Eng. Research Bull.
Faculty of Eng. & Tech.,
Menoufia University.
Vol. VII Part II, 1985 pp. 259-267

ADAPTATION OF SOME DESIGNS FOR NILE IRRIGATION SYSTEM

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ABSTRACT

This paper is concerned with adapting and mechanizing Archimedean screw for low head Nile irrigation purposes, Using an electric motor or a petrol engine as a prime mover.

This study was carried out to determine the optimum conditions from the technical and economical point of view. The effects of the operating speed ranges (from 20 to 120 r.p.m), flow rate, the torsion moment and the power consumption on the performance of the Archimedean screw have been investigated. Finally an economical study concerened with this investigation is presented.

KEYWORDS

design, materails handling, pumps, archimedian screw, agriculture engineering, irrigation.

NOMENCLATURE

Q	= Capacity or discharge	$m^3/hr.$
M_t	= Torsion moment	kg.m.
N	= Power consumption	HP
$\eta_{o.a}$	= Overall efficiency $= \frac{\gamma_w QH}{75 \times M_t}$	
γ_w	= Water specific weight	kg/m^3
H	= Head of lifted water	m
W	= Angular velocity	rad/sec.
n	= Number of revolutions per minute.	(r.p.m)

INTRODUCTION

Agriculture is undoubtedly the backbone of food security. In Egypt, it depends mainly on animals and human power. Animals consume about one third of the land products in addition to dry food which required, during summer, and the lost area of about 1/8 feddan accupied by water wheel system(1).

The oldest types of pumps ; the lift pumps may be divided into two groups :

1) Direct lift devices which may be oscillating like a shadoof or rotating as a wheel containing buckets which is well known as sakia. The power required to pump water with sakia is about 0.5 HP even for lift heads of 0.9 m. for flow rates of 75 m^3/hr [2].

Animal driven water wheel and electrical water wheel in Nile irrigation are also studied [3].

11) The Archimedean Screw : is a device invented by Archimeds (287-212 B.C) for raising water [4].

William H.Borger [5], studied the relationship between the screw conveyor percent of theoretical capacity and the helix or lead angle of screw.

Also, L.Botes [6], studied the effect of screw conveyor casing clearance on the screw capacity.

M.A. ESAI [7] investigated the dynamic effects in an irrigation pumping system using different types of power sources.

The present work is concerned with mechanization of the Archimedean screw using an electric motor or a petrol engine as a prime mover, for obtaining a maximum discharge and adapting it for use in low head Nile irrigation.

2-EXPERIMENTAL WORK

2.1- INTRODUCTION

To study the effect of different speeds on the flow rate,an ...imental station was designed and constructed.

2.2- EXPERIMENTAL STATION

The basic components of the experimental station are shown in Figure 1, are:

2.2.1- Archimedean screw set : Comprising:-

1- The prime mover which may be an electric A/C motor or a petrol engine.

2- Reduction gear system.

2.2.2- The suction reservoir.

2.2.3- The delivery channels.

2.3- THE MEASURING DEVICES

- Flow rate measurments were obtained by using calibrated V.Notch.
- Torque measurements by calibrated torque transducer, PHILIPS type (9372) attached with P.R type universal measuring bridge for indicating the magnitude of torque. For recording the torque signals A.u 12010 12-channel oscilloscript was used
- The speed of Archimedean screw was measured by using PR 91310/00 type portable digital tachometer.

2.4- EXPERIMENTAL RESULTS

Case 1 : Using a petrol engine as a prime mover .
The values of the measured parameters are given in table (1) and graphically illustrated in Figs (2,3,4,5).

Case II: Using an electric motor as a prime mover.
The values of the measured parameters are given in table (2) and graphically illustrated in Figs (6,7,8,9).

The relation between R.P.M., Q , M_t and η_{o-a} using a petrol engine as a prime mover of Archimedean screw.

R.P.M	Q m^3/hr	M_t kg.m	N HP	η_{o-a}
30	54.30	6.4	0.268	69.0 %
40	66.30	8.0	0.447	50.5 %
50	79.30	6.8	0.475	57.2 %
60	111.50	8.8	0.737	51.6 %
80	120.50	11.6	1.290	31.8 %
100	149.50	11.6	1.619	31.5 %
120	125.66	7.2	1.206	35.5 %
130	120.12	7.2	1.307	31.3 %

Table (1)

The relation between R.P.M., Q, M_t , N and η_{o-a} using an electric motor as a prime mover of Archimedean screw

R.P.M	Q m^3/hr	M_t kg.m	N HP	η_{o-a}
20	43.680	8.0	0.223	66.7 %
30	54.298	9.6	0.402	46.0 %
40	66.330	8.0	0.447	50.6 %
50	79.830	9.6	0.670	40.6 %
60	111.460	10.4	0.871	43.6 %
70	120.376	9.6	0.983	43.7 %
80	120.376	9.6	1.072	38.3 %
90	129.700	8.0	1.005	43.9 %
100	149.600	10.4	1.452	35.1 %
110	129.700	8.0	1.229	53.9 %

Table (2)

2.5- DISCUSSION

From the performance curves of the Archimedean screw the following remarks may be deduced :-

The flow rate increases with an increase of the speed of rotation until it reaches a maximum value (about = 150 m^3/hr at 100 r.p.m), as shown in Figs (2 and 6). For speeds higher than 100 r.p.m, the flow rate decreases with an increase of speed of rotation. This may be attributed to the eddy currents at the inlet of the Archimedean screw leading probably to the cavitation phenomena.

The power consumption increases as the speed of rotation increases until it reaches a maximum value, then it decreases as shown in Figs. (3 and 7).

The relation between the flow rate and the power consumption is shown in Figs (4 and 8). It is thought that, the increase of power consumption is logically accompanied by an increase in the flow rate.

The overall efficiency decreases with an increase in the flow rate as shown in Figs. (5 and 9). This may be attributed to the losses due to the frictional resistance, eddy currents and centrifugal forces.

3- ECONOMICAL COMPARATIVE STUDY

The economical studies of irrigation methods are of great interest for researchers in the field of agriculture development. Numerical studies have been carried out,[8] for some irrigation methods such as,

1- Classical manual labour.
2- Manual labour using bearings to support the Archimedean screw.
3- Using a petrol engine as a prime mover .
4- Using an electric motor as a prime mover.

As a result of the presented work it may be concluded that, the total cost required to irrigate one feddan by the classical method amounts to 9.8 $, compared with 7.89 $ for the manual labour using bearings to support the system. Also when using a petrol engine as a prime mover the total cost is 2.2 $. While it reaches 1.9 $ when using an electric motor as a prime mover.

4- CONCLUSION

From the above study of adapting and mechanizing Archimedean screw the main conclusions are summerized blow:
The optimum operating speed ranges from 70 to 100 r.p.m, the latter value gives the optimum operating conditions. A maximum flow rate of 150 m^3/hr needs 1.6 horse power in using a petrol engine,compared with 1.45 horse power in the case of using an electric motor.

Power consumption increases as the flow rate increases. Overall efficiency decreases with an increaseses in the flow rate. Using an electric motor as a prime mover reduces the power consumption and also the total irrigation cost.

5- REFERENCES

1. A.A. NASSER, "Feasibility study of electrification of irrigation means, Animal driven water wheels and diesel driven pumps in Menoufia Governorate (A.R.E)", Engineering research bulletin of Menoufia University. Vol 1, part I, 1978.

2. KAMINAKA, GARETT and MAJAJA, "Development of a small power unit for water lifting under local Egyptian conditions". California University, rebort for agriculture mechanization in Egypt.

3. A.A. NASSER, " Field and laboratory investigation for various types of electrification methods of Nile irrigation in Menoufia governorate", Engineering research bulletin of Menoufia University. Vol. I, Part I, 1978.

4. The new conxton encyclopedia, Vol. 16, 1977.

5. WILLIAM H. BOGAR and A. MILLER and A. MILLER, "Materials handling ".

6. L. BATES, C. Eng., M.I. Mech. E., F.I.M.H. Ajax equipment (Bolton) Ltd., Bolten, U.K., " Application and design of helical serew equipment." Solids Handling Conference, 1980.

7. A. EASI. Thesis "Dynamic Investigation of Irrigation pumping system using different types of power sources." 1980.

8. M. ASY. thesis " Adaptation of some designs for Nile irrigation system ". 1982.

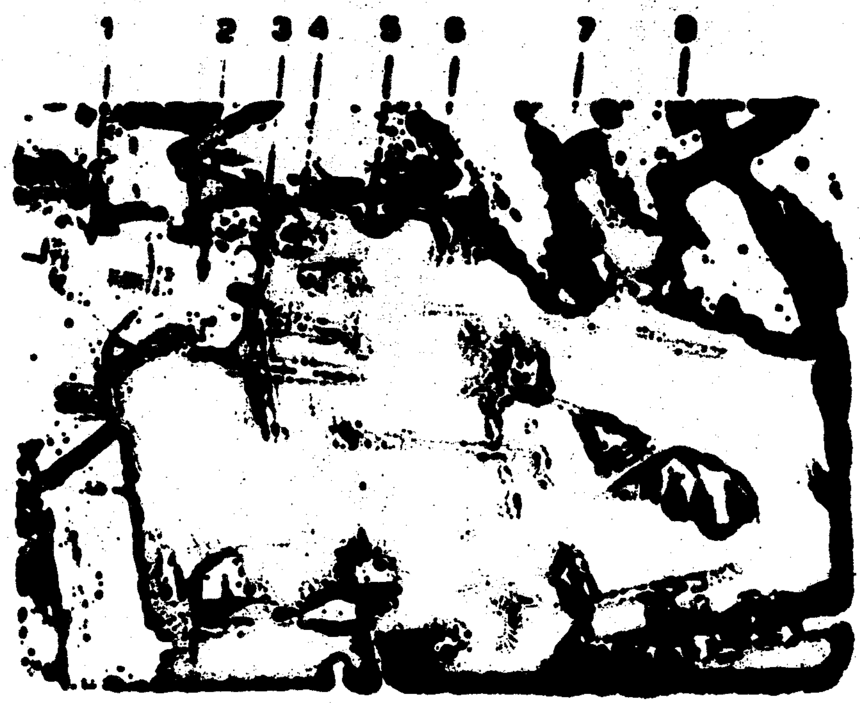

Fig. (1)

1- The prime mover.

2- Reduction system.

3- Single row deep groove radial ball bearings type 60 06.2 RS.

4- V-pulleys and belts.

5- Torque transducer.

6- Hook's joint.

7- Taper roller bearings type 320/28 x.

8- Archimedean screw.

Archimedean Screw Set.

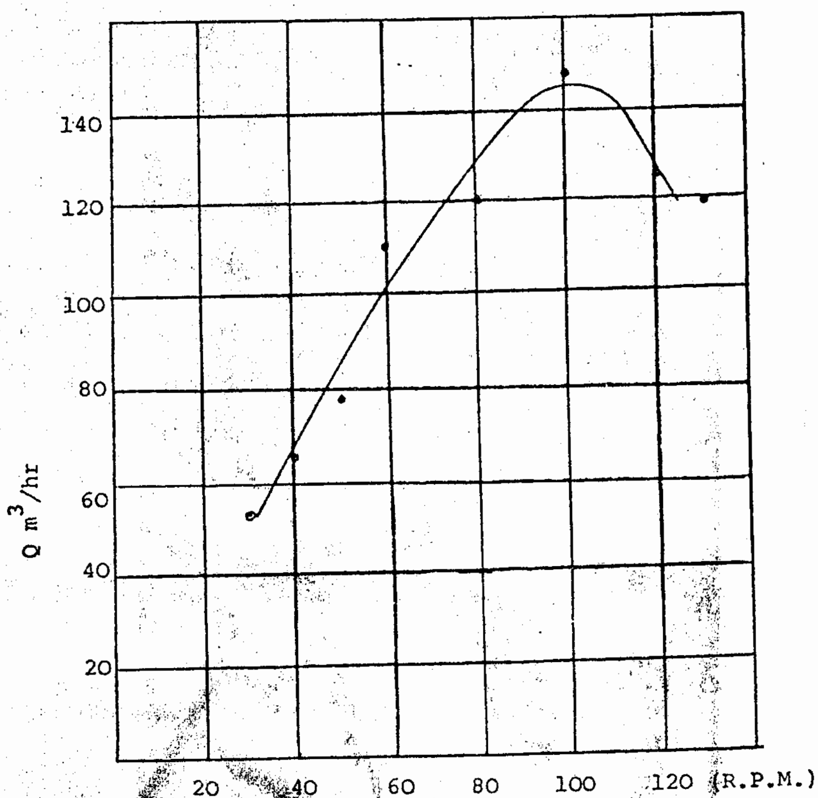

Fig. (2) The relationship between the discharge ($Q\ m^3/hr$) and the number of revolution (R.P.M.) using a petrol engine as a prime mover.

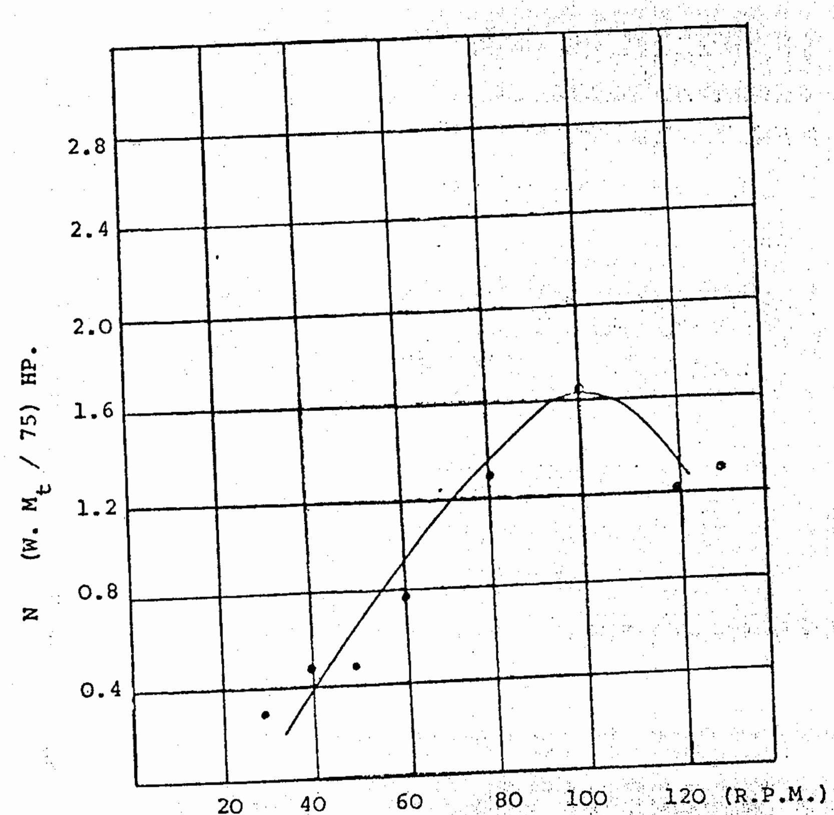

Fig. (3) The relationship between the number of revolutions (R.P.M.) and the power consumption (N HP) using a petrol engine as a prime mover.

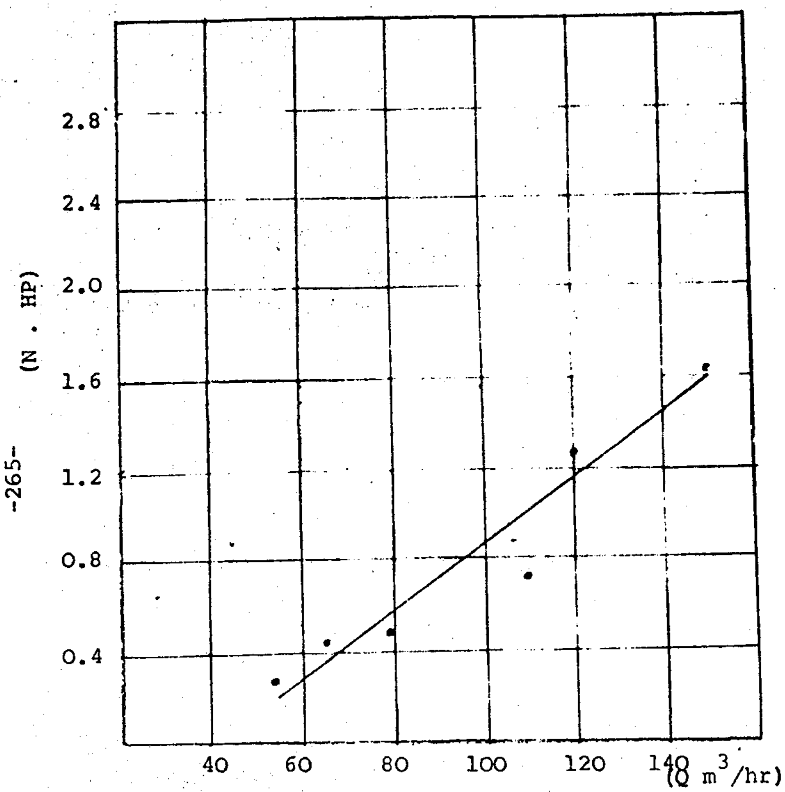

Fig.(4) The relationship between the discharge ($Q\ m^3/hr$) and the power consumption (N HP) using a petrol engine as a prime mover.

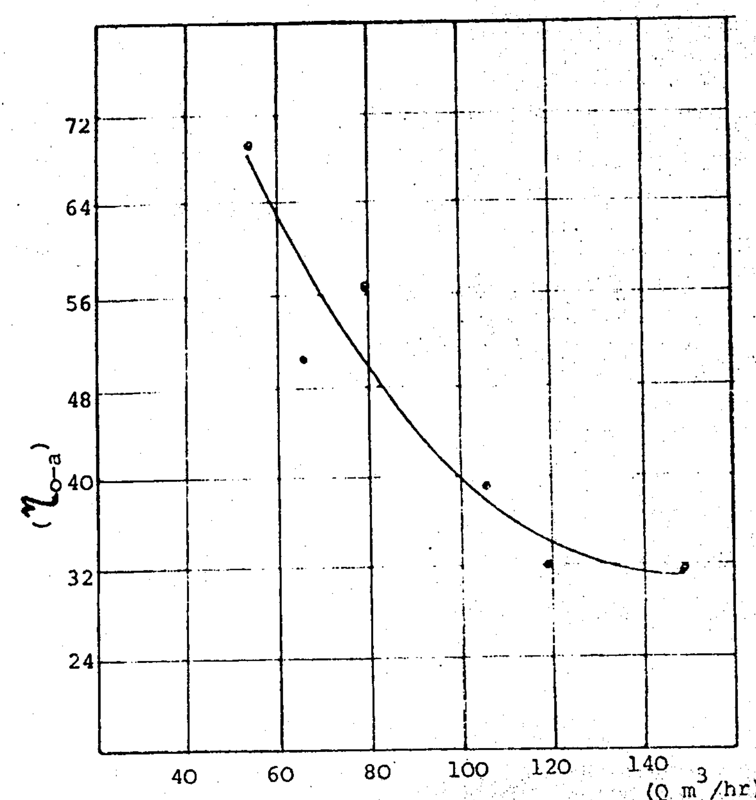

Fig.(5) The relation ship between the discharge ($Q\ m^3/hr$) and the overall efficiency (η_{o-a}) at varible speeds using a petrol engine as a prime mover.

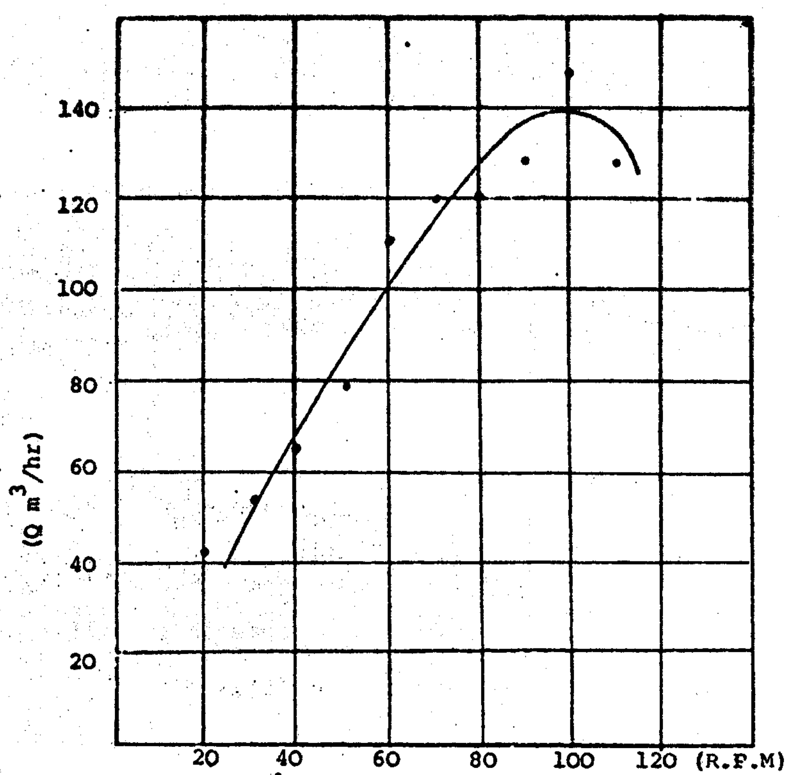

Fig. (6) The relationship between the number of revolutions (R.P.M) and the discharge (Q m^3/hr) using an electric motor as a prime mover.

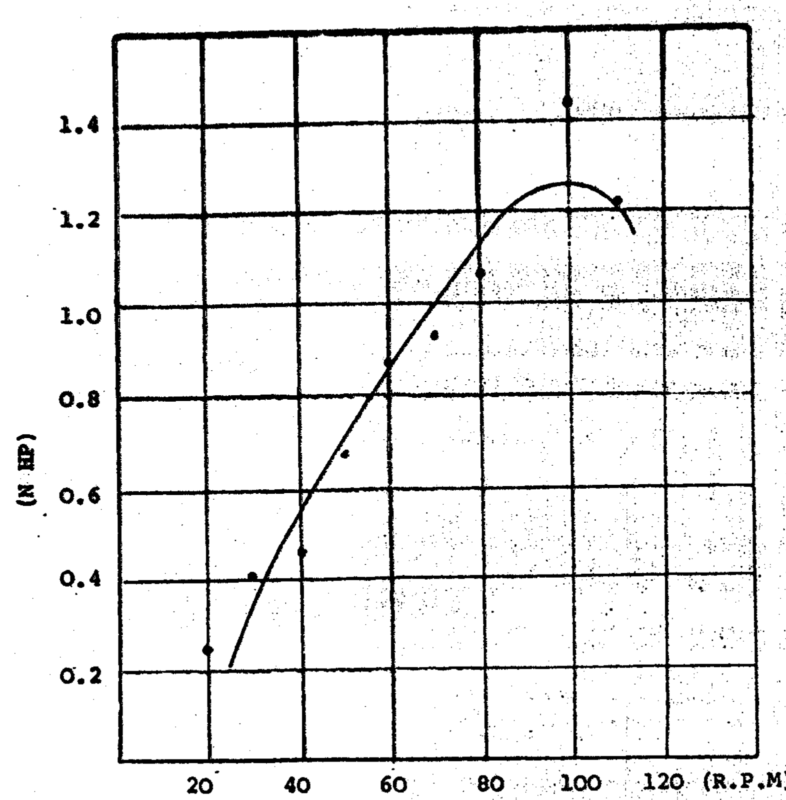

Fig.(7) The relationship between the number of revolutions (R.P.M) and the power consumbtion (N HP) using an electric motor as a prime mover.

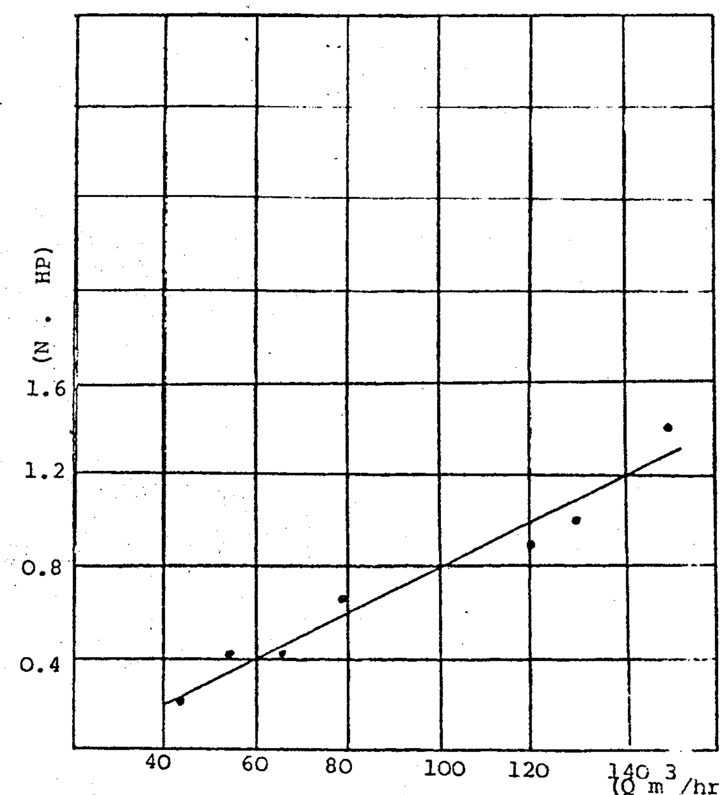

Fig.(8) The relationship between the discharge ($Q\ m^3/hr$) and the power consumption (N HP) using an electric motor as a prime mover.

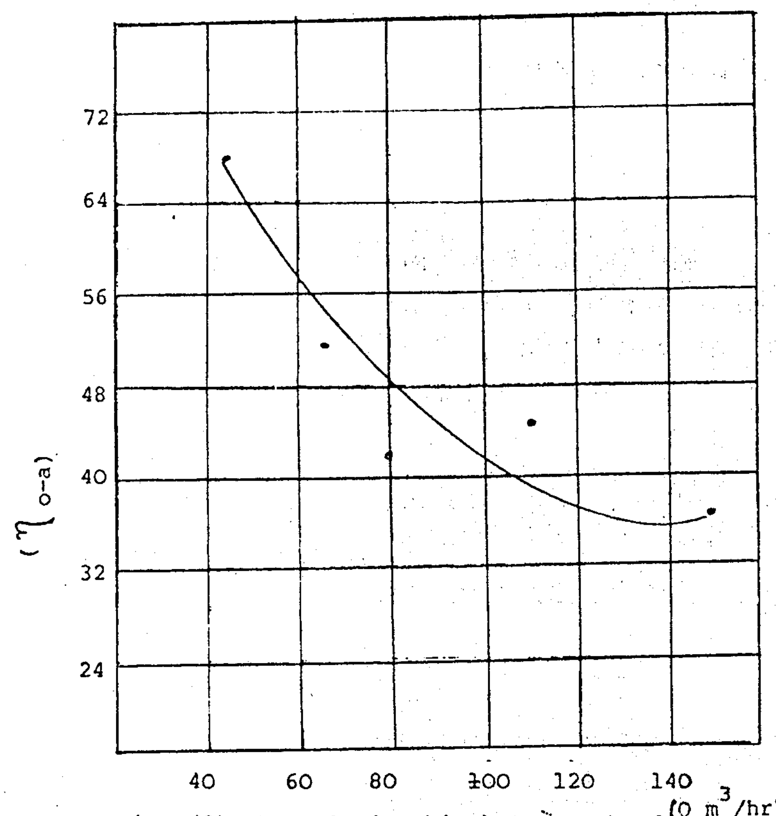

Fig. (9) The relationship between the discharge ($Q\ m^3/hr$) and the overal efficienoy (η_{o-a}) using an electric motor as a prime mover.