EFFECT OF NON-NEWTONIAN FLUID PROPERTIES ON PERFORMANCE OF SWIRL TYPE SPRAYERS

ES.A. Salem(1) , B.A. Khalifa(2) , M.A. Shawqy(3) & M.N. Nasr (4)

SUMMARY:

This paper presents experimental investigation of non-Newtonian fluid properties effect on performance of sprayers. The experimental study includes the measurements of the spray angle of liquid, flow rate and pressure distribution in the swirling chamber, at different; supply pressure, spray nozzle diameter, helix angle of the cylindrical block, number of grooves, concentrations of the non-Newtonian liquid and cone angle at concentrations = 10000 p.p.m.

The fluid used in water solutions of sodium carboxy - methyle cellulose (C.M.C.) as non-Newtonian pseudo-plastics fluids.
The results of the experimetnal work are presented in curves to show the relationship between the different parameters.

It was deduced, by least squares method, an empirical formula for spray angle and flow rate which contain the different parameter which has effect on it, namely supply pressure, spray nozzle diameter, helix angle, number of grooves and the density ratio of liquid.

NOMENCLATURE:

Symbol	Quantity	Units
ρ	Density	Kg/cm^3
ρ_w	Water density	Kg/cm^3
ρ/ρ_w	Density ratio	
P_s	Supply pressure	N/m^2
P_r	Static pressure at radius (r) in the conical swirl chamber	N/m^2

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Symbol	Quantity	Units
Q	Flow rate	lit/sec.
μ	Dynamic viscosity	$dyne.sec^n/m^2$
n	Flow index of non-Newtonian fluid	
ν	Kinematic viscosity	Stokes
β	Inlet ports helix angle with horizontal line.	$( )^o$
α	Cone angle of swirl chamber with horizontal line	$( )^o$
m	Number of inlet grooves.	
d_n	Diameter of spray nozzle	mm
γ	Spray angle of liquid	$( )^o$
p.p.m.	Part of polymer per million part of water by weight.	
τ	Shear stress	$dyne/cm^2$
$\gamma = \partial v/\partial y$	Shear strain rate	1/sec.

1) INTRODUCTION:-

Non-Newtonian fluids form an extremely wide class of different substances whose only common features are fluidity and a failure to obey Newton's law of viscosity $\tau = (\partial v/\partial y)$. Spraying is one of the flow cases which find wide applications in industry and agriculture, such as spray drying, spray cleaning of various products, insecticidal spraying, asphalt sprayers, sprinkler irrigation, application of pesticides and fertilizer as sprays and other purposes.

The expierimental investigation were made to estimate the effect of polymer on the spray angle of liquid, flow rate and pressure distribution in swirl chamber.

Many investigators treated the performance of sprayers using water such as;
Gore & Ranz (1964) (2) and Talyor (1950) (3) treaded the swirling flow in a perfectly conical funnel.
Binnie and Co-Workers (1948, 50,56,57), (4,5,6,7) carried experiments in swirling water, with a nearly free vortex tangential velocity distribution which passed through convergent nozzles.

Fraser (1958) (8) mentioned that the discharge coefficient and spray angle depend on the geometry of the discharge orifice.

S.Ahmed (1971) (9) mentioned that the discharge and spray angle are increased with increasing the nozzle diameter, number of supply holes and width of swirl chamber.

Lane (1951) (10) studied the atomization of liquid.

A. Gomaa (1978) (11) studied the sprayer in which the flow "water" is unguided free vortex and found that the dimensionless pressure profile inside the swirl chamber is not effected by the pressure variation.
He found also that increasing in spray nozzle diameter and working pressure, due to increasing the spray angle and flow rate.

E. SALEM and S. El-SALOMOUNI (1976) (12) mentioned that the rheological properties of C.M.C. solution are;

Properties.	.M.C.% in water			Tap
	1%	3%	4%	
μ $\frac{dyne.sec.^n}{cm^2}$	0.11	1.06	2.96	0.01
n	0.88	0.75	0.69	1.00
ρ gm/cm^3	1.01	1.03	1.04	1.00
ν stokes	0.108	1.03	2.35	0.01

It can be noticed from the discused previous work that most of the work delt with spraying of Newtonian fluid, in spite of the fact that most of the sprayed solution are non-Newtonian.

The aim of this experimetnal work is to investigate the performance of sprayer using non-Newtonian fluids.

The parameters measured are;
1) Rate of flow 2) Spray angle.
3) Pressure profile in conical swirl chamber.

The characteristic parameters of sprayers are function of geometrical and fluid parameters.
The geometrical parameters affecting the atomization of the fluid are:

1) Rate of flow 2) Spary angle.
3) Pressure profile in conical swirl chamber.

The characteristic parameters of sprayers are function of geometerical and fluid parameters.
The geometrical parameters affecting the atomization of the fluid are:-
1) Helix angle, shape and number.
2) Spray nozzle diameter and length.
3) Cone angle.

The fluid properties and flow parameters can be;
1) Physical properties of the liquid.
2) Supply pressure.

In this work the effects of geometrical parameters, fluid parameters and supply pressure on flow rate and spray angle are investigated.

2) EXPERIMENTAL WORK:

The presented experimental work was carried out to study the spray angle and flow rate through sprayer.

In order to have the necessary data for the analysis the following quantities were measured;
1) Supply pressure.
2) Pressure distribution on the wall of the conical swirl chamber..
3) The fluid spray cone was photographed to estimate the spray angle.
4) Flow rate with the help of an orifice meter.

Fig. (1) shows the lay out of experimental set, which consists of the apparatus, the hydraulic circuit and the measuring devices of supply pressure and pressure distribution in conical swirl chamber.

The componanet of apparatus are shown in Fig. (2) and Fig. (3).

Four spray nozzles, diameters (5, 10, 16, 20 mm), two helix angles (20^{o}, 40^{o}), three numbers of grooves (2, 4, 6) and three cone angles (30^{o}, 45^{o}, 60^{o}) were used in this investigation.

3) ACCURACY OF EXPERIMENTAL DATA:

It is very important to estimate the accuracy of the measured quantities, in order to make possible correct analysis of experimental data.
Relative error in "Q" taking into consideration calibration error is "8.2%".
For pressure distribution 2%.
For supply pressure 0.12%
For spray angle 1^{o}.

4) EXPERIMENTAL RESULTS, ANALYSIS AND DISCUSSION:

The experimental results are presented in curves and tables, to give a clear idea about the performance of swirl sprayers when using non-Newtonian fluid under different working condition and sprayers geometries.

4.1) Effect of concentration of non-Newtonian fluid on spray angle:

The effect of geometrical parameters on spray angle is shown on Fig. (4, 5, 6, & 7)

- From Fig. (4), it is clear that the increase in helix angle leads to a corresponding decrease in the spray angle at all concentrations since the component of tangential velocity of vortex will decrease.
- Increase of number of grooves leads to decrease of spray angle. Increase of grooves number means more flow cross-sectional area in the cylinder block. At constant supply pressure the frictional losses are more due to increase of frictional area. This leads to decrease of available pressure in swirl chamber.

The tangential velocity accordingly decrease and hence the spray angle decrease.

- From Fig. (6), it can seen that if the supply pressure increase the spray angle will increase.
  Increase of supply pressure leads to corresponding increase of hydrodynamic pressure in swirl chamber.
  Both static and dynamic pressure increases. The increase of tangential velocity leads accordingly to increase of spray angle.
- If the diameter of spray nozzle increase, the spray angle will increase.

When the diameter of spray nozzle increase the centrifugal force increases and accordingly the spray angle increases at all concentration.

Concerning the effect of the fluid properties it is clear from figures that, the spray angle decreases with increasing the concentration up to 20000 p.p.m. after which the spray angle increases until concentration of 30000 p.p.m. is reached.

After 30000 p.p.m. the spray angle starts to decrease again. When the concentration increase, the viscosity will increase and therefore the spray angle will decrease. The drag reduction effect will begin to appear at concentration of about 20000 p.p.m. and for that reason the spray angle will increase again with the concentration increase.

The effect of drag reduction is continuous up to concentration of about 30000 p.p.m. After that viscosity will increase again causing the spray angle to decrease.

4.2) Effect of concentration on flow rate:

The effect of geometrical parameters on the flow rate is shown on fig (8, 9, 10 & 11).

- Figure (8), shows that the increase in helix angle leads to a corresponding increase in the flow rate at all concentration due to increase of axial velocity of vortex.

- Figure (9), show that the increase in number of grooves leads to a corresponding increases in the flow rate at all concentration, since the area of flow increases with number of grooves.

From figures (12, 13, 14 & 15) it is noticed that:

1) The increase of supply pressure leads to a corresponding in the spray angle up to supply pressure of 13 x 10^4 N/m^2, beyond which an increase in the pressure value does not greatly affect the spray angle for all the examined combination of geometrical parameters.

2) The varition of spray angle with the diameter of spray nozzle is linear in the region ($10 < d_n < 20$ mm) but in the region ($0 < d_n < 10$ mm) that relation is nonlinear.

3) The increase in cone angle leads to a corresponding increase in spray angle.

4) The relation between diameter of spray nozzle and discharge is straight line in the region 10 mm $\leq d_n \leq$ 20 mm. In region ($d_n <$ 10mm) the relation in nonlinear.

5) From table (1), the discharge will be nearly constant for different values of cone angle.

4.4) <u>Pressure profile in the swirl chamber:</u>

1) The pressure inside the swirl chamber is nearly constant at different value of (r) for a certain concentration (Fig. (16)).

2) The increase in helix angle and diameter of spray nozzle and decreasing in supply pressure, leads to a corresponding decrease in the pressure inside the swirl chamber (table (II) & Fig (17)).

3) The pressure at each radius inside the swirl chamber is nearly constant at the different number of grooves and cone angle table (II) (The increasing of (m) leads to increase of frictional area and decrease of velocity, which seem to give a constant pressure drope).

4) The pressure inside the swirl chamber at constant radius, is nearly constant at different values of concentration (Fig. 18).

The previous discussion showes that the performance of swirl type sprayer is function of many parameters. An empirical formula for the performance of sprayers is of great importance to those concerned with design and or selection of swirl type sprayers.

It was deduced, by the least square method, an empirical formula, for spray angle and flow rate, which contain the different parameter which has an effect on it, namely, helix angle, number of grooves spray nozzle diameter and supply pressure in addition to the rheological properties of fluid.

It can be seen that the empirical formula is in good agreement with the experimental data. The deviation of calculated from the empirical formula and the experimental is within 7.7% for the spray angle and 10.15% for the flow rate.

5) CONCLUSIONS:-

From the analysis of the experimental data and the discussions the following conclusions can be deduced:-

1) The spray angle was found to increase with the increase of spray nozzle diameter, cone angle, supply pressure. The effect of rheological properties of the fluid on the spray angle is some what complicated, since at low concentration of polymer the spray angle decreases till a minimum value at concentration about 20000 p.p.m. At concentration between 20000 p.p.m. and 30000 p.p.m. the spray angle increases reaching maximum value very near to that of pure water. At concentrations more than 30000 p.p.m. the spray angle redecreases. This may be explained by the drag reducing effect of polymer concerning the number of inlet ports and helix angle, the increase of each leads to decrease of spray angle.

The spray angle can be predicted from the empirical formula,

$$\gamma = \frac{0.132}{N} \left(987.58 \frac{\rho}{\rho_w} - 943.33\right) d_n^{0.89} \, p_s^{0.22} \, m^{-0.42} \, \beta^{-0.414}$$

$$N = \left(92.2 \frac{\rho}{\rho_w} - 89.846\right) \quad 1 \leqslant \frac{\rho}{\rho_w} \leqslant 1.02$$

$$N = \left(19.52 \frac{\rho}{\rho_w} - 15.2\right) \quad 1.03 \leqslant \frac{\rho}{\rho_w} \leqslant 1.04$$

Where, 10 mm $\leqslant d_n \leqslant$ 20 mm

p_s is in (N/m^2) $\qquad$ d_n is in (mm)

2) The flow rate was found to increase with the increase of spray nozzle diameter, number of inlet ports, helix angle, cone angle and supply pressure. The concentration ratio increase leads to very small, even negligible increase at very small, even negligible increase at very small concentration followed by a small decrease of flow rate at higher concentrations, but below 10000 p.p.m. The rate of decrease of flow rate increases from 10000 to 20000 p.p.m., reaching minimum value.

The flow rate begins to increase from 20000 p.p.m. to 30000 p.p.m., where it reaches its maximum value, which is very near to its value in case of pure water.

Rather increase of concentration above 30000 p.p.m.leads to increase of flow rate.

This complicated behaviour is connected with the drag reducing effect of the polymer.

The discharge can be obtained from the empirical formula:

$$Q = \frac{10^{-5}}{M} \left(42.68 \frac{\rho}{\rho_w} - 40.712\right) \sqrt{p_s} \, m^{0.28} \, d_n^{1.6} \, \beta^{0.14}$$

$$M = 32.5 \frac{\rho}{\rho_w} - 31.66 \qquad 1.01 \leqslant \frac{\rho}{\rho_w} \leqslant 1.02$$

$$M = 47 \frac{\rho}{\rho_w} - 46.8 \qquad 1.03 \leqslant \frac{\rho}{\rho_w} \leqslant 1.04$$

Where 5 mm d_n 20 mm

P_s is in (N/m^2) d_n is in (mm)

Q is in (lit/sec.)

3) For all concentrations the pressure inside the swirl chamber is nearly constant at the different value of swirl chamber radius and different number of grooves. The increase in helix angle and diameter of spray nozzle and decreasing in supply pressure lead to a corresponding decrease in the pressure inside the swirl chamber.

6) RECOMMENDATIONS:-

1) Numberof inlet ports is of a great importance in case of high flow rate however, this will affect the spray angle.

2) To realise the highest spray angle a combination of small helix angle, small number of inlet ports, big cone angle and big diameter of spray nozzle.

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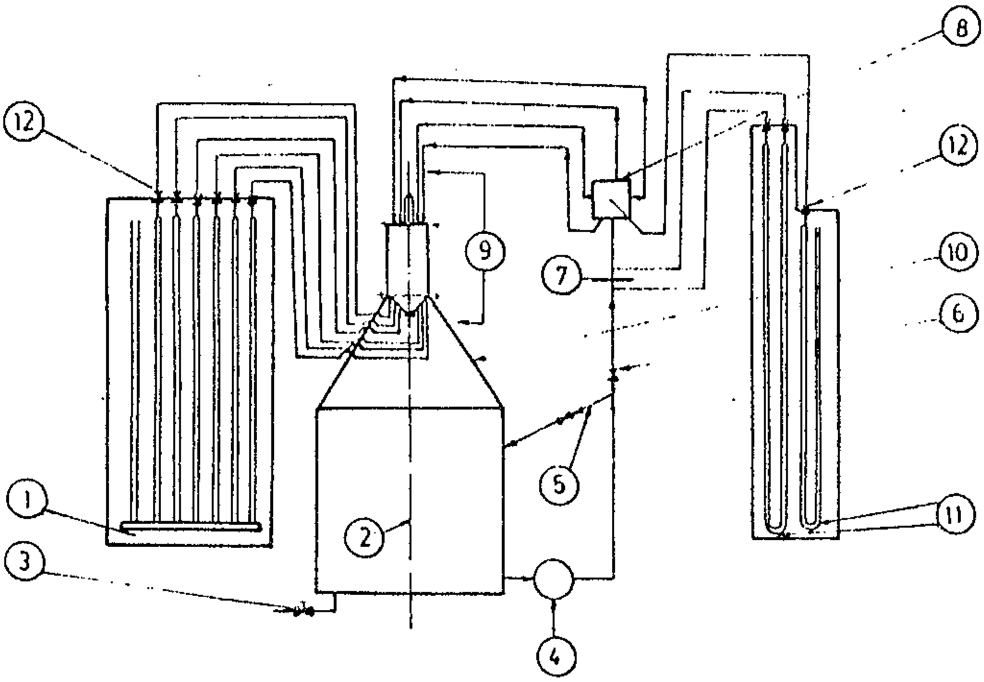


1_ Monometer Common Manifold.
2_ Supply Tank
3_ Drain Line.
4_ Pump.
5_ By Pass Line.
6_ Supply Valve
7_ Orifice Meter.
8_ Common Supply Manifold
9_ Apparatus
10_ Apparatus Carrier
11_ U_ Tubes
12_ Air Vents

Fig. (1) General Lay Out For Experimental Set

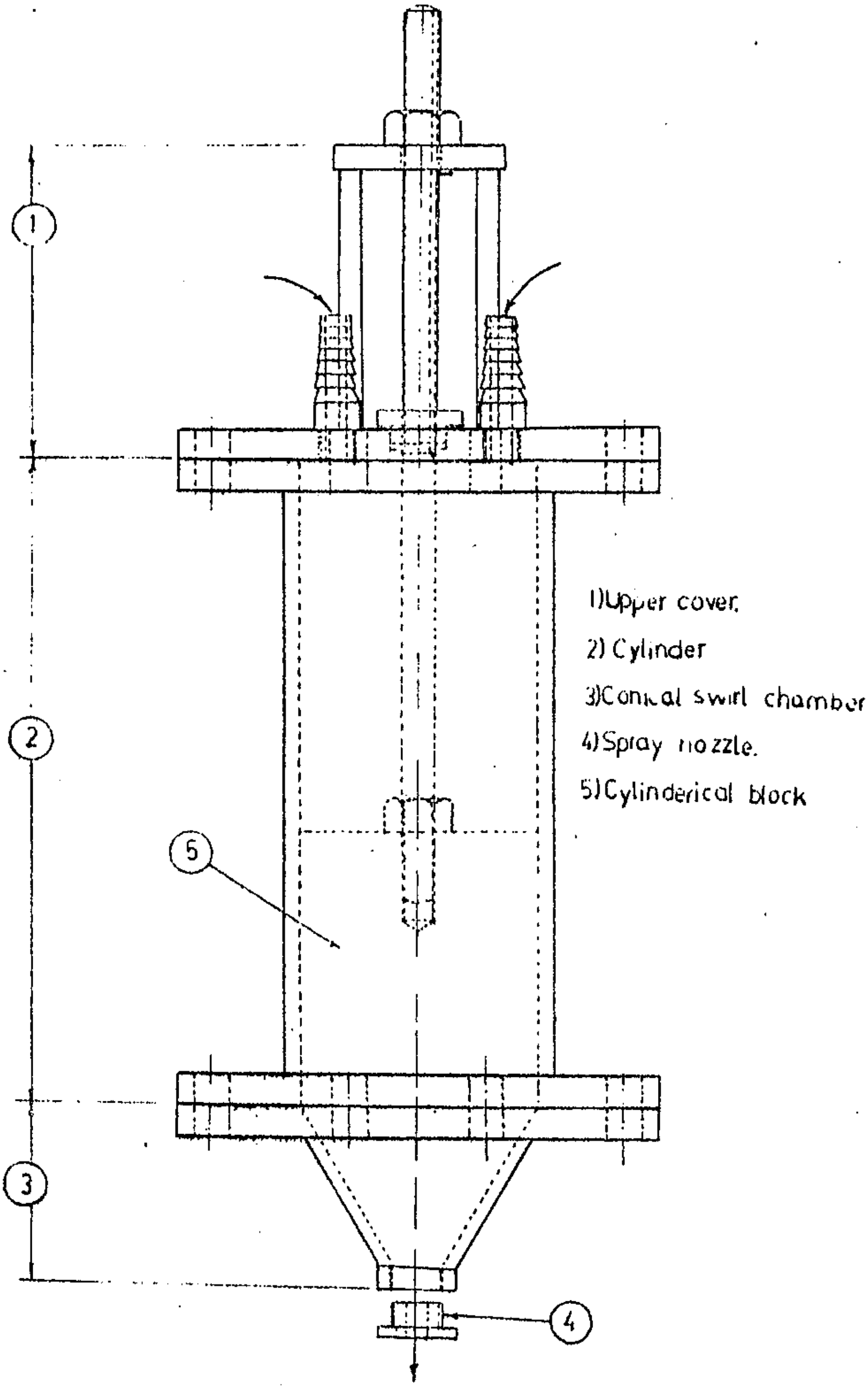
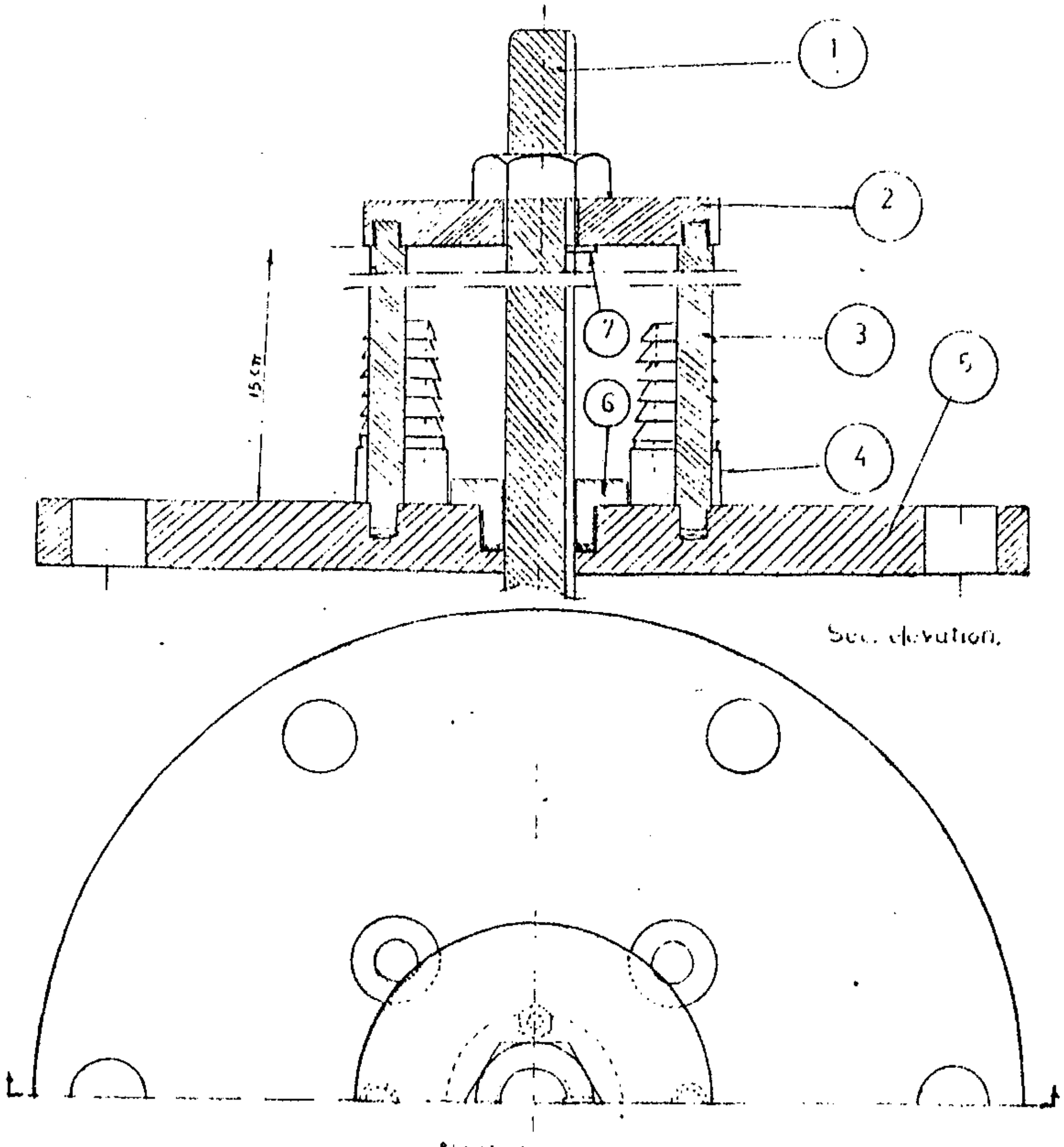


FIG.(2).Elevation projected of apparatus.



FIG(3 .) Support upper cover. Scale 1 : 2.

1)Block guide. 2)Circular disc. 3)Two columns. 4)Nipples.
5)Upper cover. 6)Oil seal. 7)A pen.

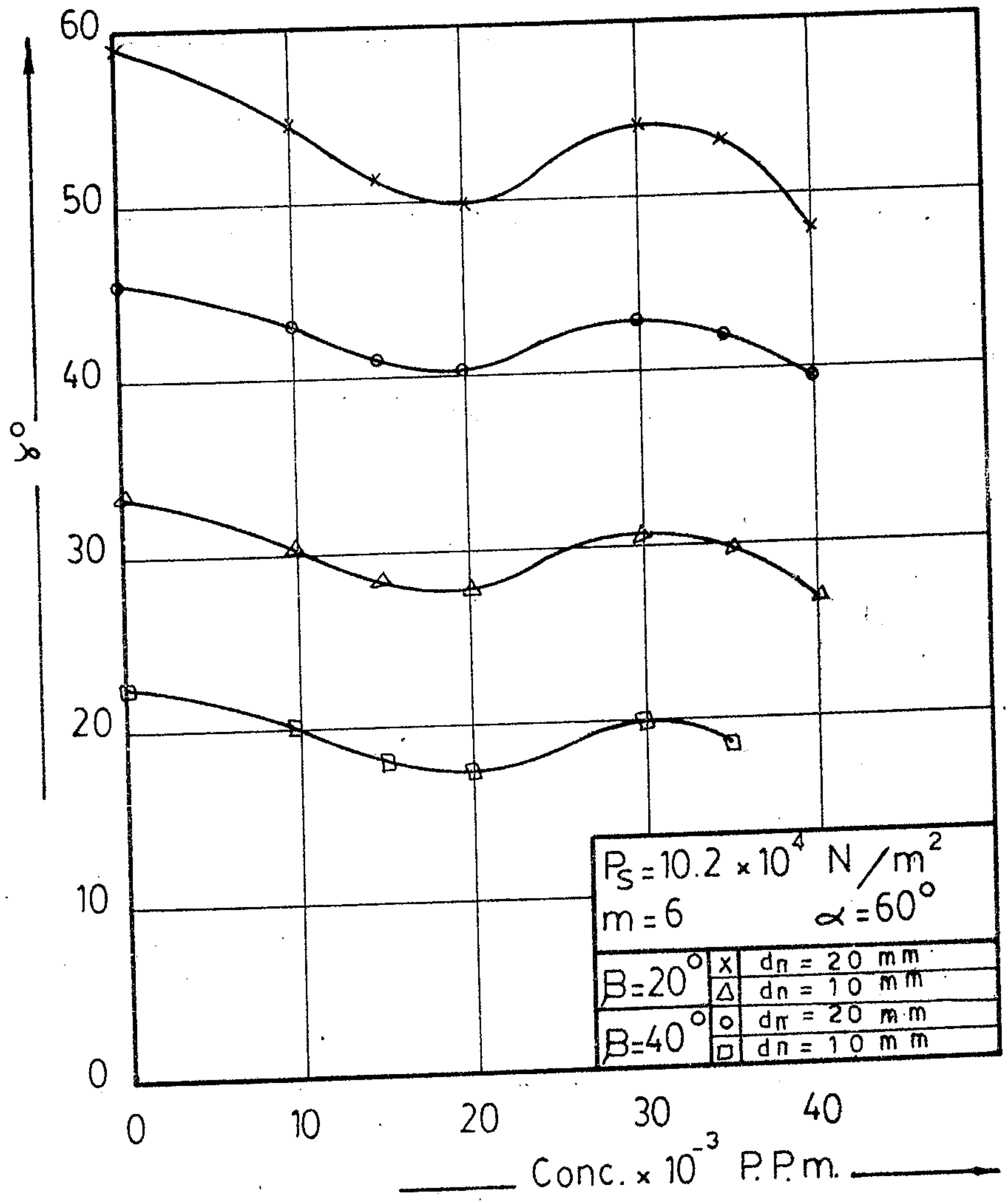
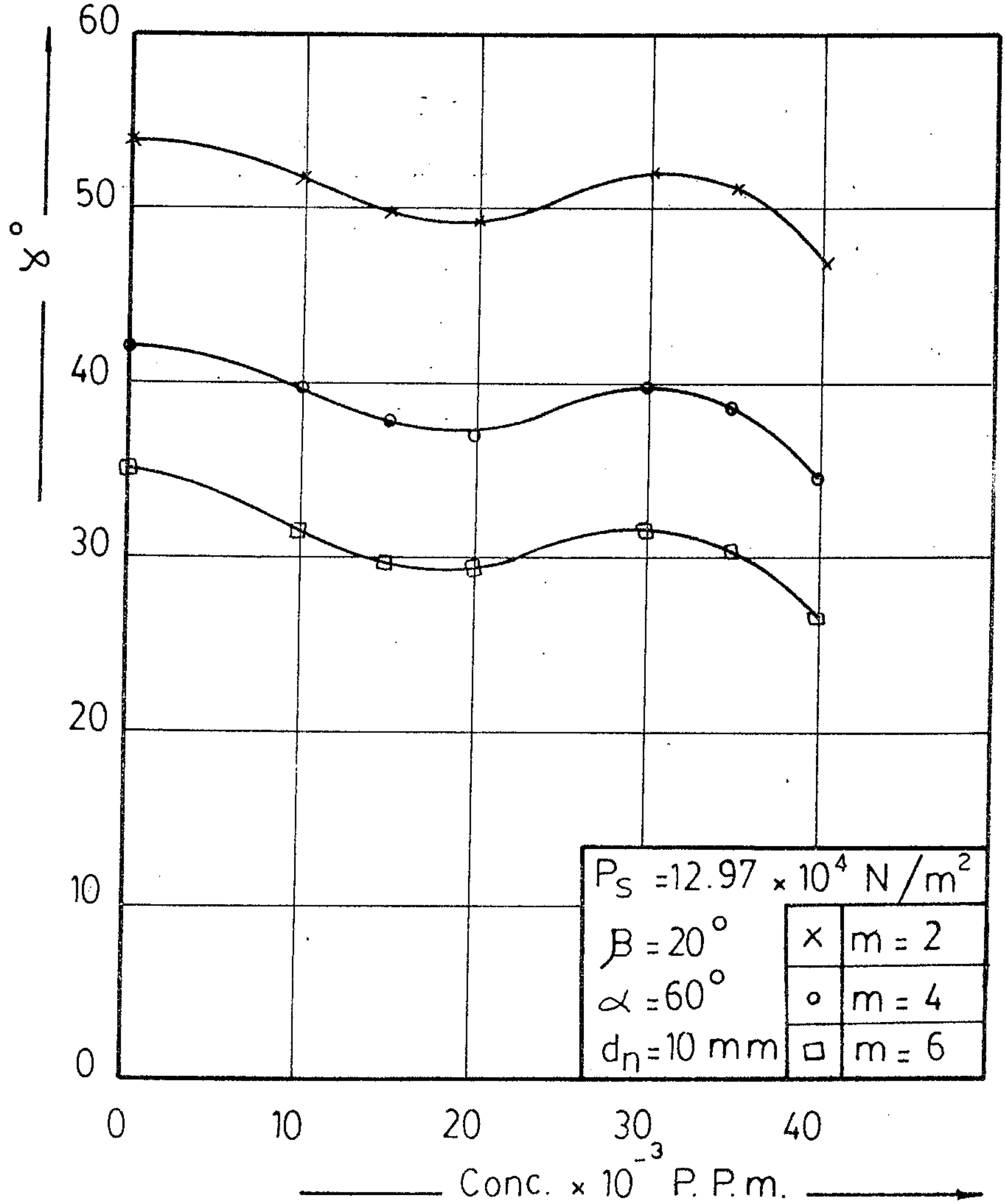

60
50
40
30
20
10
0
γ°
0
10
20
30
40
Conc. × 10⁻³ P.P.m.
Ps = 10.2 × 10⁴ N/m²
m = 6
α = 60°
β=20°
x dn = 20 mm
Δ dn = 10 mm
β=40°
o dn = 20 mm
□ dn = 10 mm

Fig. (4)



60
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γ°
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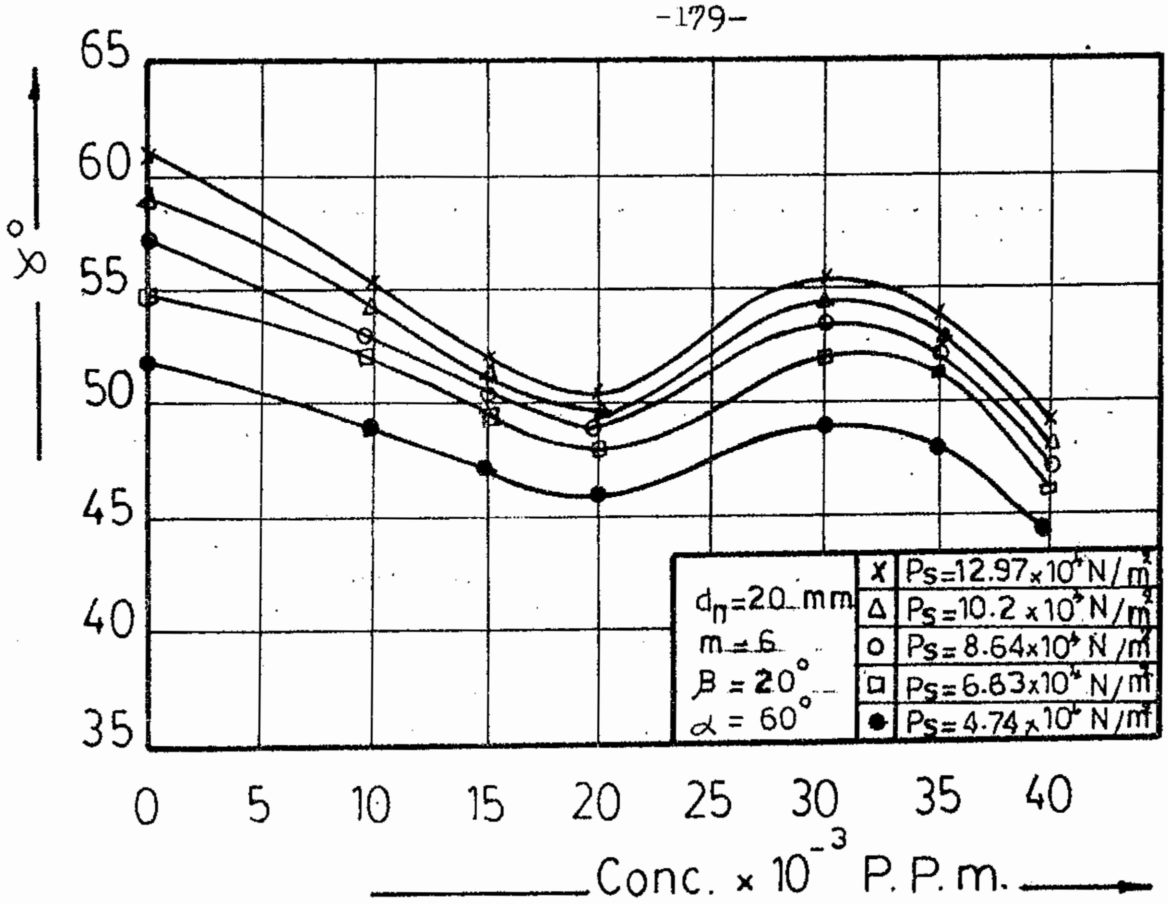
40
Conc. × 10⁻³ P.P.m.
Ps = 12.97 × 10^4 N/m^2
β = 20°
α = 60°
dn = 10 mm
× m = 2
o m = 4
□ m = 6

Fig. (5)


65
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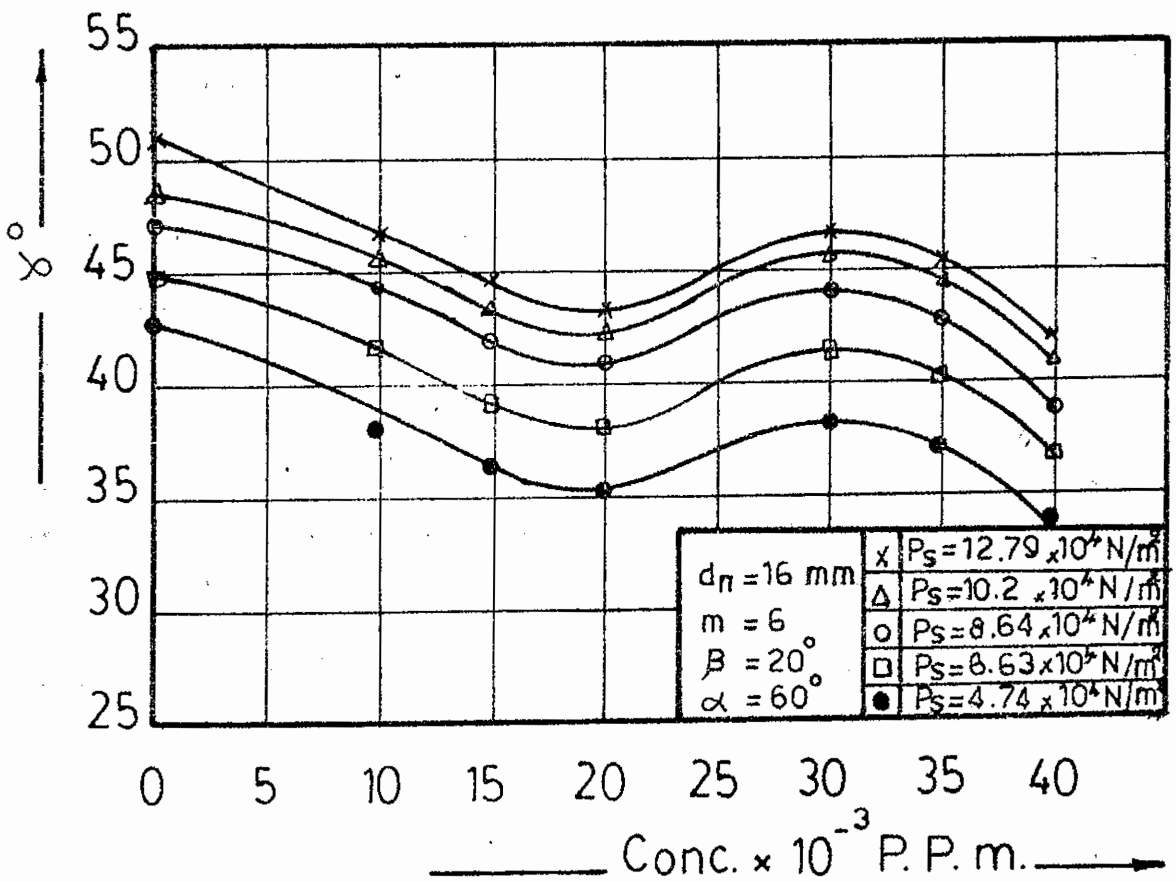
γ°
0 5 10 15 20 25 30 35 40
Conc. × 10^-3 P.P.m.
dn=20 mm
m = 6
β = 20°
α = 60°
Ps=12.97×10^4 N/m^2
Ps=10.2 ×10^4 N/m^2
Ps= 8.64×10^4 N/m^2
Ps= 6.63×10^4 N/m^2
Ps= 4.74×10^4 N/m^2

Fig.(3-6) (6)


55
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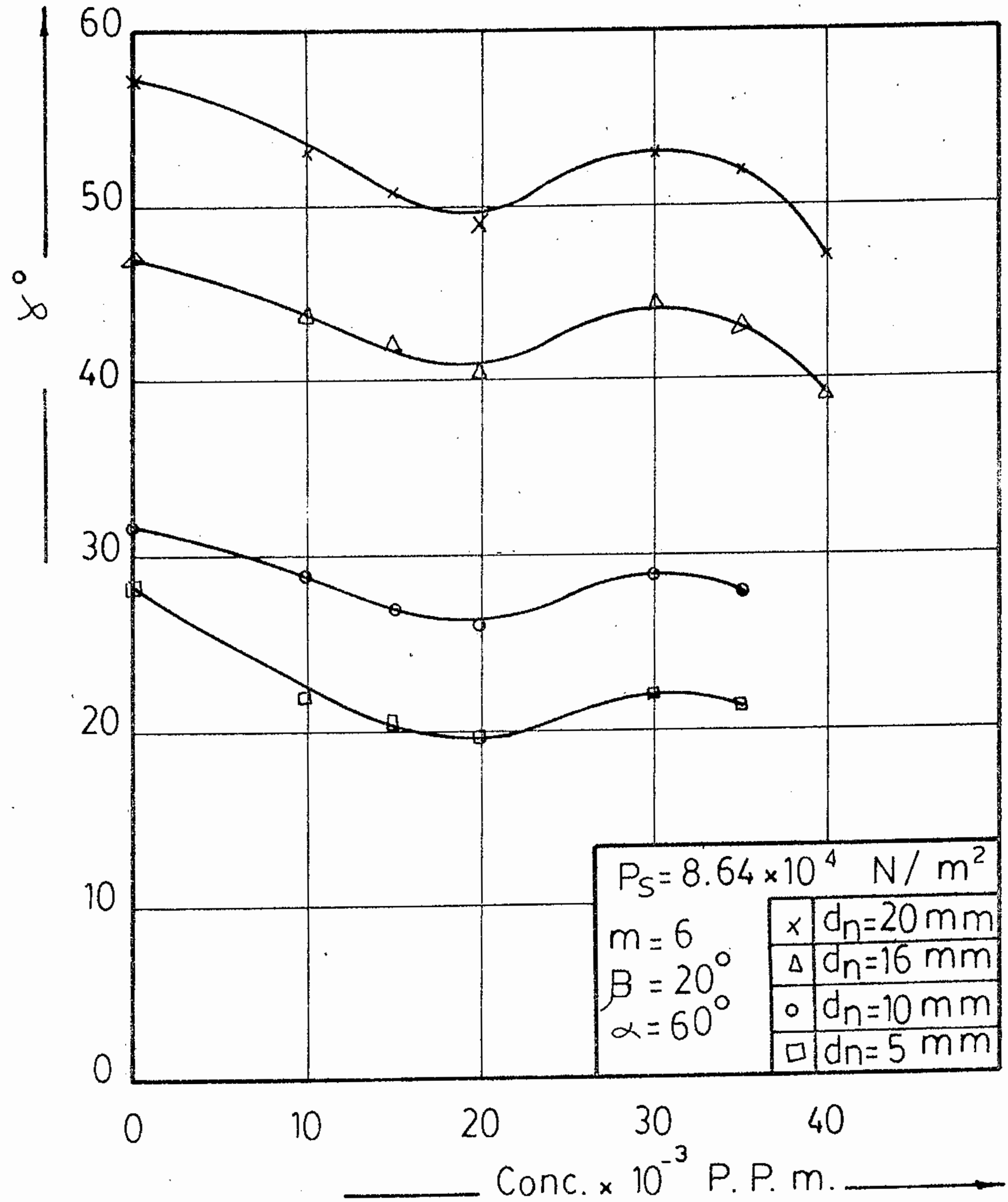
25
γ°
0 5 10 15 20 25 30 35 40
Conc. × 10^-3 P.P.m.
dn =16 mm
m = 6
β = 20°
α = 60°
Ps=12.79×10^4 N/m^2
Ps=10.2 ×10^4 N/m^2
Ps=8.64×10^4 N/m^2
Ps=6.63×10^4 N/m^2
Ps=4.74×10^4 N/m^2

Fig. (6)



60
50
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γ°
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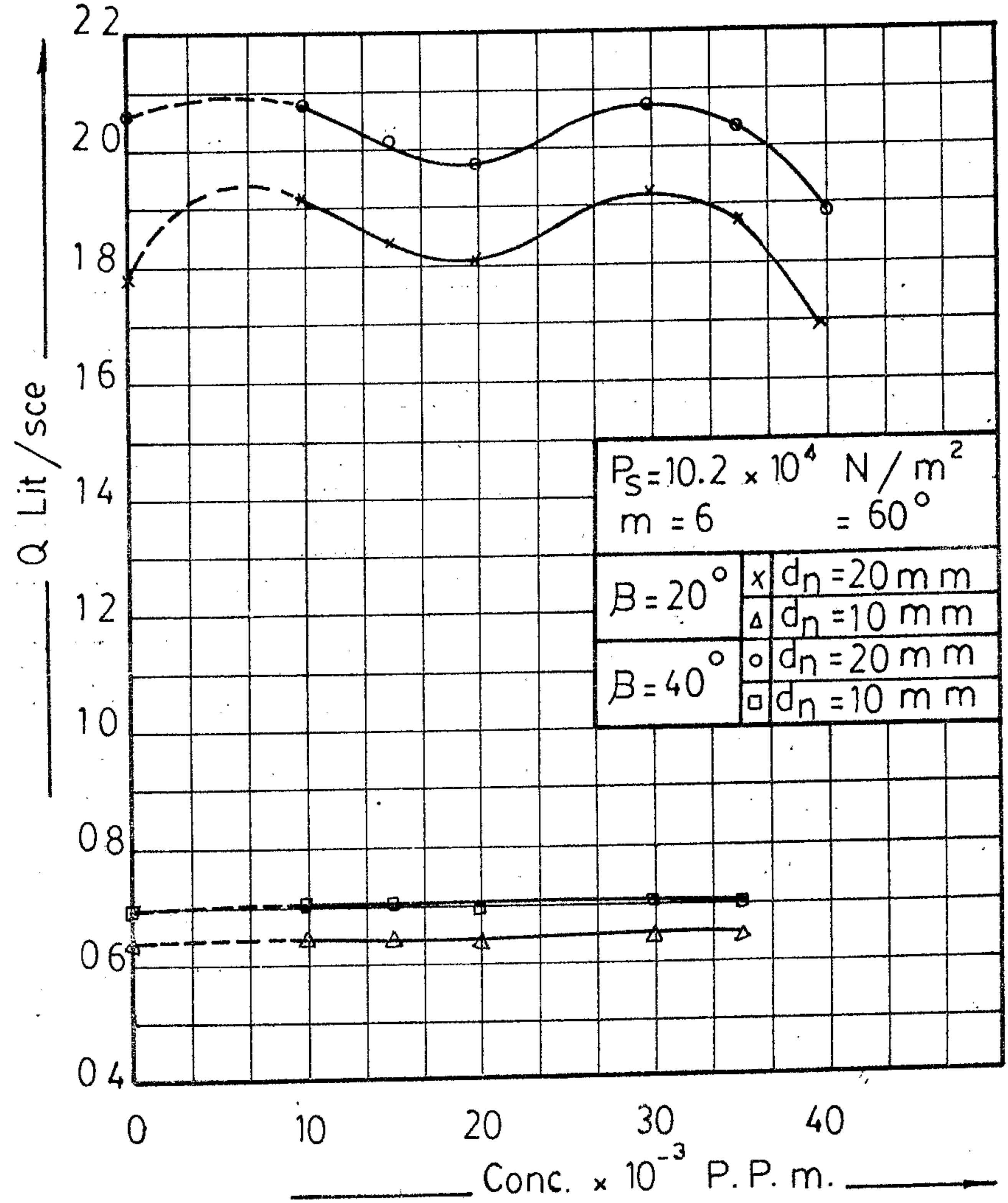
Conc. × 10^-3 P. P. m.
Ps = 8.64 × 10^4 N/m^2
m = 6
β = 20°
α = 60°
× dn=20 mm
Δ dn=16 mm
o dn=10 mm
□ dn= 5 mm

Fig. (7)


22
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08
06
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Q Lit /sce
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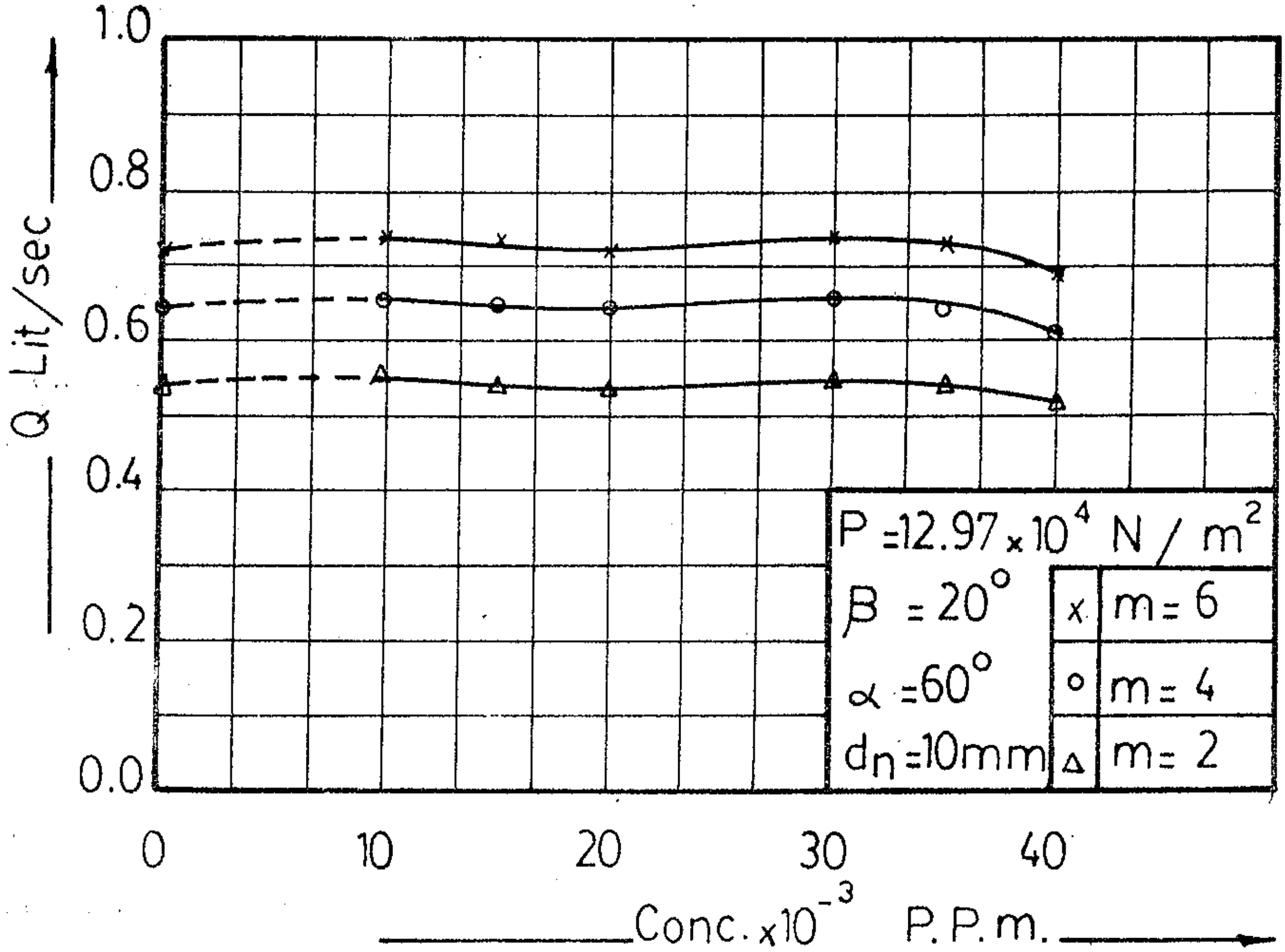
Conc. × 10^-3 P. P. m.
Ps = 10.2 × 10^4 N / m^2
m = 6
= 60°
B = 20°
x dn = 20 m m
Δ dn = 10 m m
B = 40°
o dn = 20 m m
□ dn = 10 m m

Fig. (8)



1.0
0.8
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0.4
0.2
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Q Lit/sec
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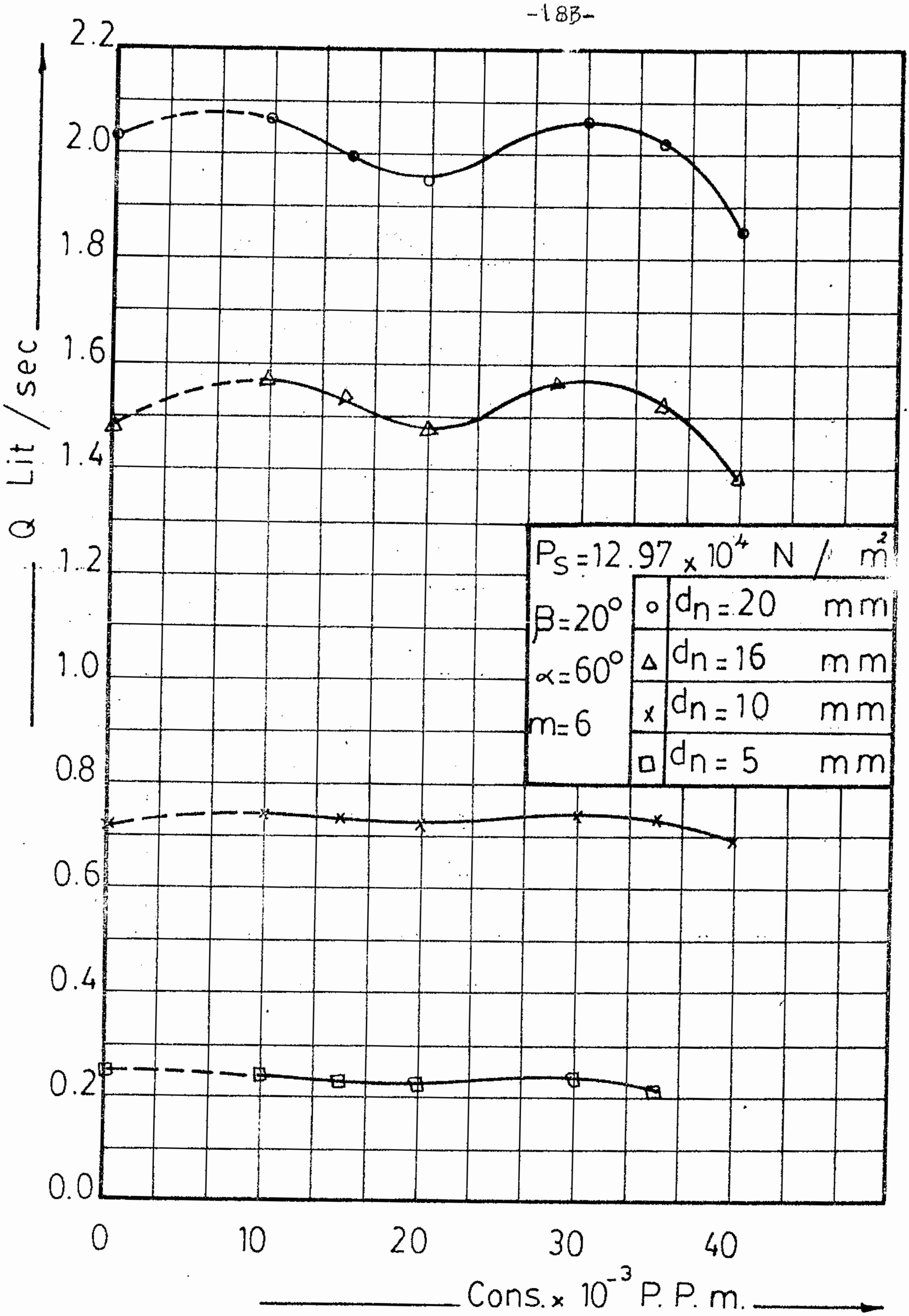
30
40
Conc. x10^{-3} P.P.m.
P =12.97 x 10^{4} N / m^{2}
β = 20°
α =60°
d_n =10mm
x m= 6
o m= 4
Δ m= 2

Fig. (9)



2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Q Lit /sec
$P_S = 12.97 \times 10^4$ N / m^2
$\beta = 20^\circ$
$\alpha = 60^\circ$
m= 6
o d_n = 20 mm
Δ d_n = 16 mm
x d_n = 10 mm
□ d_n = 5 mm
0
10
20
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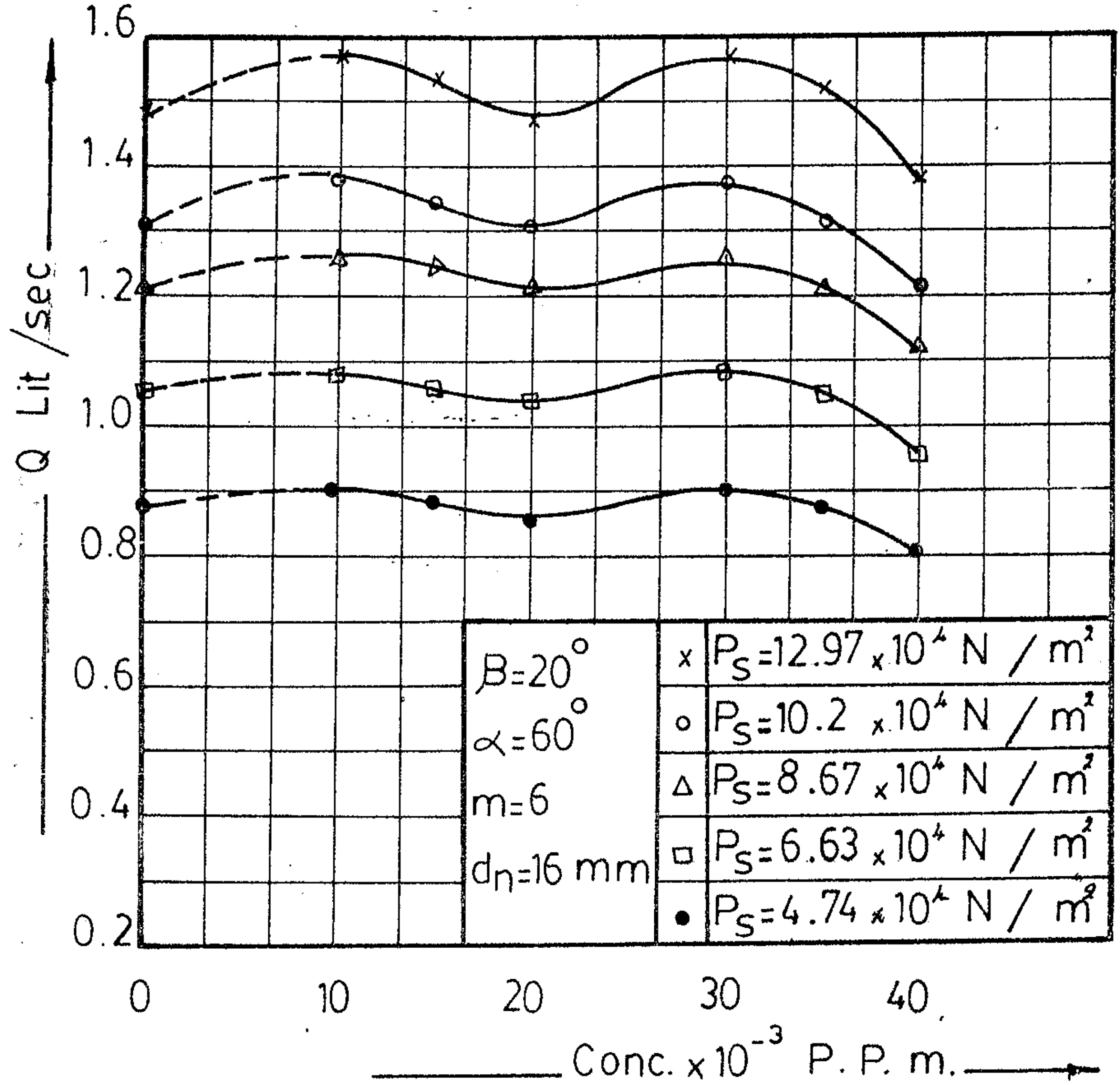
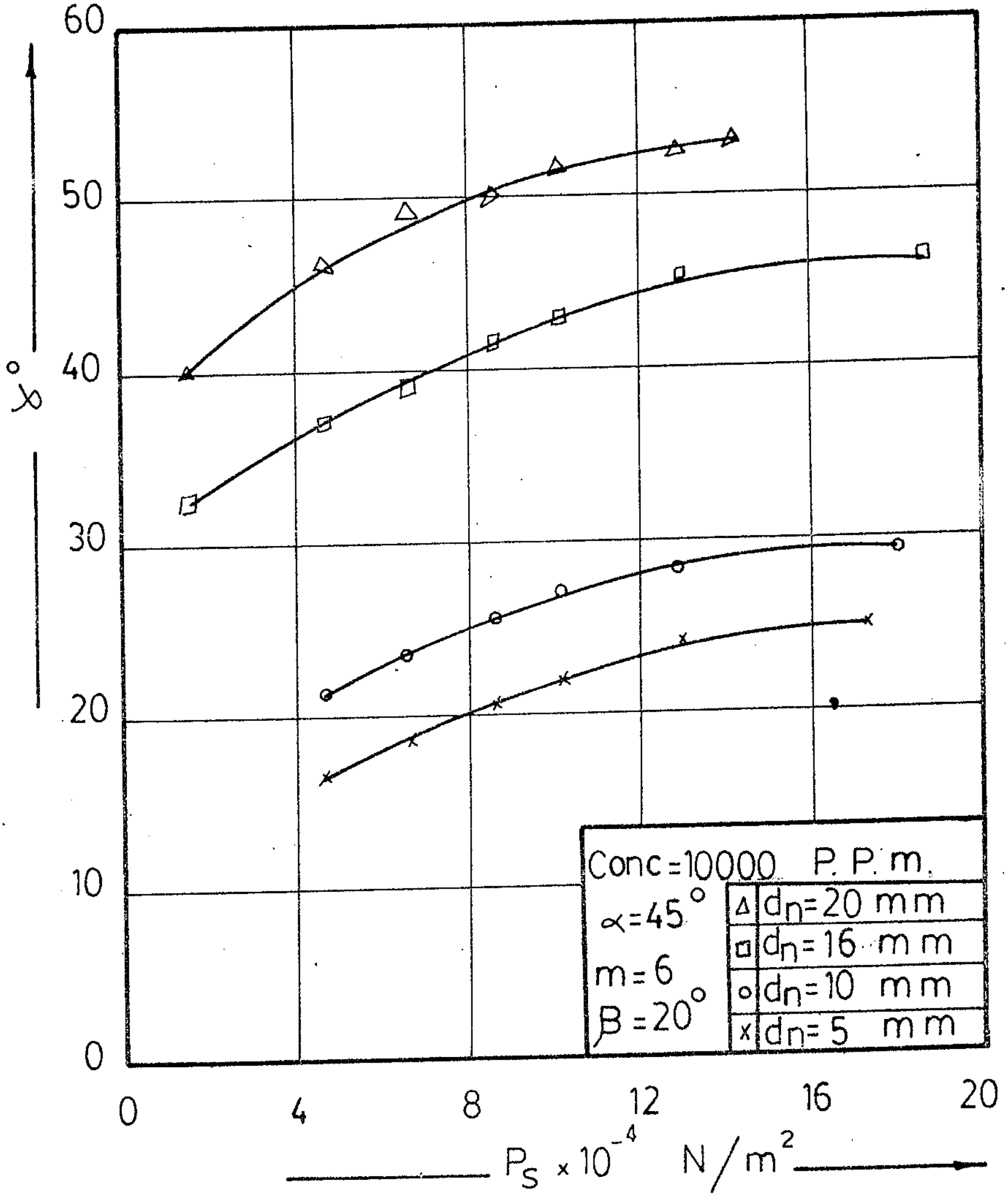
40
Cons. x 10^{-3} P. P. m.

Fig. (10)



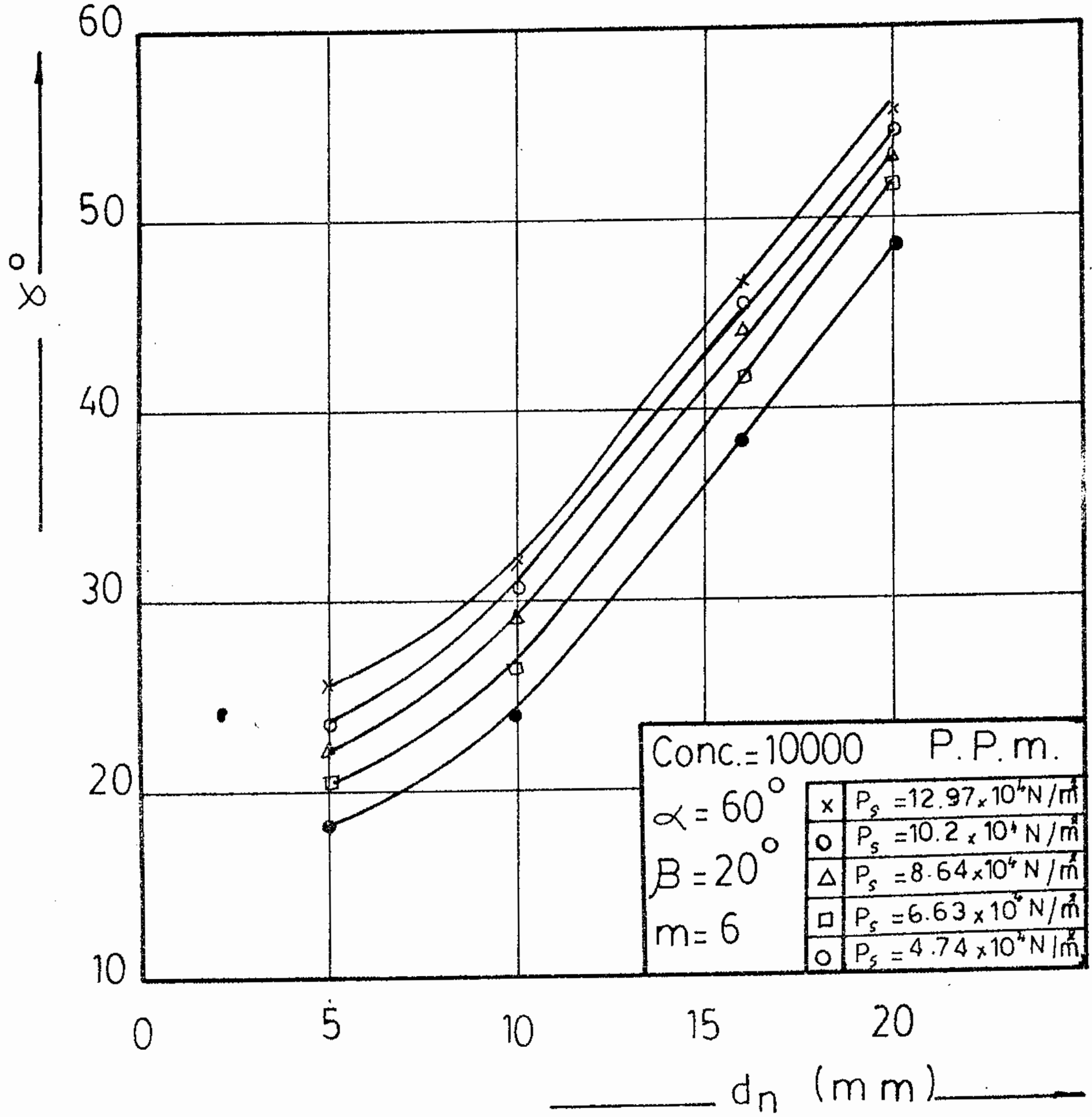
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Q Lit /sec
0
10
20
30
40
Conc. x 10^-3 P. P. m.
B=20°
α=60°
m=6
dn=16 mm
x Ps=12.97 x 10^4 N / m^2
o Ps=10.2 x 10^4 N / m^2
Δ Ps=8.67 x 10^4 N / m^2
□ Ps=6.63 x 10^4 N / m^2
• Ps=4.74 x 10^4 N / m^2

Fig. (11)



60
50
40
30
20
10
0
γ°
0
4
8
12
16
20
$P_s \times 10^{-4}$ N/m²
Conc = 10000 P.P.m.
α = 45°
m = 6
β = 20°
Δ d_n = 20 mm
□ d_n = 16 mm
○ d_n = 10 mm
x d_n = 5 mm

Fig. (12)


60
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γ°
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15
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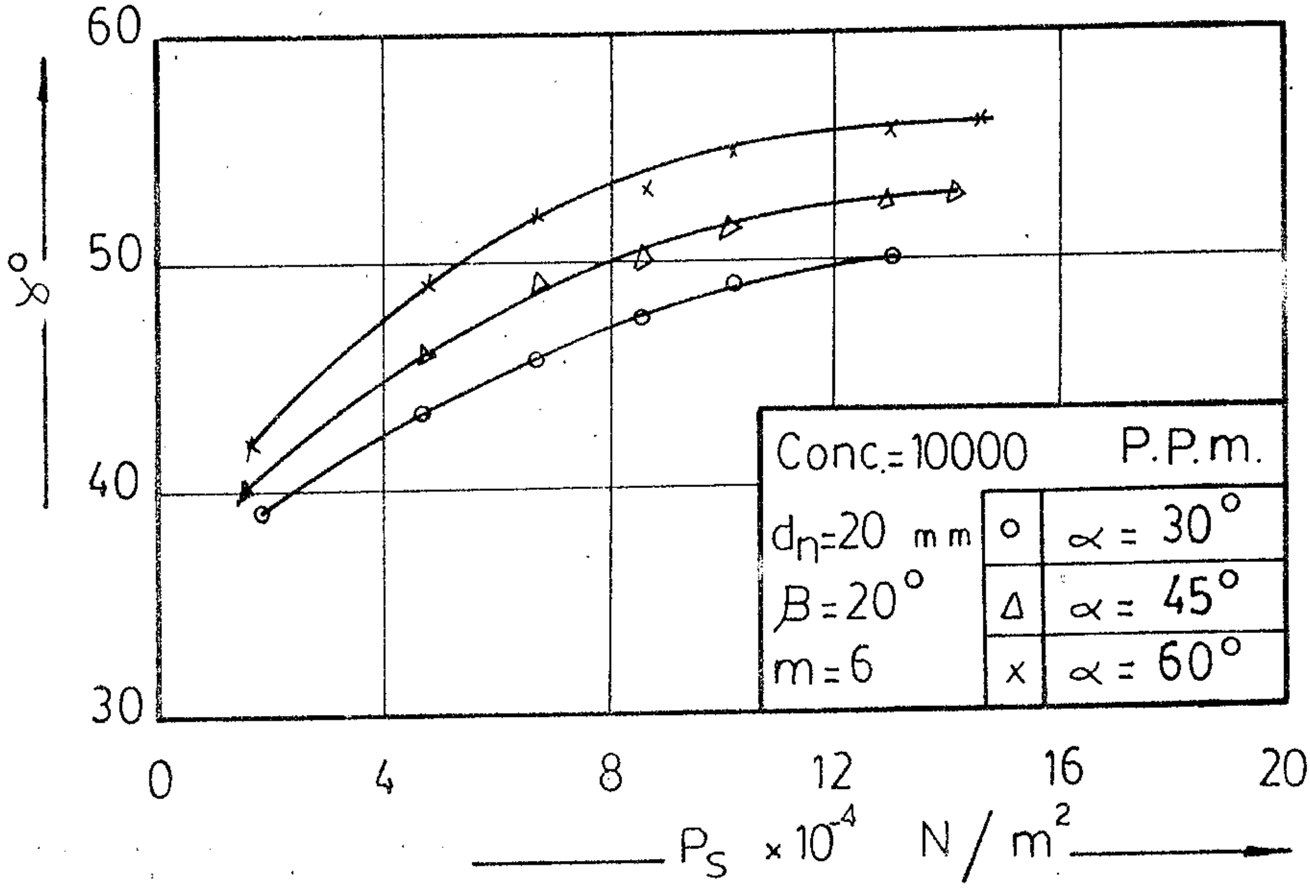
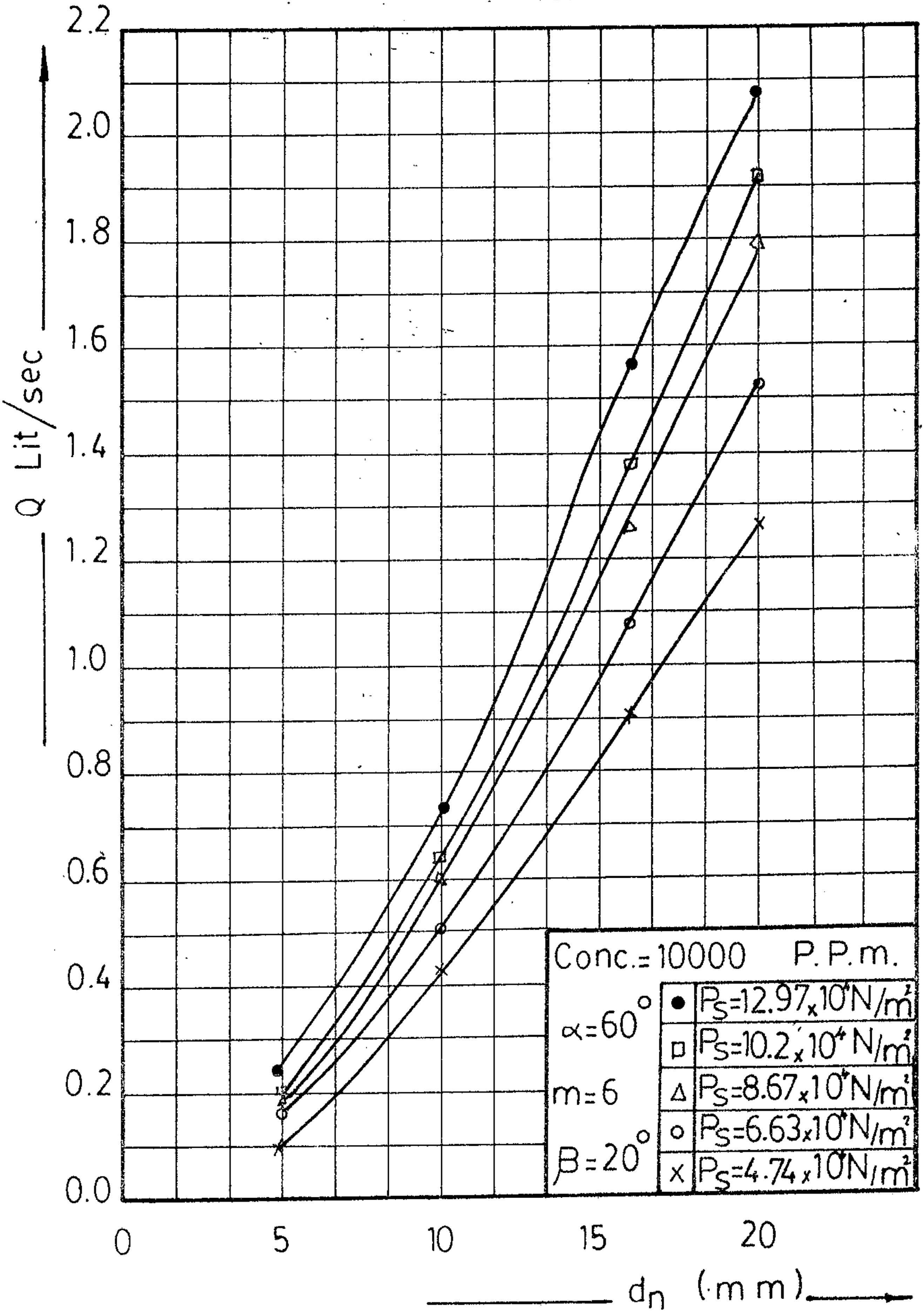
dn (mm)
Conc.=10000 P.P.m.
α = 60°
β = 20°
m= 6
× Ps =12.97x10⁴N/m²
○ Ps =10.2 x 10⁴ N/m²
△ Ps =8.64x10⁴ N/m²
□ Ps =6.63 x 10⁴ N/m²
○ Ps =4.74 x10⁴ N/m²

Fig.(13)



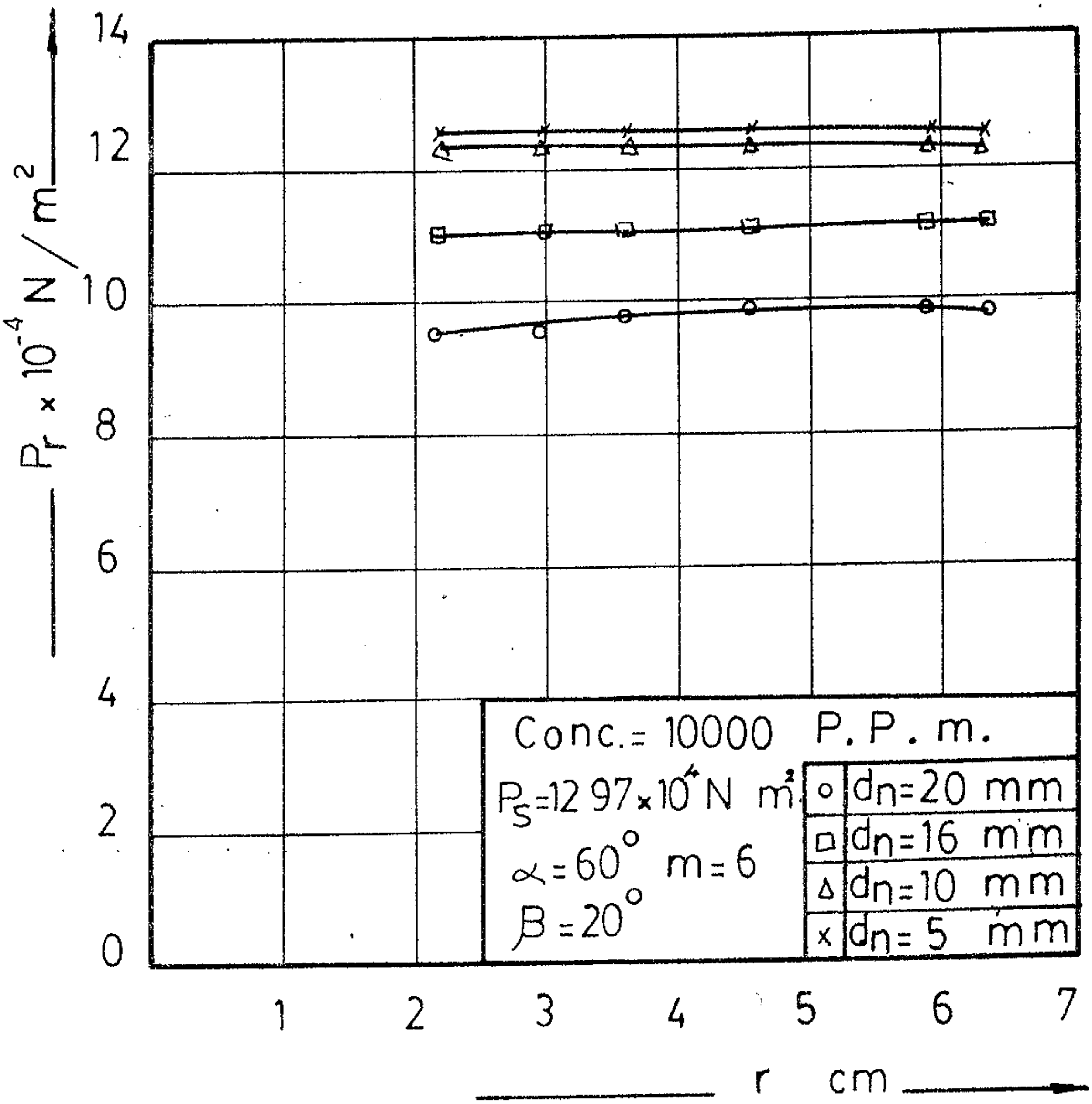
60
50
40
30
γ %
0
4
8
12
16
20
Ps × 10⁻⁴ N/m²
Conc.=10000 P.P.m.
dn=20 mm
β=20°
m=6
o α = 30°
Δ α = 45°
x α = 60°

Fig. (14)



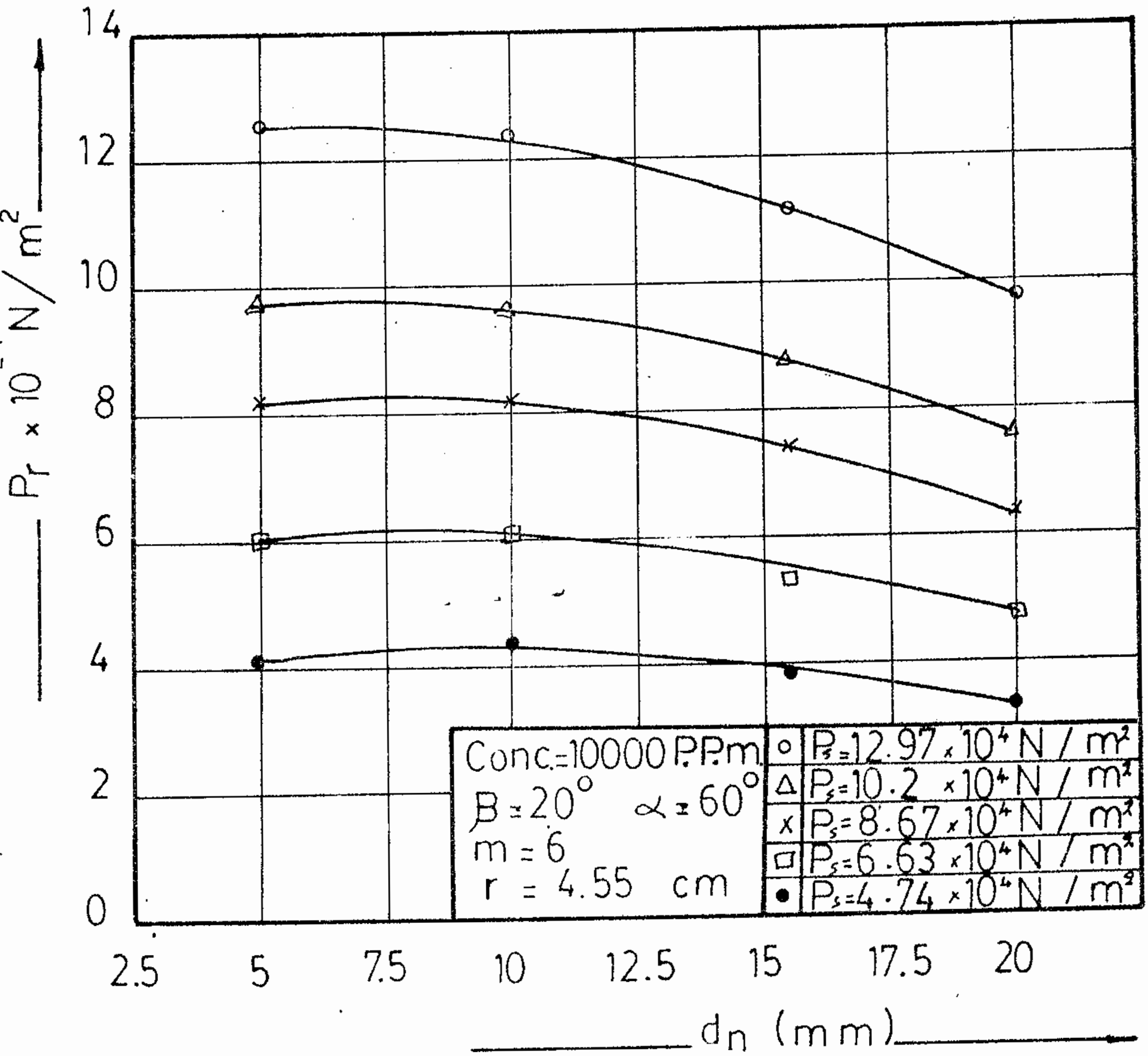
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Q Lit/sec
0
5
10
15
20
dn (mm)
Conc.= 10000 P.P.m.
α = 60°
m = 6
β = 20°
Ps=12.97x10⁴N/m²
Ps=10.2x10⁴N/m²
Ps=8.67x10⁴N/m²
Ps=6.63x10⁴N/m²
Ps=4.74x10⁴N/m²

Fig. (15)



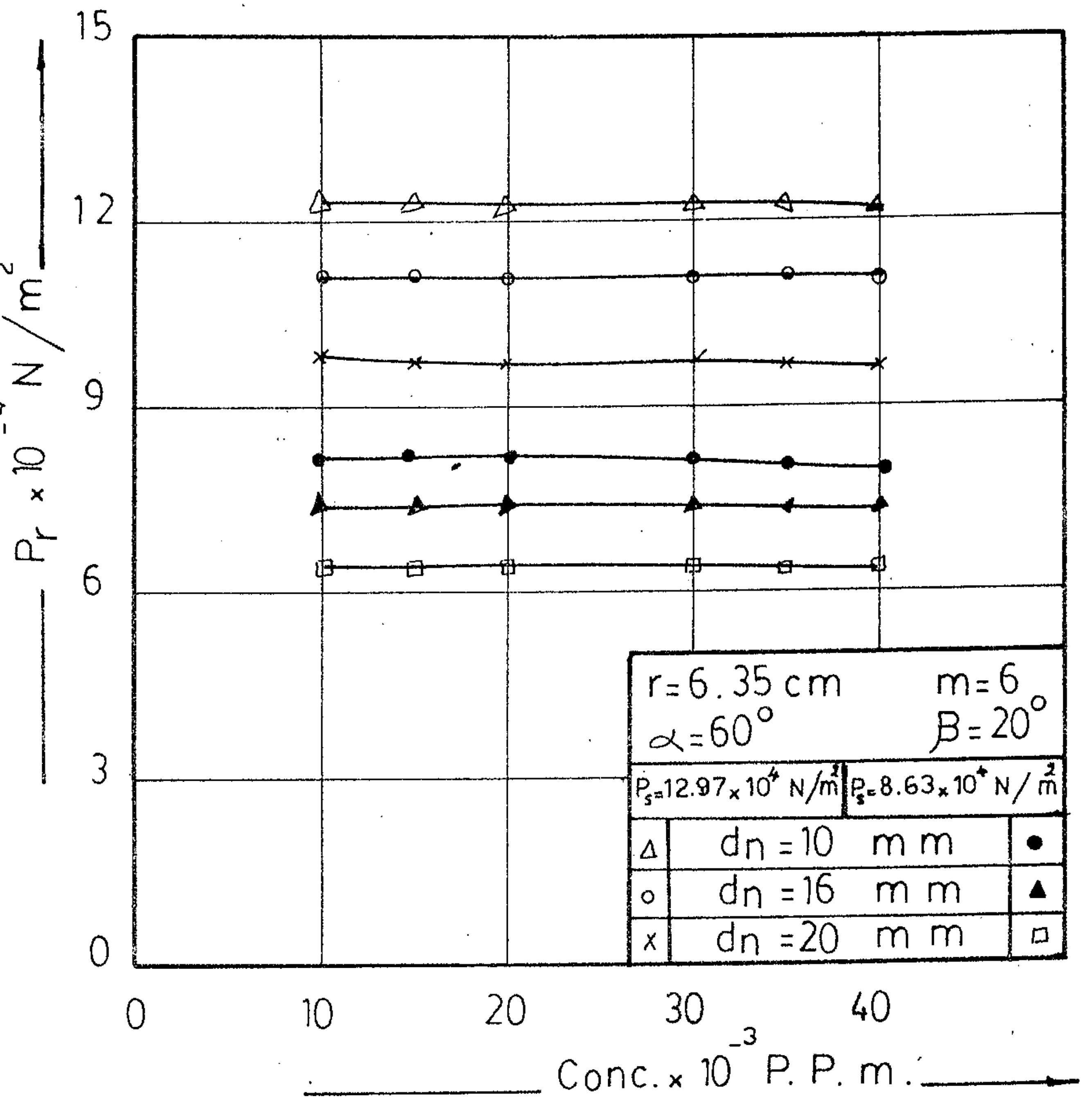
14
12
10
8
6
4
2
0
$P_r \times 10^{-4}$ N/m^2
1
2
3
4
5
6
7
r cm
Conc. = 10000 P.P.m.
P_S = 12 97 × 10^4 N m^2
α = 60° m = 6
β = 20°
o dn = 20 mm
□ dn = 16 mm
Δ dn = 10 mm
x dn = 5 mm

Fig. (16)



14
12
10
8
6
4
2
0
Pr × 10^-4 N/m^2
2.5
5
7.5
10
12.5
15
17.5
20
dn (mm)
Conc.=10000 P.P.m.
β = 20° α = 60°
m = 6
r = 4.55 cm
○ Ps=12.97 ×10^4 N / m^2
△ Ps=10.2 ×10^4 N / m^2
x Ps=8.67 ×10^4 N / m^2
□ Ps=6.63 ×10^4 N / m^2
● Ps=4.74 ×10^4 N / m^2

Fig.(17)



15
12
9
6
3
0
$P_r \times 10^{-4}$ N/m²
0
10
20
30
40
Conc. × 10^{-3} P. P. m.
r = 6.35 cm
m = 6
α = 60°
β = 20°
P_s=12.97 × 10^4 N/m²
P_s=8.63 × 10^4 N/m²
dn = 10 mm
dn = 16 mm
dn = 20 mm

Fig (18)

Conc. = 10000 p.p.m.

Table (I)

$\beta = 20^{\circ}$ m = 6

diameter of spray nozzle = 20 mm.			
Supply Pressure N/m^2	Flow rate Lit/sec		
	$\alpha = 30^{\circ}$	$\alpha = 45^{\circ}$	$\alpha = 60^{\circ}$
12.97×10^4	2.033	2.055	2.068
10.2×10^4	1.88	1.92	1.92
8.64×10^4	1.755	1.78	1.79
6.63×10^4	1.5	1.525	1.53
4.74×10^4	1.3	1.26	1.27

Diameter of spray nozzle = 16 mm			
Supply Pressure N/m^2	Flow rate Lit/se		
	$\alpha = 30^{\circ}$	$\alpha = 45^{\circ}$	$\alpha = 60^{\circ}$
12.97×10^4	1.52	1.553	1.57
10.2×10^4	1.34	1.266	1.38
8.64×10^4	1.23	1.25	1.26
6.63×10^4	1.05	1.07	1.08
4.74×10^4	0.87	0.89	0.905

Diameter of spray nozzle = 10 mm.			
Supply pressure N/m^2	Flow rate lit/ sec.		
	$\alpha = 30^{\circ}$	$\alpha = 45^{\circ}$	$\alpha = 60^{\circ}$
12.97×10^4	0.71	0.74	0.74
10.2×10^4	0.63	0.64	0.64
8.64×10^4	0.58	0.6	0.6
6.63×10^4	0.49	0.5	0.51
4.74×10^4	0.42	0.43	0.43

Diameter of spray nozzle = 5 mm.			
Supply pressure N/m^2	Flow rate lit/sec.		
	$= 30^{\circ}$	$= 45^{\circ}$	$= 60^{\circ}$
12.97×10^4	0.24	0.24	.24
10.2×10^4	0.22	0.2	0.2
8.63×10^4	0.19	0.19	0.18
6.63×10^4	0.14	0.14	0.16
4.74×10^4	0.12	0.12	0.1

Table (II)

°	$P_s \times 10^{-4}$ N/m^2	m	B°	dn (mm)	$P_r \times 10^{-4}$ N/m^2 r_1	r_2	r_3	r_4	r_5	r_6
60°	12.97	6	20°	20	9.83	9.81	9.81	9.75	9.57	9.52
				10	12.383	12.378	12.389	12.393	12.379	12.366
		4	20°	10	12.385	12.38	12.38	12.36	12.32	12.29
		2	20°	10	12.462	12.458	12.456	12.447	12.395	12.383
	10.2	6	20°	20	7.67	7.66	7.55	7.6	7.44	7.391
				10	9.644	9.639	9.65	9.654	9.64	9.628
			40°	10	9.6	9.6	9.61	9.62	9.61	9.61
				20	7.09	7.07	7.06	7.02	6.91	6.88
		4	20°	10	9.715	9.71	9.72	9.72	9.69	9.68
		2	20°	10	9.723	9.718	9.729	9.733	9.693	9.681
	6.63	6	20°	20	4.86	4.84	4.836	4.773	4.71	4.675
				10	6.175	6.17	6.18	6.184	6.17	6.158
			40°	10	6.1	6.1	6.12	6.12	6.12	6.13
				20	4.49	4.48	4.48	4.46	4.43	4.37
45°	12.97	6	20°	20	9.77	9.76	9.75	9.74	9.68	9.59
30°	12.97	6	20°	20	10.06	9.97	9.91	9.85	9.73	9.56

= 60° r_1= 6.35 cm r_2= 5.9 cm r_3= 4.55 cm r_4= 3.6 cm r_5= 2.95 cm r_6= 2.2 cm

= 40° r_1=6.6 cm r_2= 5.92cm r_3= 5.125cm r_4= 4.42cm r_5= 3.5 cm r_6= 2.9 cm

= 30° r_1=6.625 cm r_2= 5.31cm r_3= 4.18 cm r_4= 3.4 cm r_5= 2.4 cm r_6= 1.9 cm

تأثير الخصائص الغير نيوتونية للمائع على اداء الرشاشات

ا ٠د ٠ عصام احمد سالم (١)　　ا ٠د ٠ بسيونى احمد خليفة (٢)
د ٠ مدحت عباس شوقى (٣)　　م ٠ مصطفى نصر محمد نصر (٤)

هذا البحث يدرس تأثير خصائص الموائع الغير نيوتونية على اداء الرشاشات والدراسة المعملية تشمل قياس زاوية رش المائع ومعدل التصرف وتوزيع الضغط خلال الغرفة المخروطية الدوامية ومدى تأثرها بتغيير كل من :

١ ــ ضغط المنبع　　٢ ــ قطر بوق الرش
٣ ــ زاوية الحلزون على القلب الداخلى للرشاش
٤ ــ عدد مجارى الحلزون على قلب الرشاش
٥ ــ تركيزات مختلفة للمائع الغير نيوتونى
٦ ــ زاوية مخروط للغرفة الدوامية عند تركيز ١٠٠٠٠ جزء من البوليمر / مليون جزء مياة

والمادة التى تجعل المائع غير نيوتونى هى مادة (صوديوم كاربوكسى ميثيل سيليلوز)

والنتائج المعملية سجلت فى منحنيات لتبين العلاقة بين البرامترات المختلفة واستخدمت طريقة (　　) لايجاد صورة معملية لزاوية رش المائع ومعدل التصرف كدالة فى البرامترات المختلفة مثل ضغط المنبع وقطر بوق الرش وزاوية حلزون القلب وعدد مجارى الحلزونية وكثافة المائع ٠

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