EFFECT OF WATER PURENESS ON THE VIBRATION OF ELECTRIC IRRIGATION PUMPS

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1. ABSTRACT:

The Nile irrigation follows the cannal irrigation system in which the water is distributed by scheme of shifts. By this system, water level in channels and branches is subjected to be raised or downed. Logically, for low water level in channel, the pureness of water is changed in addition to plant ristriction and seasonal clearing of the channel ..... etc. So, the Nile irrigation is continuously subjected to changes in its pureness specially during pump operation.

Therefore, the effect of water pureness on the dynamics of the pump system is considered major factor in service life of the irrigation pump. The service life of the system is an economical indicator which must be considered in the electrification of irrigation means.

This research aims at finding out the effect of water pureness on the vibration phenomena of low pressure pump. The following types of water will be used in this study:

1. Drinkage Water,
2. Mud Water:
   a - $\frac{1}{40}$ mud ratio,
   b - $\frac{1}{20}$ mud ratio.

2. INTRODUCTION:

The vibration response of centrifugal pumps (low pressure pumps) is largely dependent on the dynamic forces arising from hydrodynamic bearing and the flow at suction and delivery sides 1*. It was difficult to obtain quantitive values for the dynamic forces arising from impeller and impeller/diffuser because this combination are more complex and less well understood 2*.

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The water pureness has a large effect on the forces arising from the flow and consequently increases the forces resulting from hydrodynamic bearings.

For this reasons, the measuring of vibration must be done on the shaft bearings in order to get out a relation between water type (drinkage water and mud water) and vibration (Amp., Vel., Acc.) and it was noted that all these measures must be made at normal temperature.

3. SYMBOLS:

A_m : Amplitude of vibration in μ_m pk-pk.,
A_{m_h} : Horizontal measuring of vibration amplitude in μ_m Pk-Pk.,
A_{m_v} : Vertical measuring of vibration amplitude in μ_m Pk-Pk.,
A_{cc} : Acceleration of vibration in g units,
A_{cc_h} : Horizontal measuring of acceleration in g units,
A_{cc_v} : Vertical measuring of acceleration in g units,
V : Velocity of vibration in mm/sec.,
V_h : Horizontal measuring of velocity in mm/sec.,
V_v : Vertical measuring of velocity in mm/sec.,
Q : Rate of flow (Capacity) in m^3/hr.,
H_t : Total head in mt. H_2O.,
N_m : Motor horsepower in HP.,
S.HP : Shaft horsepower in HP.,
γ : Specific weight in Kg/m^3.

4. EXPERIMENTAL WORK:

The arrangement of the station used in this study is designed and constructed at the Faculty of Engineering and Technology at Shebin EL-Kom, Menoufia University. This arrangement and the procedure used are represented in the first paper.

5. EXPERIMENTAL RESULTS:

The effect of discharge (Q) on the vibration for different types of water and at the prementioned three parts of the pump were illustrated graphically in Fig's (1 to 12).

The pump performance was controlled by the delivery and suction valves, the measured quantities of pump characteristices were:

H_s(Cm.Hg), H_d(mt,H_2O), $\frac{P_1}{\gamma}$(mt.H_2O), $\frac{P_2}{\gamma}$(mt.H_2O), N_m(Kw).

The calculation procedure was as follows:

Total head (H_t) = H_s(Cm.H_g) x 0.13595 + H_d(mt.H_2O)...mt.H_2O,

Rate of flow = $\frac{C_d \alpha_o}{3600} \sqrt{29 \frac{P}{\gamma}}$ m^3/hr.

The motor power (Nm) = Nm (Kw) x 1.36

The pump performance for different types of water is presented in the hydraulic part.

The hydraulic measurements accuracy are:

Head ± 5%, N_{motor} ± 5%

The accuracy of vibration readings is: ± 3%.

5.1. Vibration Results for Bearing No. ONE:

Table (1) represents the magnitudes of the vertical (Amp., V. and Acc.) with respect to the horizontal at different speeds, drinkage water and average capacity (Q = 110 m^3/hr.).

Table (1)

ITEMS / R.P.M	Acceleration in g units	Velocity mm/sec.	Amplitude μ mm
1350	1.75	1.16	1.19
1550	2.05	1.28	1.10
2350	1.20	1.05	1.16
2700	2.09.	1.12	1.19
3300	1.77	1.19	1.04

Table (2) represents the values of horizontal and vertical (Amp) for bearing No. 1 for different types of water, mean discharge (110 m^3/hr.) and different speeds for bearing 1.

Table (2)

Water type / R.P.M.	Drinkage Water H.	Drinkage Water V.	Mud Water $\frac{1}{40}$ H.	Mud Water $\frac{1}{40}$ V.	Mud Water $\frac{1}{20}$ H.	Mud Water $\frac{1}{20}$ V.
1350	34.5	40.2	29.4	37.1	24.5	24.9
1550	30.4	33.5	35.0	39.9	25.6	27.9
2350	27.0	32.0	37.6	48.4	27.6	40.0
2700	24.4	29.0	28.3	30.4	21.3	22.5
3300	20.8	21.8	25.1	26.5	17.95	17.4

Table (3) represents the shaft horse power at different speeds, different mud ratioes and mean capacity of 110 m^3/hr.

Table (3)

R.P.M. / S.HP.		1350	1550	2350	2700	3300
D.W.		6.5	9.4	17.2	24.1	29.2
M.W.	$\frac{1}{40}$	7.1	10.0	17.4	25.0	32.2
	$\frac{1}{20}$	7.5	10.7	18.2	25.8	34.7

5.2. Vibration Results for Bearing No. TWO:

Table (4) shows a comparsion between vibration velocities for different types of water and various speeds. For bearing (2).

Table (4)

ITEM / R.P.M.	Drinkage Water V_h	Drinkage Water V_v	Mud Water $\frac{1}{40}$ V_h	Mud Water $\frac{1}{40}$ V_v	Mud Water $\frac{1}{20}$ V_h	Mud Water $\frac{1}{20}$ V_v
1350	4.52	5.26	1.15	1.48	1.40	2.30
1550	4.27	6.76	1.50	1.54	1.60	2.80
2350	6.52	6.85	1.65	2.13	2.30	4.20
2700	4.30	4.82	1.10	1.40	1.13	2.20
3300	3.80	4.52	0.83	1.38	0.90	1.70

The results obtained for (Amp) and (Acc) have nearly the same trend as velocity.

5.3. Vibration Results for suction and delivery pipes:

Table (5) compares between the (Amp) for the suction and delivery pipes for the previous conditions.

Table (5)

Water Type	Items	R.P.M / Measuring Parts	1350	1550	2350	2700	3300
D.W.	AMPLITUDE	Suction	18.2	21.8	25.6	14.2	9.8
M.W. $\frac{1}{40}$			19.4	22.7	27.0	14.5	12.2
M.W. $\frac{1}{20}$			19.6	23.2	27.6	18.6	17.6
D.W.		Delivery	17.0	21.3	25.6	15.6	9.4
M.W. $\frac{1}{40}$			19.4	21.4	25.1	18.4	16.0
M.W. $\frac{1}{20}$			19.6	26.0	30.1	19.0	18.6

The results obtained for (V) and (Acc) have nearly the same trend as (Amp).

6. DISCUSSION:

The results of the experimental work treated as follows:

The temperature of water was ranging from 20 to 23°C, the mud ratio in water takes different ratioes $\frac{1}{40}$ and $\frac{1}{20}$. The cavitation was impossible to occur and to achieve the cavitational regime, a special deep vaccum pump must be used.

The main tendency is that the values of (A_{cc}), (V) and (Amp) for vertical measurement (using drinkage water) is larger than that of horizontal measurement. Figures (1, 2) shows that the vertical (Amp) is 1.136 times than that of the horizontal (Amp).

When the R.P.M. increases the (A_{cc}), (V) and (Amp) increases, but for values of R.P.M. larger than 2350, these values decreases as shown in Fig. (1+12).

In case of mud water, the values of vibration items have the same trend but there values are larger than that obtained using drinkage water. This trend will have the same behaviour for R.P.M. up to 2350.

With the increase in mud ratio (which operates as a hummer on the impeller blades) the values of (A_{cc}), (V) and (Amp) will increase. This increase in vibration is due to the new specific weight of water which results from increasing the mud ratio.

Fig's (1, 2, 7, 8) illustrates graphically the vibration (Amp) for bearing 1 and 2 for different types of water and various speeds.

The (V-Q) relations for drinkage water shows that if the R.P.M. increases the vibration velocities increases. In case of $\frac{1}{40}$ mud ratio, the vibration velocities become larger than the first case and take the same behaviour. In case of $\frac{1}{20}$ mud ratio, the values become more larger and have the same trend. Fig's (3, 4, 9, 10) illustrates graphically the vibration velocities for bearing 1 and 2 for different speeds and different types of water.

Fig's (5, 6, 11, 12) illustrates graphically the vibration (Acc) for bearing 1 and 2 for different types of water and different speeds.

It was noted that, increasing the R.P.M. up to 2350 will increase the vibration. But at high speeds (above 2350 R.P.M.) the vibration decreases due to the decrease in discharge which leads to decreasing the chocks of water on the impeller blades.

Also for all the previous cases, the vertical vibration was larger than the horizontal vibration because the motion in the vertical direction is larger than that in the horizontal direction.

7. CONCLUSIONS AND RECOMMENDATIONS:

The vibration (Amp, V and A_{cc}) of the irrigation pumps (centrifugal pumps) at the shaft bearings varies according to the mud ratio.

The vibration Amp. proporionally increases with discharge of the pump, till 2350 R.P.M. and with the mud ratio, while it decreases with the increase of R.P.M. above 2350.

In order to decrease the operating costs of the pump, the pump must operate at low vibrations as possible that leads to increase the service life of the pumps.

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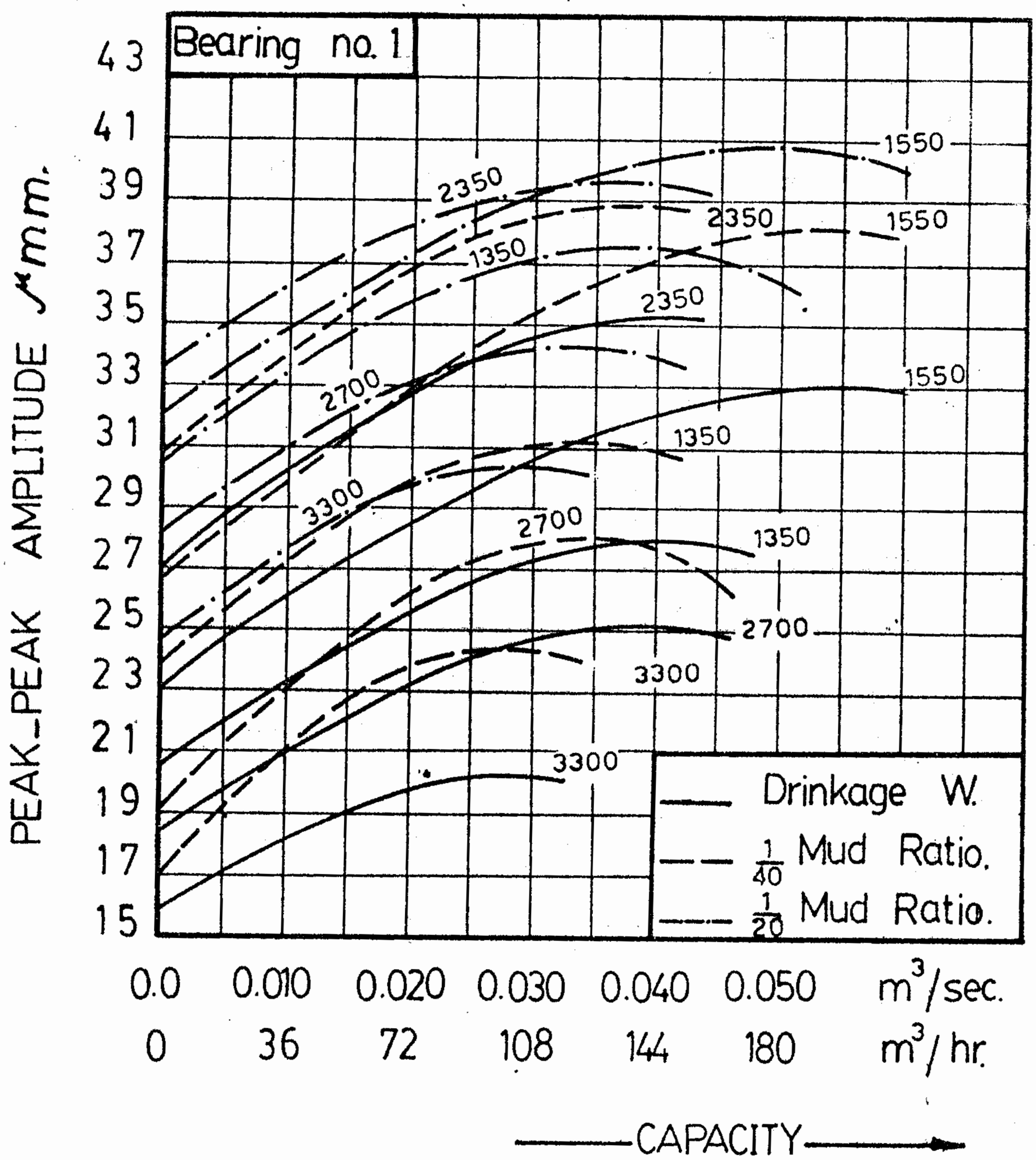
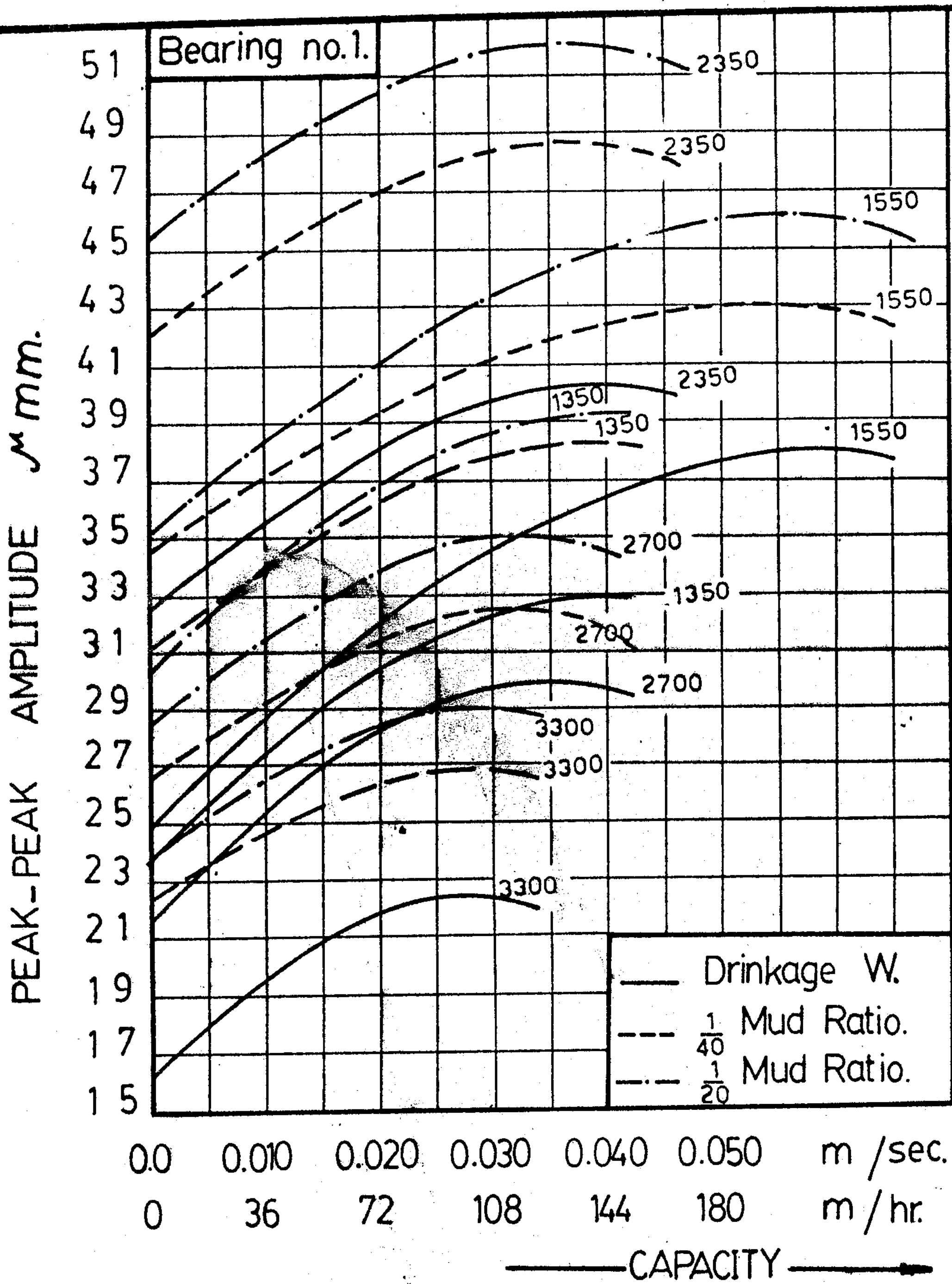


Fig(1) Effect of Capacity (Q) on the Amplitude (Amp$_h$) Using Different Mud Ratioes at Different Speeds. [Herizontal Measurement]



Fig(2) Effect of Capacity (Q) on the Amplitude (Amp) Using Different Mud Ratioes at Different Speeds. [Vertical Measurement].

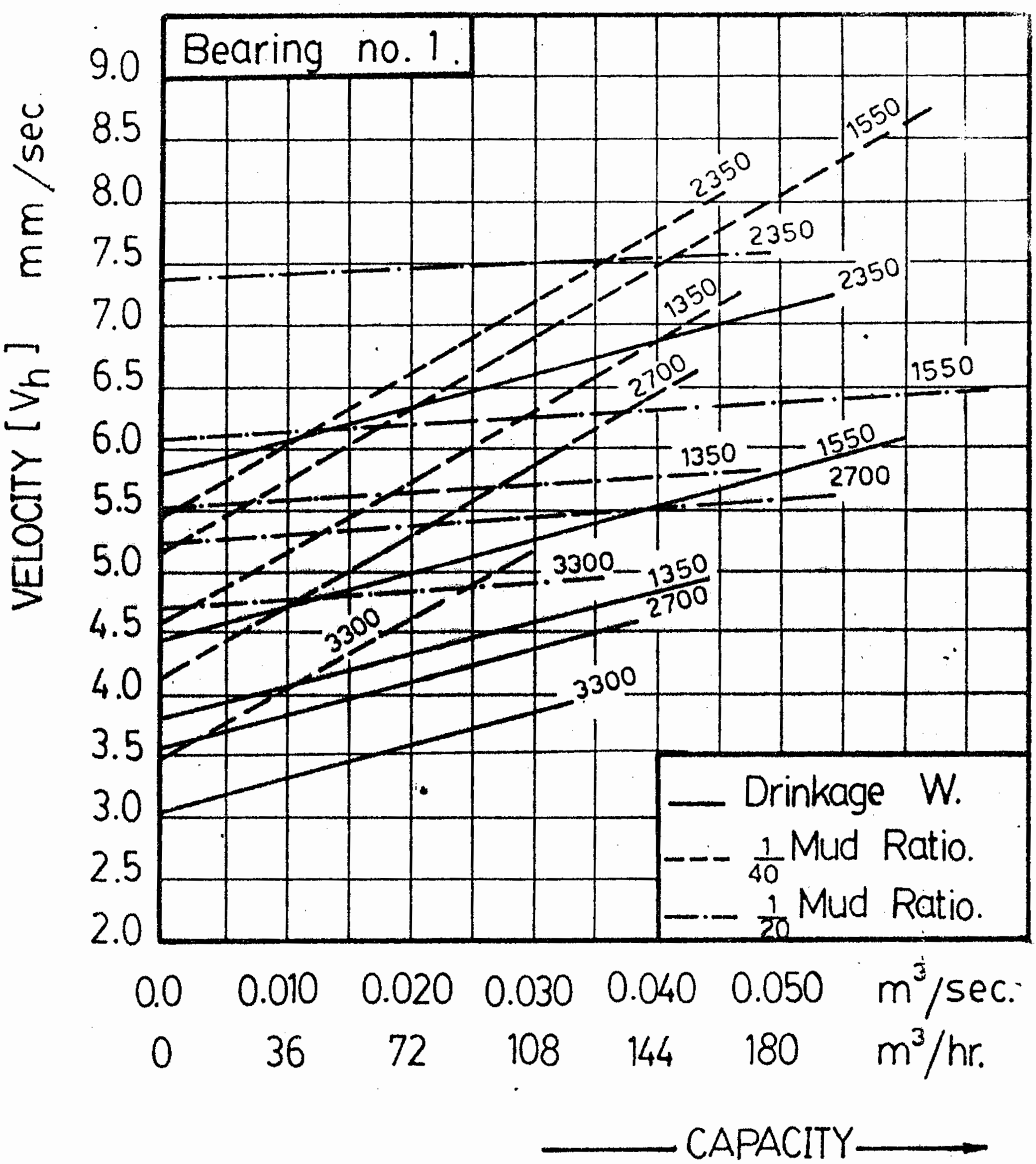


Fig (3) Effect of Capacity (Q) on the Velocity (V_h) Using Different Mud Ratioes at Different Speeds.

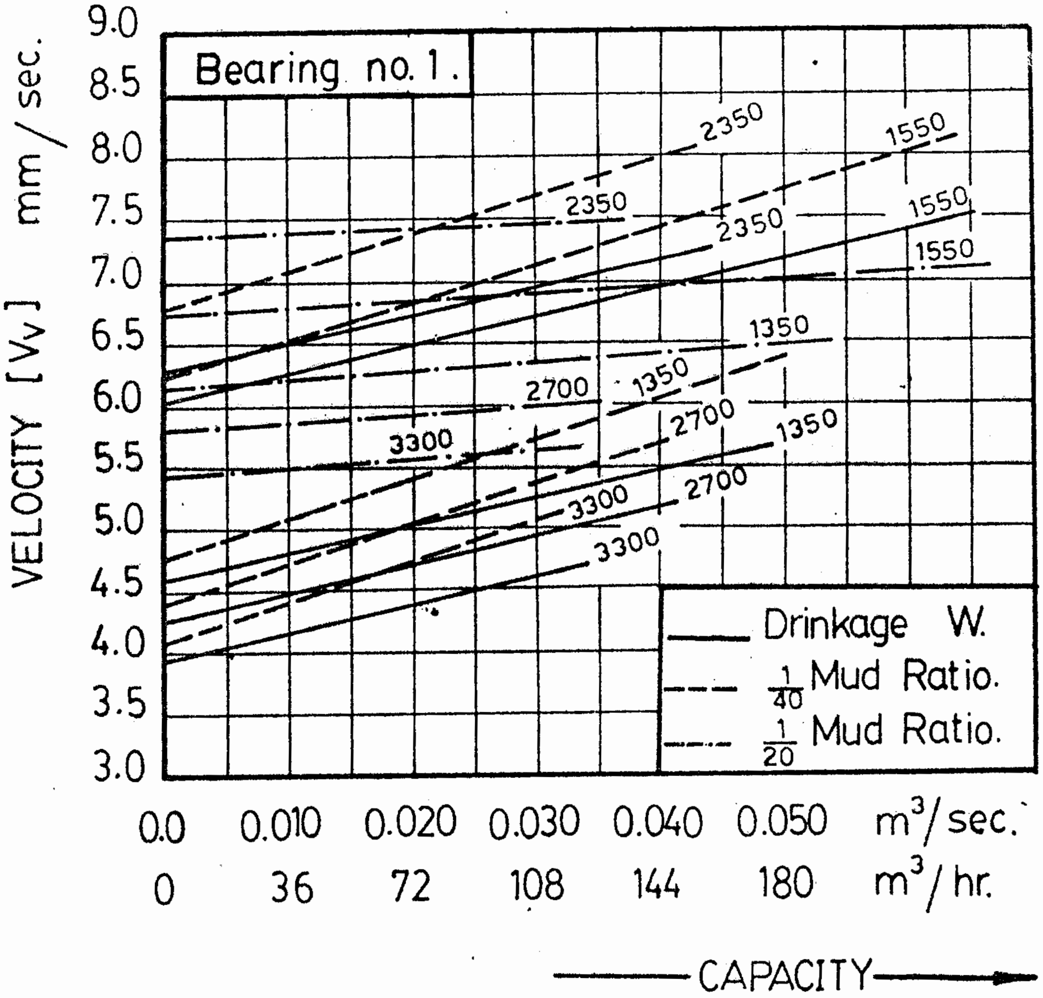


Fig (4) Effect of Capacity (Q) on the Velocity (V_v) Using Different Mud Ratioes at Different Speeds.

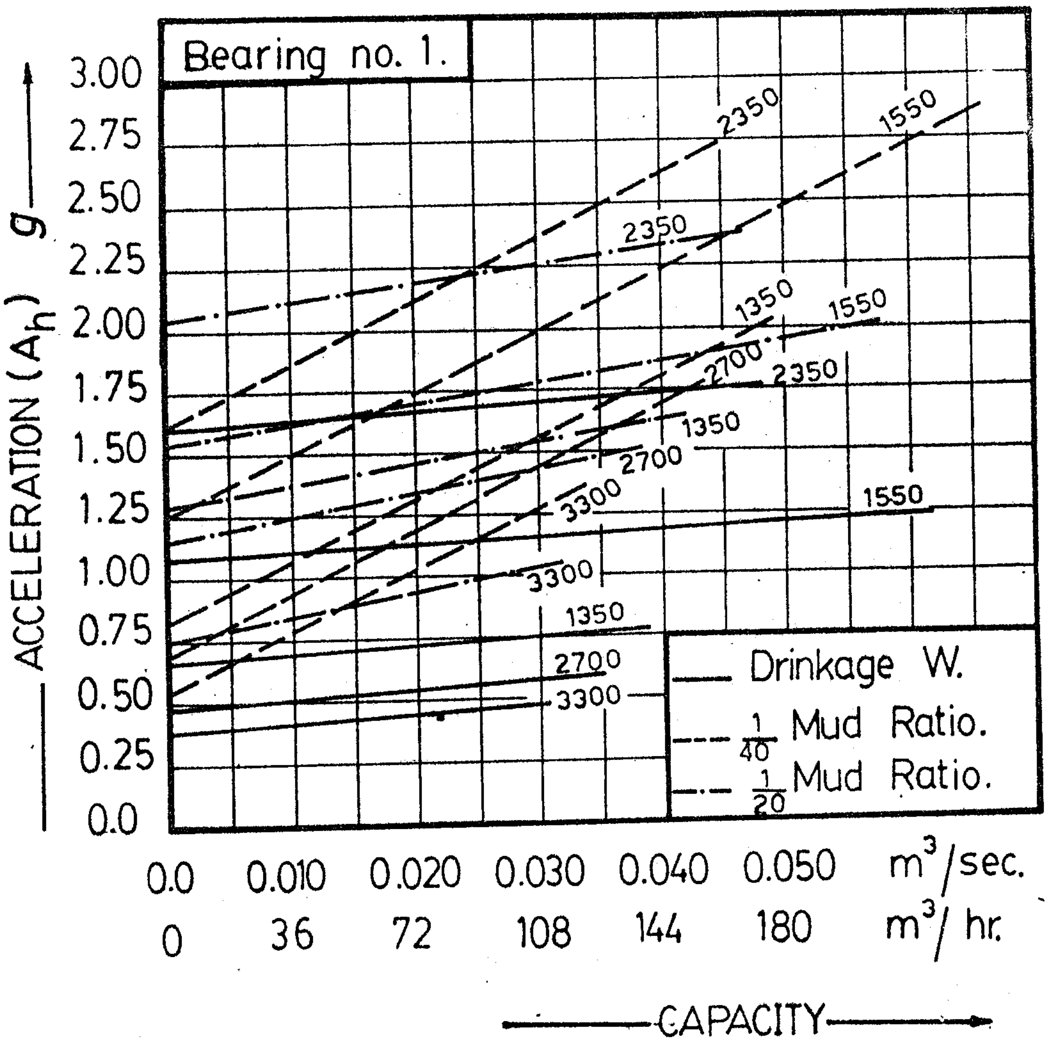


Fig (5) Effect of Capacity (Q) on the Acceleration (A_h) Using Different Mud Ratioes at Different Speeds.

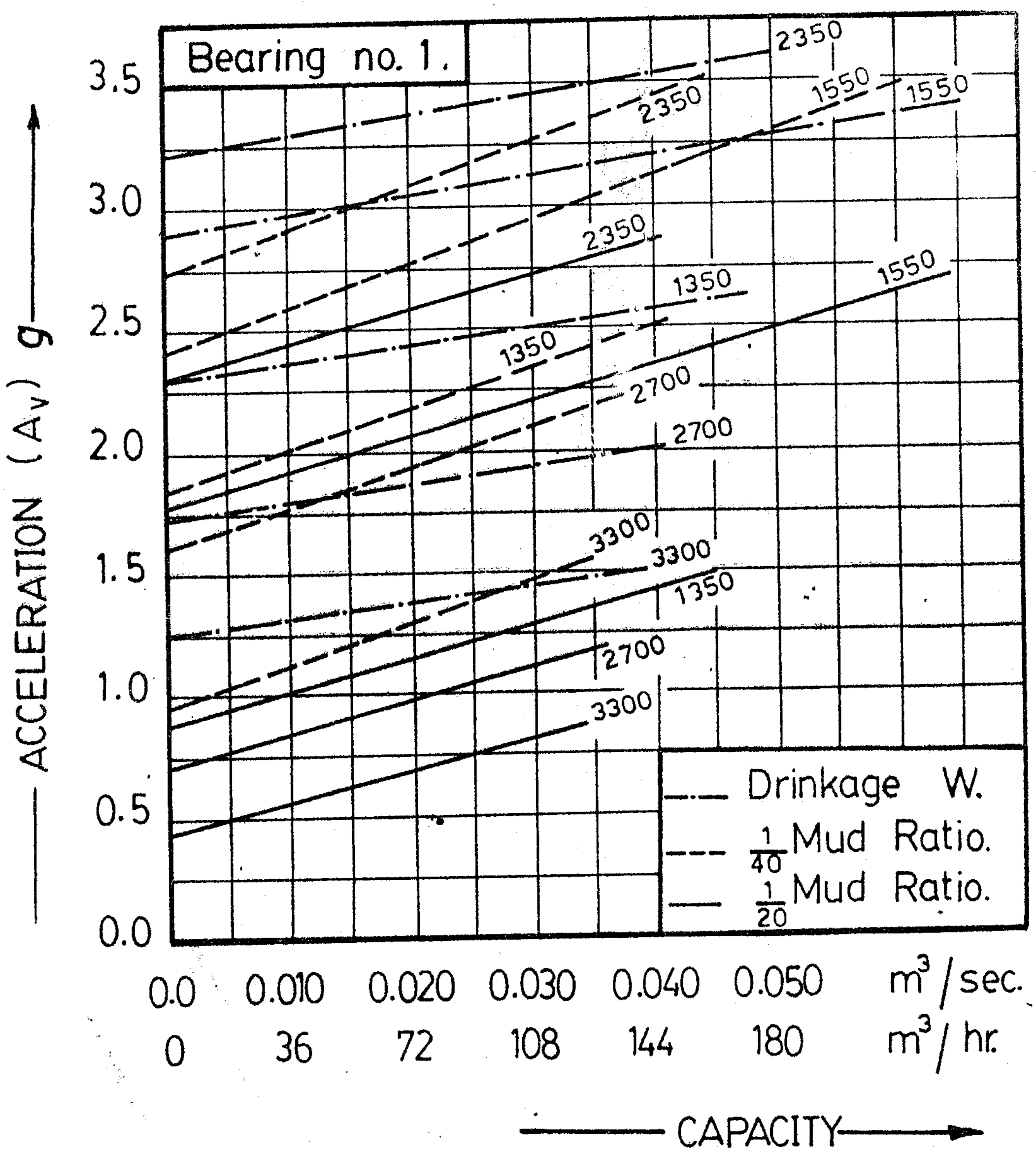


Fig (6) Effect of Capacity (Q) on the Acceleration (A_v) Using Different Mud Ratioes at Different Speeds.

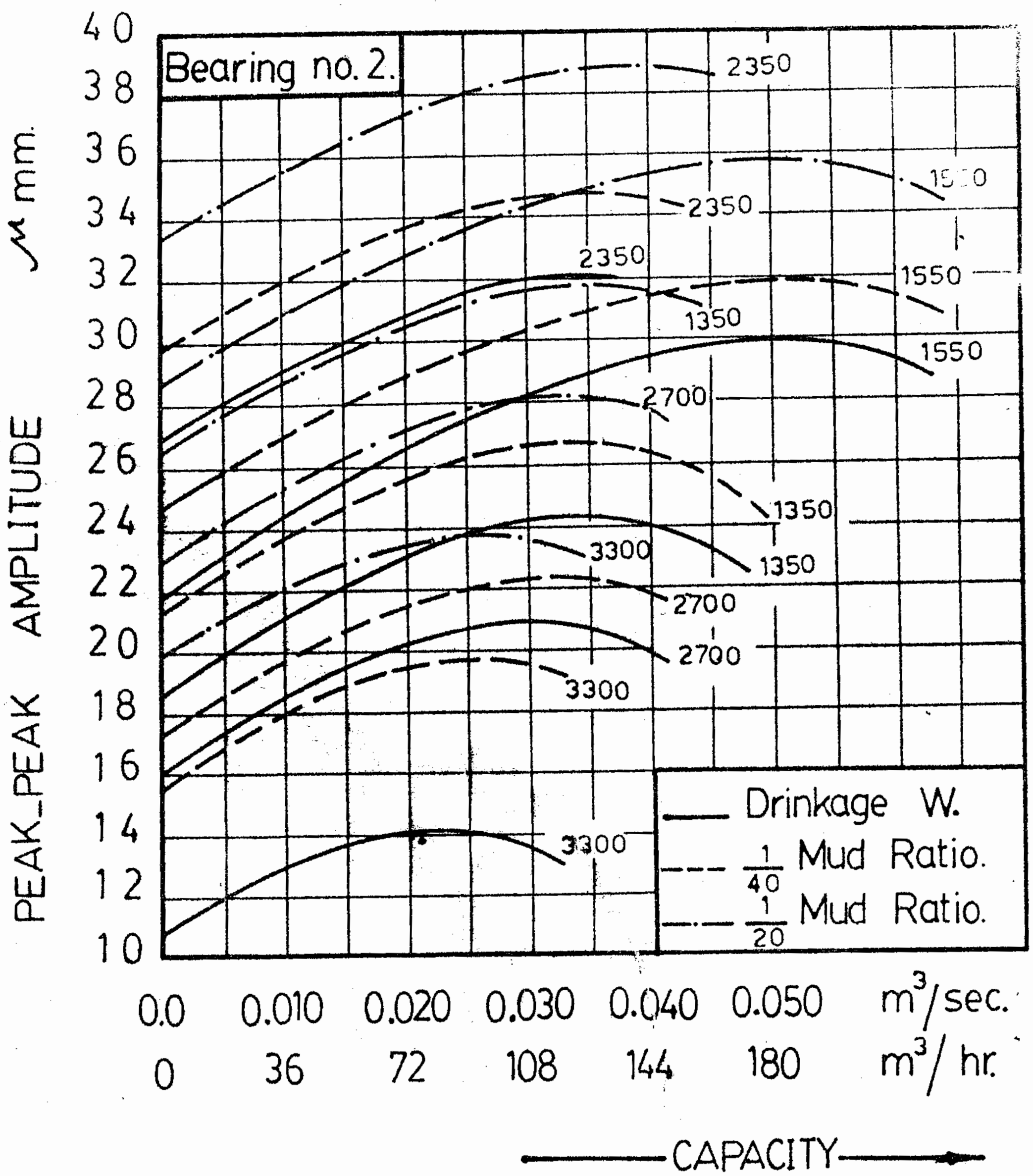


Fig (7) Effect of Capacity (Q) on the Amplitude (Amp) Using Different Mud Ratioes at Different Speeds. [Herizontal Measurement]

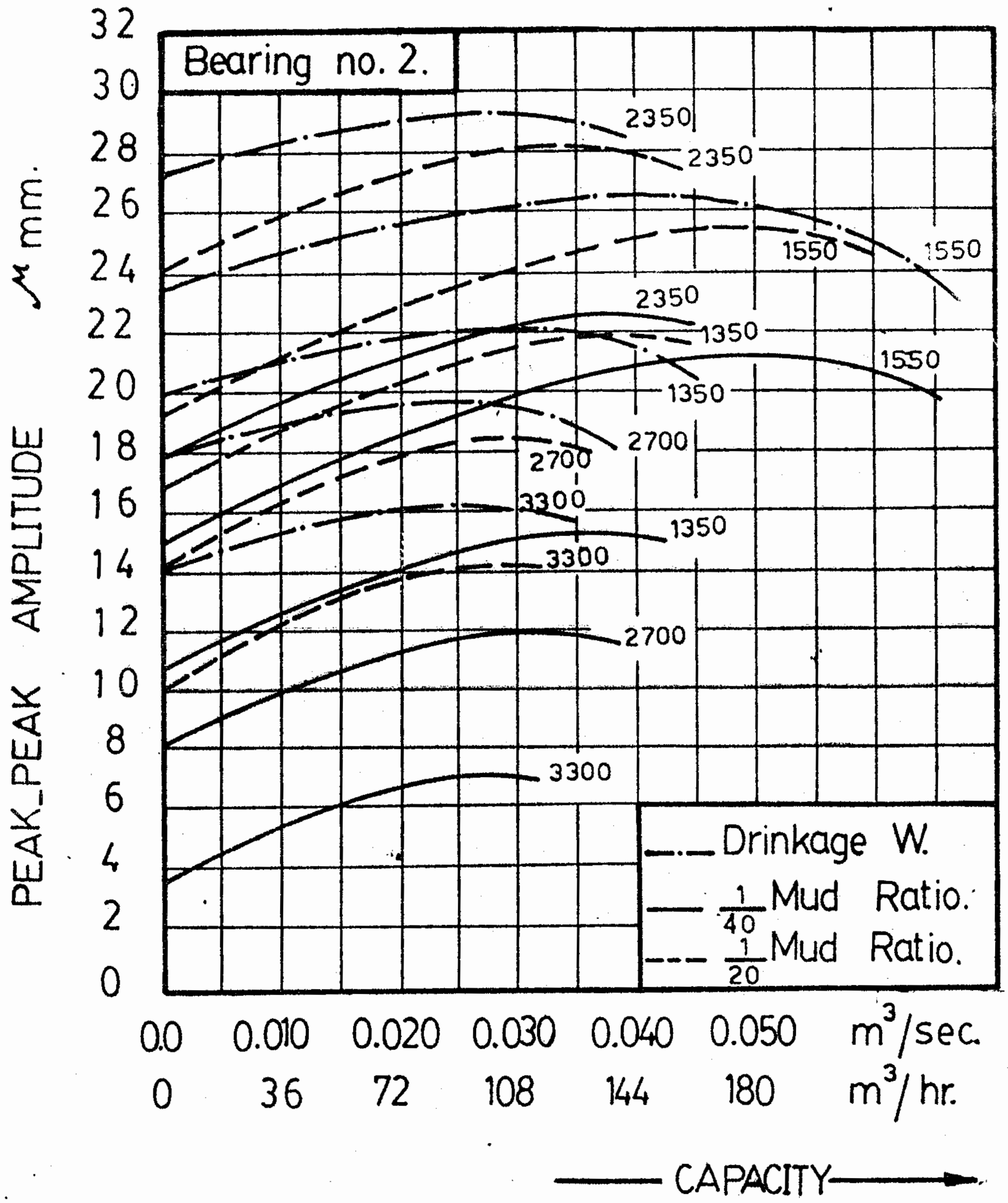


Fig. (8) Effect of Capacity (Q) on the Amplitude (Amp) Using Different Mud Ratioes at Different Speeds. [Vertical Measurement]

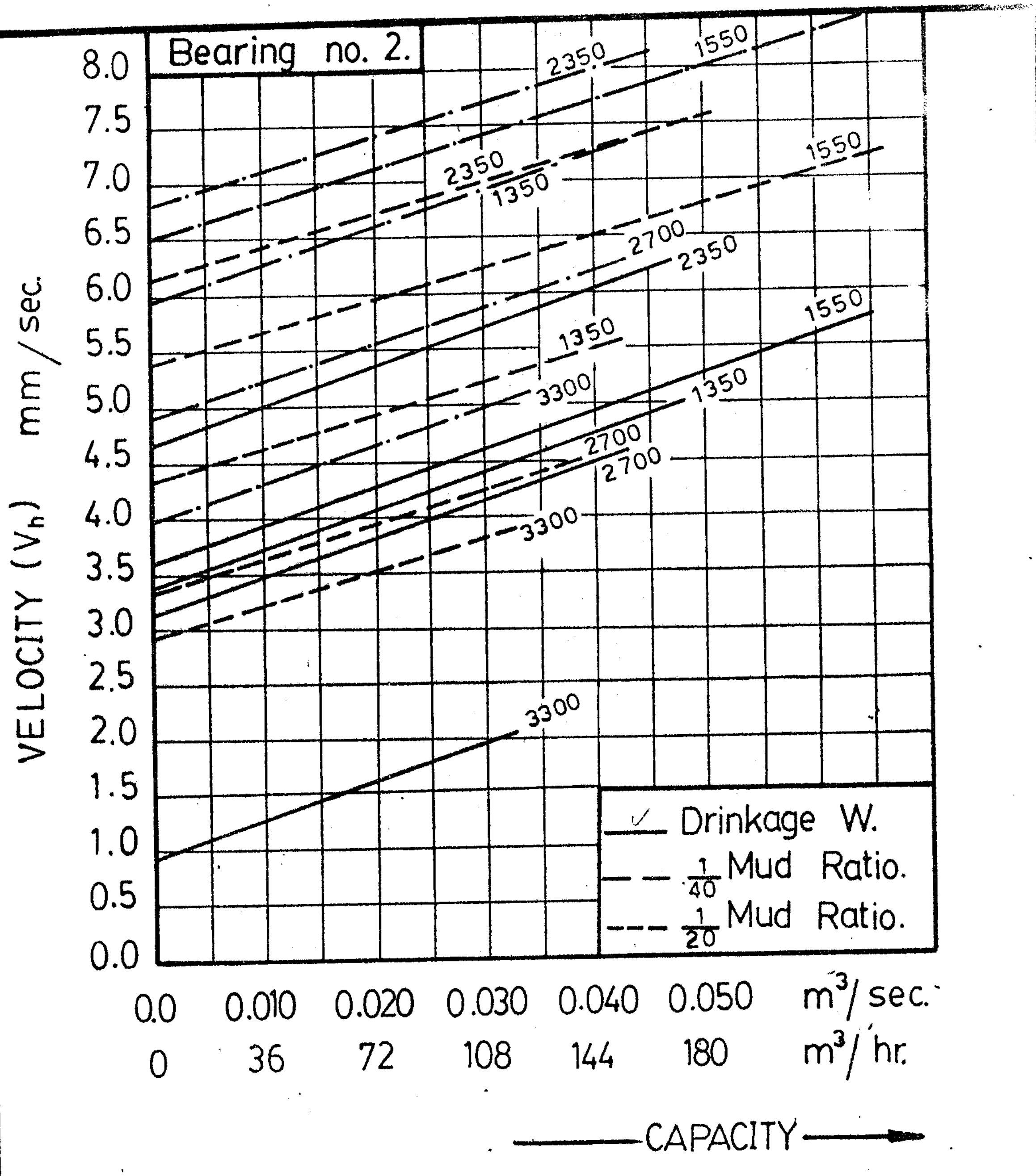


Fig.(9) Effect of Capacity (Q) on the Velocity (V_h) Using Different Mud Ratioes at Different Speeds.

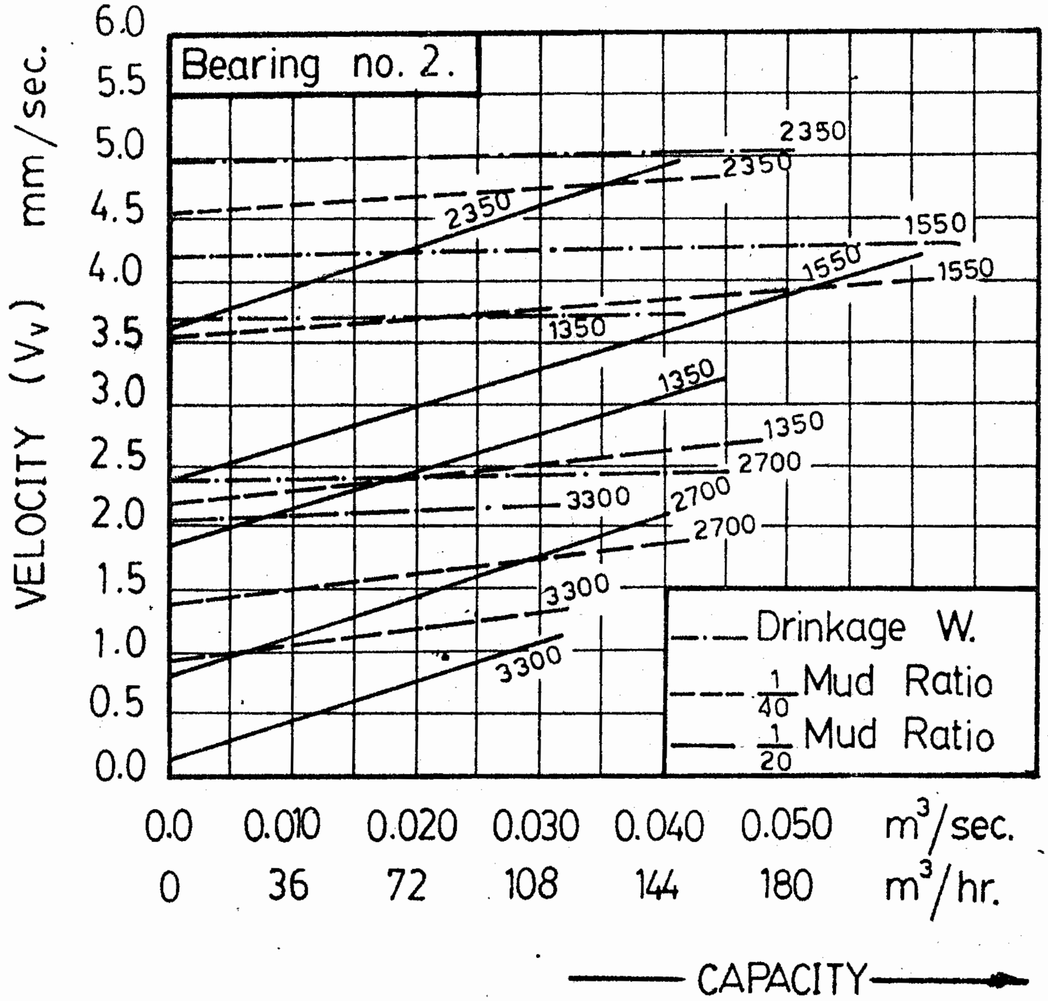


Fig.(10) Effect of Capacity (Q) on the Velocity (V_v) Using Different Mud Ratioes at Different Speeds.

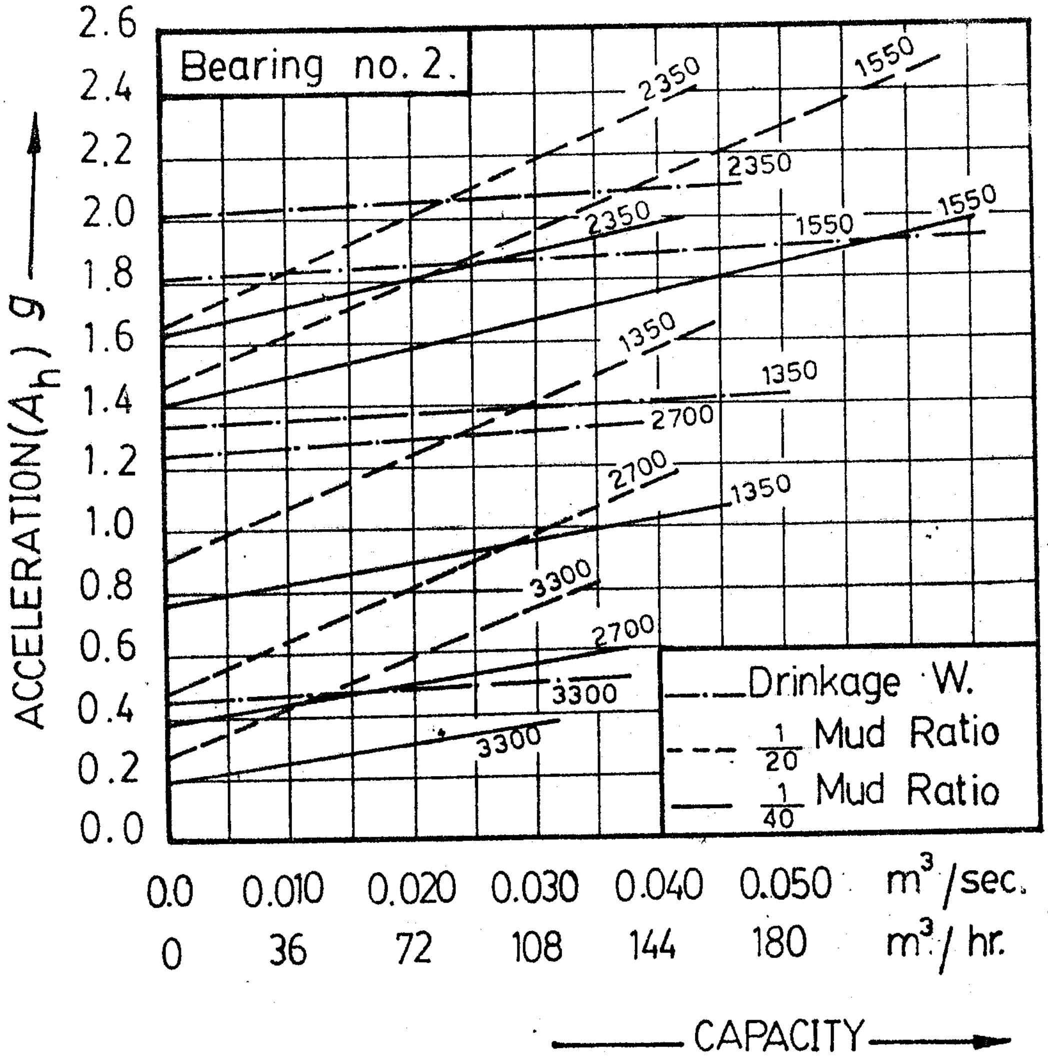


Fig.(11) Effect of Capacity (Q) on the Acceleration (A_h) Using Different Mud Ratioes at Different Speeds.

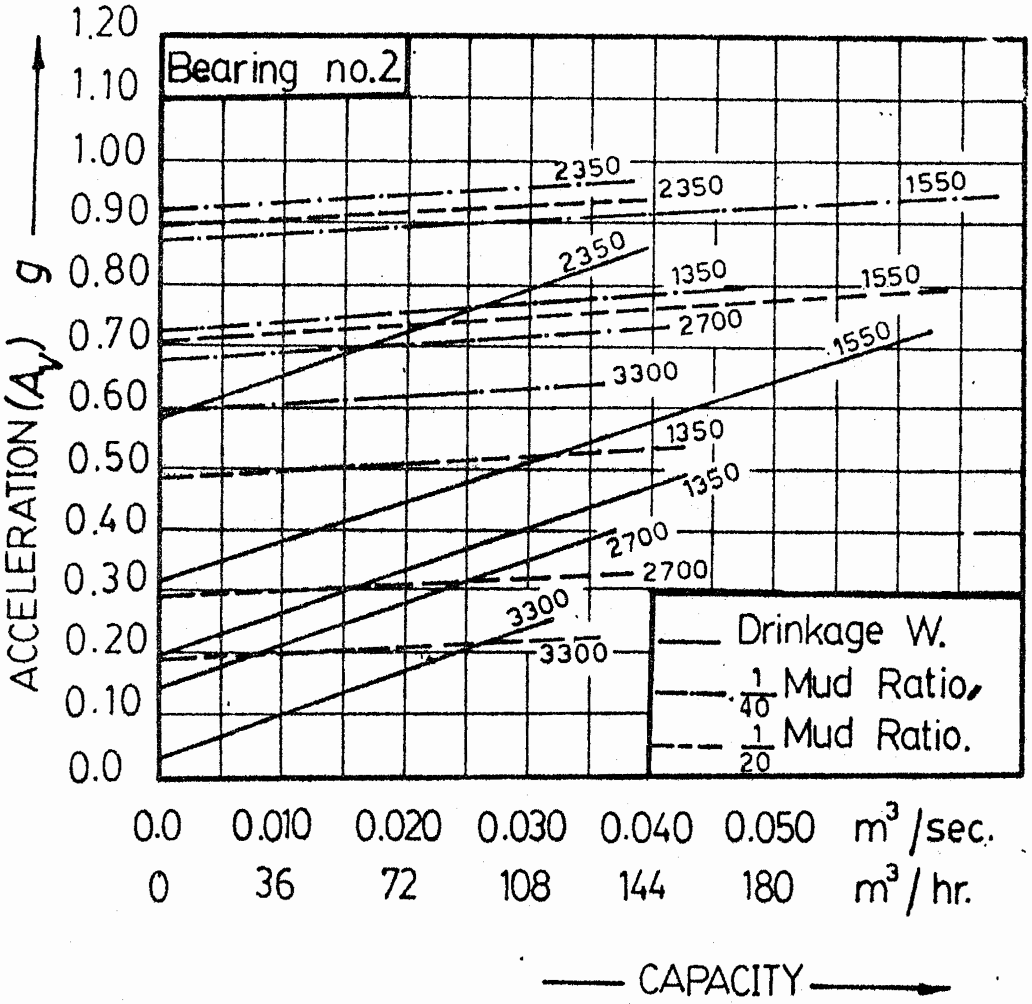


Fig.(12) Effect of Capacity (Q) on the Acceleration (A_v) Using Different Mud Ratioes at Different Speeds.

"تاثير نقاء المياه على الاهتزازات الناتجة فى مضخات الرى النيلى المنخفضة العلو"

أ٠د٠ عبد الهادى ناصر ، أ٠د٠ سعد محمد وهيبه ، أ٠د٠ عصام أحمد سالم
م٠ أحمد محمود عيسى

لقد تم فى هذه الدراسة تجهيز محطة متصلة بابار لها نسبة خلط ثابتة للسيطرة على تماثلية نسبة الطين فى الماء ولقد تم تسجيل نتائج الاهتزازات فى ظروف نسبة طين $\frac{١}{٤٠}$ ، $\frac{١}{٢٠}$ وزنا ـ واستخدمت مصادر طاقة مختلفة وسرعات مختلفة اثناء عملية القياس ـ ولقد تمت عملية القياس على كراسى المحاور وعلى كل من ماسورتى السحب والطرد ٠

من تحليل نتائج هذه الدراسة وجد أنه كلما زادت نسبة الطين فى المياه زادت قيم الاهتزازات وهذه الزيادة تتراوح بين ١٠ ـ ١١٪ تقريبا بالمقارنة بالمياه النقية ٠

وأيضا وجد ان استخدام محرك ديزل تزيد الاهتزازات بنسبة ١١ ـ ١٣٪ وذلك لأماكن القياس المختلفة ٠