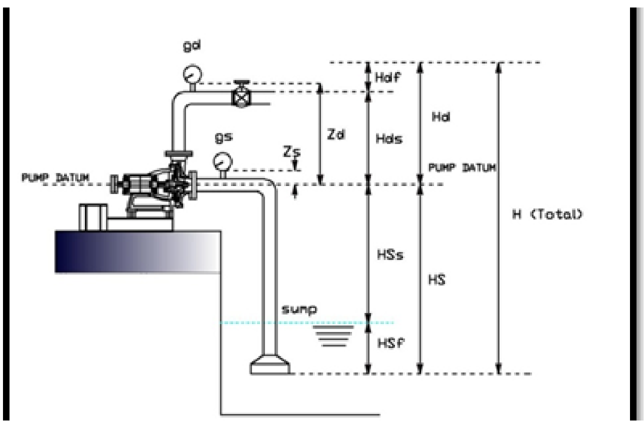

Figure 1: Symbols of total dynamic head

Water horsepower (**WHP**):power was calculated using the following formula proposed by (Arora 2005).

WHP = QH /273

Where Q = discharge , m3 / h

H = Head

WHB = Water horsepower - HP

BHP :Brake horsepower was measured using an electric motor that was calibrated and measuring the electrical . power consumed in kilowatts according to the proposed equation of (Alqaice 2008).

P in put = $\sqrt{3}$ ***× v × I × cos***

Whereas:

P input =The power withdrawn from the electric motor,(watt)

V = voltages (380 v)

I = pull current (Ampere)

cos θ= power factor (0.8) (as determined by the manufacturer company)

Thus, the output power of the electric motor is extracted from the following equation

P out put = p in put × motor eff.

(Where: p out put = power out of the electric motor (engine column capacity), watt)

Motor eff. = Electrical design efficiency % (87)

(As determined by the manufacturer)

The input capacity of the pump (column capacity) (Bhp) is then derived from the following equation

BHP. = p output × drive eff.

Whereas:

BHP. = Brakehorsepower ,(Watt)

Drive eff. = Efficient transfer of kernels (0.95 -0.97)

Then watt will be convert to the horse from by using the following equation which proposed by :***Watt / 1000 = kwx1.341 = hp***

PumpingEfficiency:

The pumpingefficiency, which is the ratio between Water Hours Power capacity and brake horsepower, is measured by the following equation (Robert L.S 1998).

Eff. pump = output / input = WHP / BHP

Where: eff.pump = total efficiency of the pump %

WHP. = water horsepower, hp.

BHP = brake horsepower, hp.

III. Results and Discussion

1.Dicharge (Q): Table (1) shows that the results of the statistical analysis showed a significant effect of sump in discharge where the discharge decreased as the sumpincreased . The discharge decreased from (61.9 m3/hr) to (56.9 m3/hr) and then To (51.9 m3/hr) when using the sump (0.6m, 1.1m, 1.6m) respectively, and the results in the same table showed that the push pressure has a significant effect in the discharge as the increase of pressure from (5m) to (10m) and then to (15m) led decreased discharge from (68.1 m3/hr) to (56.33 m3/hr) and then to (46.76 m3/hr), and these results correspond to the characteristics of the centrifugal pumps The central curves of pump properties (Robert . 1998. Characteristic curve)

The double interference between the water level and the push pressure had a significant effect on the discharge. The double between the first sump(0.6 m) and the first push pressure (5m)was superior In getting higher discharges of (73.06 m3/hr). The lowest discharge was (41.26 m3/hr) a record of the interference between the third sump (1.6 m) and the third push pressure (15 m) .

.Table 1: the effect of the interaction between pushing pressure and the sump on discharge, m3 / h.

Delivery Head / Sump	5 m	10 m	15 m	Sump Average
0.6 m	73.067	61.333	51.3	61.9
1.1 m	68.133	56.333	46.233	56.9
1.6 m	63.2	51.333	41.267	51.933
L.S.D 0.05	0.2299			0.1069
Pressure Average	68.133	56.333	46.267	**Q**
L.S.D 0.05	0.155			

2. Water Horse Power (WHP):Table (2) shows that the results of the statistical analysis showed a significant effect of sump in (BHP) where the (BHP)decreased as the sump increased. The (WHP) decreased from (2.9891hp) to (2.7676hp) and then To (2.6730 hp) when using the sump (0.6m, 1.1m, 1.6m) respectively, and the results in the same table showed that the pushing pressure has a significant effect in the (WHP) as the increase of pushing pressure from (5m) to (10m) and then to (15m) led to increase (WHP) from (2.4742 hp) to

(2.8883 hp) and then to (3.0671 hp), and these results correspond to the characteristics of the centrifugal pumps The central curves of pump properties (Robert . 1998. Characteristic curve)
The double interference between the sump and the pushing pressure had a significant effect on the (WHP). The double interaction between the first water level (0.6 m) and the third push pressure (15m)was superior in getting higher(WHP) of (3.3263 hp). The lowest (WHP) was (2.4137 hp) a record of thedouble interference between the second sump (1.1 m) and the fist push pressure (5 m).These results are consistent with the properties of centrifugal pumps and according to the laws of the theoretical pumps Affinity Laws.

Table 2: Effect of the interaction between pushing pressure and the sump in (WHP).

DeliveryHead / Sump	5 m	10 m	15 m	Sump Average
0.6 m	2.5597	3.0813	3.3263	2.9891
1.1 m	2.4137	2.8313	3.0577	2.7676
1.6 m	2.4493	2.7523	2.8173	2.673
L.S.D 0.05	0.03688			0.0196
Pressure Average	2.4742	2.8883	3.0671	**WHP**
L.S.D 0.05	0.02441			

3. Brake horsepower (BHP): Table (3) show that theresults of the statistical analysis showed a significant effect of sump in (BHP) where the (BHP) increased as the sump increased. The (BHP) increased from (5.1133hp) to (5.1378hp) and then To (5.1800hp) when using the sump (0.6m, 1.1m, 1.6m) respectively, and the results in the same table showed that the pushing pressure has a significant effect in the (BHP) as the increase of pushing pressure from (5m) to (10m) and then to (15m) led to decrease (BHP) from (5.3778hp) to (5.3522hp) and then to (4.7011hp), and these results correspond to the characteristics of the centrifugal pumps The central curves of pump properties (Robert . 1998. Characteristic curve).The double interference between the sump and the pushing pressure had a significant effect on the (BHP). The double interaction between the third sump (1.6 m) and the second push pressure (10 m) was superior in getting higher (BHP) of (5.4267 hp). The lowest (BHP) was (4.6933 hp) a record of the double interference between the second sump (1.1 m) and the third push pressure (15 m). These results are consistent with the properties of centrifugal pumps and according to the laws of the theoretical pumps Affinity Laws.

(**Table 3 :** Effect of the interaction between pushing pressure and the sump in BHP).

Delivery Head / Sump	5 m	10 m	15 m	Sump Average
0.6 m	5.3100	5.3200	4.7100	5.1133
1.1 m	5.4100	5.31	4.6933	5.1378
1.6 m	5.4133	5.4267	4.7000	5.1800
L.S.D 0.05	0.02888			0.02322
Pressure Average	5.3778	5.3522	4.7011	**BHP**
L.S.D 0.05	0.01636			

4. The efficiency of the pumping unit(*eff*.): The results from Table (4) showed that thestatistical analysis showed a significant effect of sump in (eff.) where the (eff.) decreased as the sump increased. The (eff.) decreased from (58.915 %) to (54.361 %) and then To (51.969 %) when using the sump (0.6m, 1.1m, 1.6m) respectively, and the results in the same table showed that the pushing pressure has a significant effect in the (eff.) as the increase of pushing pressure from (5m) to (10m) and then to (15m) led to increase (eff.) from (46.022 %) to (53.986 %) and then to (65.238 %), and these results correspond to the characteristics of the centrifugal pumps The central curves of pump properties (Robert . 1998. Characteristic curve). The double interference between the sump and the pushing pressure had a significant effect on the (eff.). The double interaction between the first sump (0.6 m) and the third push pressure (15 m) was superior in getting higher (eff.) of (70.622 %). The lowest (eff.) was (44.615 %) a record of the double interference between the second sump (1.1 m) and the first push pressure (5 m). These results are consistent with the properties of centrifugal pumps and according to the laws of the theoretical pumps Affinity Laws. Figure (2)

Table 4: Effect of the interaction between pushing pressure and the sump in (eff.) .

Delivery Head / Sump	5 m	10 m	15 m	Sump Average
0.6 m	48.204	57.919	70.622	58.915
1.1 m	44.615	53.321	65.149	54.361
1.6 m	45.247	50.719	59.943	51.969
L.S.D 0.05	0.7697			0.5998
Pressure Average	46.022	53.986	65.238	***Eff.***
L.S.D 0.05	0.4461			

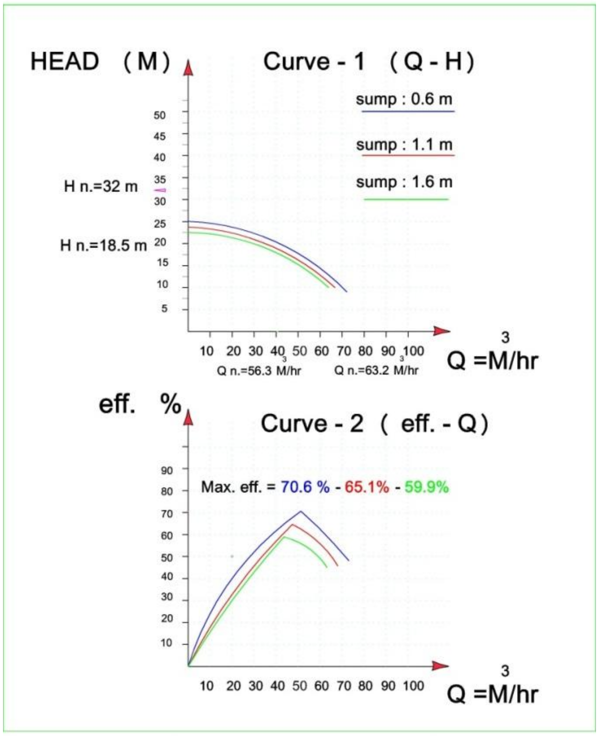

Figure (2)

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