EFFECT OF CONE ANGLE, SWIRL CHAMBER HEIGHT AND DIAMETER OF SPRAY NOZZLE ON THE PERFORMANCE OF SWIRL TYPE SPRAYERS.

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ABSTRACT:

This paper is concerned by study of the performance characteristics of swirl type sprayers experimental study concluded the effect of swirl champer cone angle, spray nozzle diameter and the swirl chamber height. Data were collected at different supply pressure. The spray angle, flow-rate and droplet size were estimated by a propriate method.

The results show that, the spray angle increases with increase of spray nozzle diameter, mean while the average droplet size decreases. The change of swirl chamber height and cone angle have no effect on the flow rate. Supply pressure increase leads to decrease of the mean droplet size.

NOMENCLATURES:

Symbol	Quantity	Units
P_s	Supply pressure	N/m^2
P_r	Static pressure at raduis (r) in the conicat swirl chamber.	N/m^2
Q	Flow rate.	Lit/sec.
	Cone angle of swirl chamber with horizontal line.	$( )^o$
d_n	Diameter of spray nozzle.	mm

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	Spray angle of water.	( )^{o}
D_d	Diameter of droplet	mm.
D_{d_m}	Mean diameter of droplet.	mm.
C.N.	Cumulative number	%

INTRODUCTION:

Study of spraying and swirl motion of fluids is important due to it's wide applications in industry and agriculture, such as in atomization of diesel fuel in engines, gas turbine development, spray drying, insecticide spraying, spray cleaning of various products, evaporative cooling of buildings, sprinkler irrigation and applications of fertilizers as sprays and other purposes. The swirl type nozzles is the most common type of spray nozzles.

Regarding the previous work in this field and relevant fields, it can be seen that:-

Swirling flow in a perfectly conical fumel was first discussed by Taylor (1950). When the flow was assumed to have a component of velocity as given by a potential line vortexlying a long the axis of the cone-an idealization of an agricultural sprayer. It was shwon that the radial pressure gradient which necessarily accompanies the swirling motion acts on the boundary layer driving it along the surface of the cone towards the apex. Within the boundary layer, fluid is retarded by viscoisity and consequently has no sufficient centrifugal acceleration to hold it in a circular path against the inward radial pressure gradient.

Binnie and co-workers (1948, 50, 56, 57)(2,4,5,6) carried experiments in swirling water, with a nearly free vortex tangential velocity distribution which passed through convergent nozzles. They found backflow and assumed that this backflow was the same in tubes of constant cross section. Long (1956) found that the fluid near the axis is accelerated towards the sink, while the fluid near the tube wall is decelerated.

Fraser (1958) (9) summarized the characteristics of swirl spray nozzles as follows:-

i) At constant nozzle size: flow rate is proportional to square root of pressure.
ii) At constant liquid pressure, flow rate is proportional to square nozzle diameter.

S. Ahmed (1971) (8) mentioned that the discharge varied in proportion to the square root of the pressure. The discharge and spray angle are increased with increasing the nozzle diameter, number of supply holes, and width of swirl chamber. The droplet diameter is decreasing with increasing the acting pressure and dicreasing the inlet port area.

Frensh (1942) and Akesson (1952) (1) reported that the average drop size, produced by a nozzle, varies nearly as the inverse square root of the pressure.

S.A. Nawaby (1970) (7) published a method of collecting droplets issued from different types of nozzles in an oil bath, measuring and counting these droplets by using direct photographic and overhead projector methods. The overhead projector method is considered to be a low cost method compared with the photographic one.

M.N. Awady (1977) (10) mentioned that the most accurate method to determine the droplet sizes is by receiving them is on oil bath. A good sample should consist of about 200 drops collected from random places.

The above demonstration of previous work shows that the effect of cone angle and swirl chamber height are still out of consideration. It seems to be of great importance to design engineer to have an estimation of the effect of each of the above mentioned parameters. This work is devoted to experimental study of the effect of cone angle, swirl chamber height and diameter of spray nozzle at different supply pressures on the characteristics of water sprayer, namely spray angle, flow rate and droplet size. Since the problem of droplet formation theoritical study in still far from hand, the approach is experimental one.

EXPERIMENTAL WORK:

The present experimental work was carried out to study the performance of water sprayer. To cary out this work, an experimental device wase set up to perform the experimental investigation of pressure distribution in the conical swirl chamber, spray angle, droplet size and following discharge.

Measurments of spray angle, droplet size, discharge and pressure distribution through swirl chamber were taken at different:-

a) Supply pressure
b) Diameter of spray nozzles
c) Swirl chamber heights
d) Cone angles.

The experiments were made using five values for supply pressure at each value, the following reading were recorded:-

1 - The sprayed flow was photographed.
2 - The reading of the piezometer tubes connected to the tapping points in the conical swirl chamber.
3 - The reading of the U-tube connected to the orifice meter.
4 - The reading of the U-tube connected to measure the supply pressure.
5 - A sample of droplets was also collected to count the number of droplets of each size. This sample contained about 200 drops collected from randum places. At each value of supply pressure the above mentioned procedure was repeated changing one of the following geometrical parameters:-

1) Swirl chamber height (L = 0,50 and 100 mm)
2) Angle of the conical swirl chamber ($\alpha = 30^{\circ}, 45^{\circ}$ and 60°)
3) Spray nozzle diameters (d_n = 5, 10, 16 and 20 mm).

The experimental set shown in Fig. (1) consists of test apparatus, hydraulic circuit, and measuring devices.

A) The test apparatus consists of:

1 - The cylinder housing:

A cylinder of 14 cm inner diameter and 30 cm height, formed by fine turning of brass.

2 - The upper cover:

In the upper cover there are four nipples, which are used to supply water into the cylinder.

3 - The cylindrical block:

A cylinder block of 16 cm height and diameter fitted to the cylinder inner diameter to minimize leakage of liquid between them (slide fit).

The flow is admitted to the swirl chamber through six helix grooves 2 X 2 cm and helix angle 20^{o}, on the outer surface of the block.

4 - The swirl chamber: The swirl chamber consisted to two parts: a) Conical swirl chamber b) Cylinderical swirl chamber

In the experimental work 3 cones with angles 30^{o}, 45^{o} and 60^{o} are used for the conical swirl chamber. To find the the pressure distribution across the conical swirl chamber, six holes, 1 mm diameter each, were drilled in the conical base at different radii normal to the inner cone surface. The cylindrical swirl chamber height can be changed from (0 to 100 mm) by moving the cylindrical block in the vertical direction.

5 - Spray nozzle:- Four different nozzles were used. All these nozzles have the same outer diameter of 3 cm to be fitted on the central hole of the conical base of the cylinder, but with different inner diameter (5, 10, 16 & 20 mm), and all of them were 2 cm long.

B) The hydraulic circuit consist of a supply tank, pump, piping system and orifice meter.

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. In this work, the estimation of the accuracy of the measured quantities show that:

1 - The maximum relative error in flow rate taking in consideration calibration error is within 8.2%.
2 - For the pressure distribution, the maximum error less than 2%.
3 - For the supply pressure, the maximum error is within 0.12%.
4 - The spray angle was measured from the photos. The accuracy of direct measurements from the photos is not more than 1^{o}.
5 - For droplet size, the analysis of droplet sizing accuracy is complicated and the technology used may be considered comparative. The number of collected droplets was found to have a serious effect on the classification. A number of about 200 droplets was found to be suitable. The deviation is within 10%.

DISCUSSION OF EXPERIMENTAL RESULTS:

In the following section the effect of geometrical parameters on the sprayer characteristics will be discussed seperately.

a) Effect of different parameters on spray angle:

A group of photographs were taken for water spray sheet, under different operating conditions. The photographs showed clearly the different stages of the liquid sheet and spray formation.

1) Effect of swirl chamber height:

When the swirl chamber height increases, the tangential velocity decreases because the area of flow through the swirl chamber will increase, in addition to the decay of swirl, leading to decrease in spray angle as shown in photographs and Fig. (2).

2) Effect of cone angle:

Fig. (3) and phtographs show the variation of the spray angle with supply pressure at different cone angles, it can be seen that, the spray angle increases with increasing the cone angle at different diameter of spray nozzles. This is due to the more gradual change in crossectional area of flow when using large cone angles. This gradual change means less hydraulic losses and stronger swirl.

3) Effect of supply pressure and diameter of spray nozzle:

If the supply pressure increases, the tangential velocity of flow will increase and hence the spray angle will increase as shown in photographs and Fig. (4). Also, from the above figure and photographs, it's shown that when the diameter of spray nozzle increases, the centrifugal force increases and accordingly the spray angle increases.

The relation between the diameter of spray nozzle and spray angle is a straight line in the region 10 mm $\leqslant d_n \leqslant$ 20mm, while in the region $d_n <$ 10 mm the relation is nonlinear as shown in Fig. (5). This is ought to be due to the disturbance of flow in the exit zone when using a small nozzle.

b) Effect of different parameters on flow rate:

1) Effect of supply pressure:

Fig. (6) show that an increase in pressure leads to a corresponding increase in flow rate. This agrees with the equation Q = Constan $\sqrt{P_s}$.

2) Effect of swirl chamber height:

The change of swirl chamber height has no effect on discharge.

3) Effect of diameter of spray nozzle:

An increase in diameter of spray nozzle leads to increase in flow rate. The relation between the discharge and diameter of spray nozzle is a straight line in region $10\ mm \leqslant d_n \leqslant 20\ mm$, and the relation is nonlinear in the region $d_n \leqslant 10\ mm$, due to increase in disturbance in the exit region in the case of small nozzle as shown in Fig. (7).

4) Effect of cone angle:

An incrase in cone angle has no effect on flow rate as shown in table (1). The values in the table shows that increasing the cone angle from 30^o to 60^o causes the discharge to increase only by 4.1% at $P_S = 12.97 \times 10^4 N/m^2$ and $d_n = 20\ mm$. This shows that this change can be neglected, since the change is withen the acurecy of measured flow rate.

c) Effect of different parameters on droplet size:-

To clarify the effect of working condition and nozzle geometry on the resulted droplet size, the cumulative curves which represents the relation between the droplet diameter versus the %ge cumulative number of droplets having the same and smaller diameter are drawn. To obtain the median droplet diameter from the cumulative curve a horizontal line is drawn, at a percentage cumulative number of 50% under any working parameters. To show seperately the effect of each parameter as follows:-

1) Effect of supply pressure:-

Fig. (8) show that increasing the supply pressure, causes the comulative curves to be displaced upward at different parameters. From Fig. (9) it's clear that, the mean diameter of droplet decreases by increasing the supply pressure. This can be attributed to the resulted increase in swirl strength which leads to increase in the spray angle and causes the spray to break into smaller drops, from this figure, it can be noted that, the relation between mean diameter of droplets and supply pressure is a straight line in the region $4.74 \times 10^4 \frac{N}{m^2} \geq P_s \leq 10.2 \times 10^4 \, N/m^2$ but in the region $P_s > 10.2 \times 10^4 \, N/m^2$ the relation is non-linear.

2) Effect of swirl chamber heiht:

An increase in swirl chamber height leads to increase in the droplet size because the increasing in volume of swirl chamber decreases the velocity of swirl as shown in Fig.(10). Fig. (11) show that the mean diameter of droplet increases by increasing the swirl chamber height, since the tangential velocity decreases.

3) Effect of cone angle:

Fig. (12) show that an increase in cone angle leads to a corresbonding decrease in the droplet size due to the more gradual change in crossectional area of flow when using large cone angles. This gradual change means less hydraulic losses and stronger swirl. Fig. (13) show that the mean diameter of droplet increase by decreasing the cone angle.

4) Effect of spray nozzle diameter:

From Fig. (14) notice that the increasing of spray nozzle diameter, leads to decrease in diameter of droplet. Fig.(9) show that the mean diameter of droplet increases with decrasing the diameter of spray nozzle because of the resulted reduction in tangential velocity at exit. The relation between mean diameter of droplet and spray nozzle diameter is a straight line in the region 10 mm $\leqslant d_n \leqslant$ 20 mm but in the region $d_n <$ 10 mm the relation is nonlinear.

d) Pressure profile in the swirl chamber:

The experimental results concerning the relation between the pressure in swirl chamber P_r and radius "r" are given in table (2). From this table and Fig. (15) it can be seen that, the pressure inside the swirl chamber is nearly constant at the different values of "r". The maximum change in pressure occurs at maximum spray nozzle diameter and maximum supply pressure.

From the table, at constant radius, it can be seen that:-

1) The pressure at each radius in the swirl chamber is nearly constant for the different values of cone angle and swirl chamber height.
2) Increasing the diameter of spray nozzle leads to decrease in the pressure in the swirl chamber because the flow rate will increase and hence the hydraulic losse will be also increased as shown in Fig. (17).
3) Fig. (16) show that decreasing of supply pressure leads to a corresponding decrease in pressure inside the swirl chamber.

CONCLUSIONS:

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

1) The spray angle was found to increase with the increase of spray nozzle diameter, and cone angle. The increase in supply pressure leads to a corresponding increase in the spray angle up to a certain pressure of 13 X 10^4 N/m^2 beyond which any increase in the pressure value does not greatly affect the

spray angle. Increase of swirl chamber hight, leads to small decrease in spray angle.

2) The flow rate was found to increase with the increase of spray nozzel diameter and supply pressure. The change of swirl chamber height and cone angle have no effect on the flow rate.

3) The mean diameter of droplets decreases by increasing supply pressure, cone angle, and diameter of spray nozzle. The diameter of droplets increases by increasing swirl chamber height.

4) The pressure inside the swirl chamber is nearly constant in the radial direction. The pressure at each raduis inside the swirl chamber is nearly constant for the different values of cone angle and swirl chamber height. Increasing diameter of spray nozzle and decreasing supply pressure leads to a corresponding decreases in pressure inside the swirl chamber.

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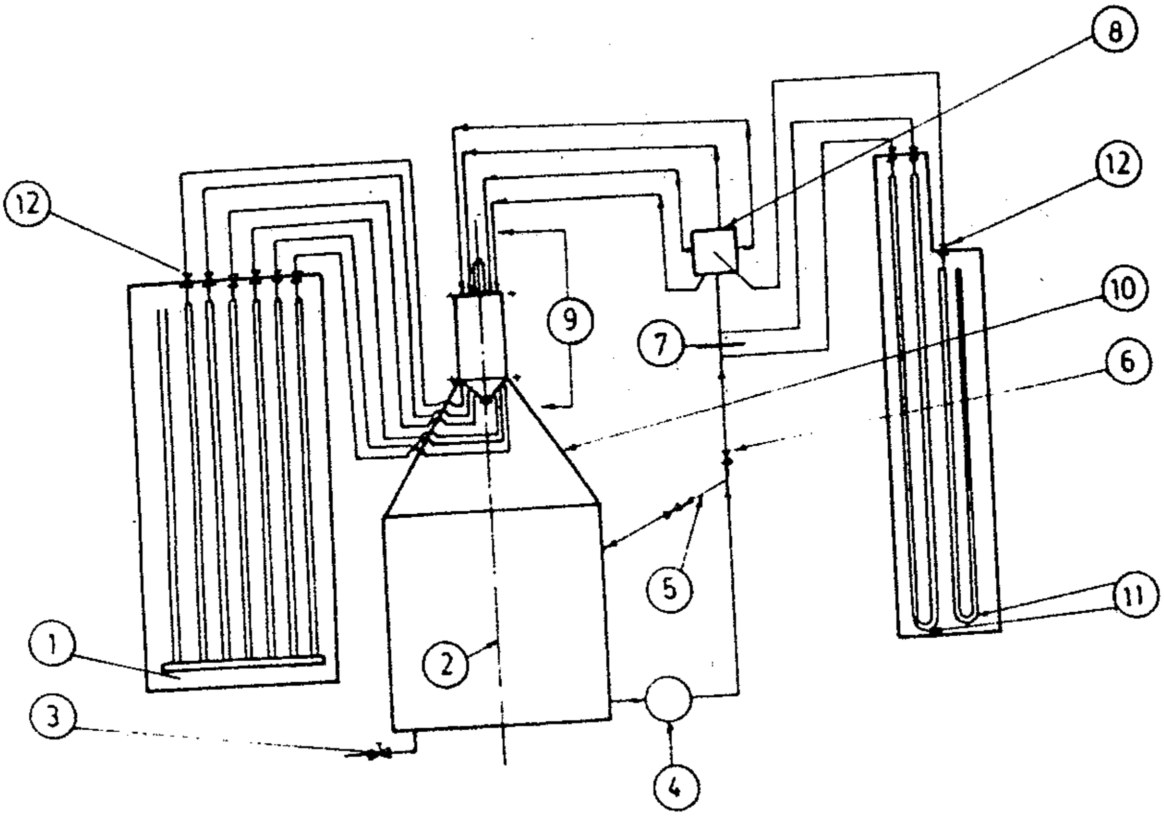
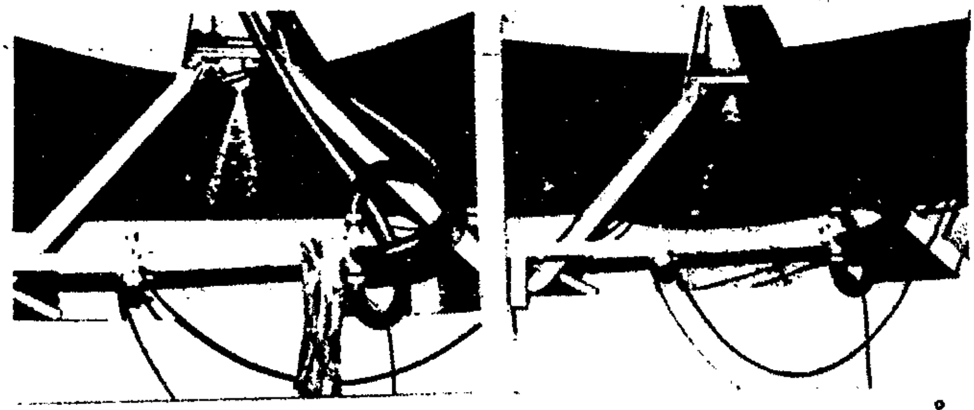


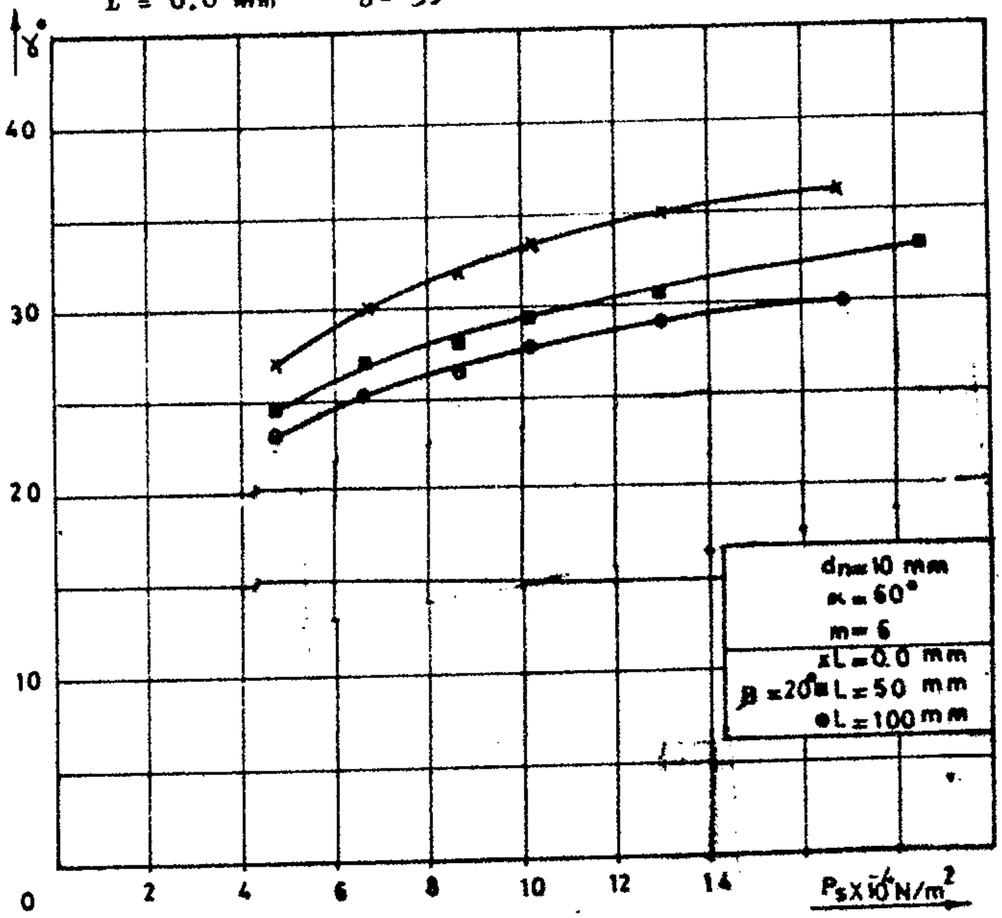
1 - Monometer Common Manifold
2 - Supply Tank
3 - Drain Line
4 - Pump
5 - By Pass Line.
6 - Supply Valve
7 - Orifice Meter.
8 - Common Supply Manifold
9 - Apparatus.
10 - Apparatus Carrier
11 - U - Tubes.
12 - Air Vents

Fig. (1) General Lay Out For Experimental Set

P_S=12.97N/m²

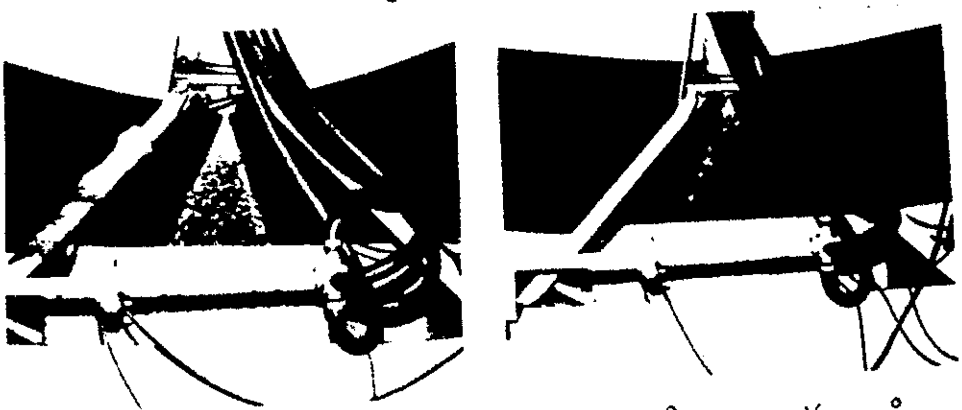


L = 0.0 mm   γ= 35°   L = 100   γ= 29°



FIG(2)

$P_s = 10.2 \times 10^4\ N/m^2$



$\alpha = 60°$ $\gamma = 48.5°$ $\alpha = 30°$ $\gamma = 45°$

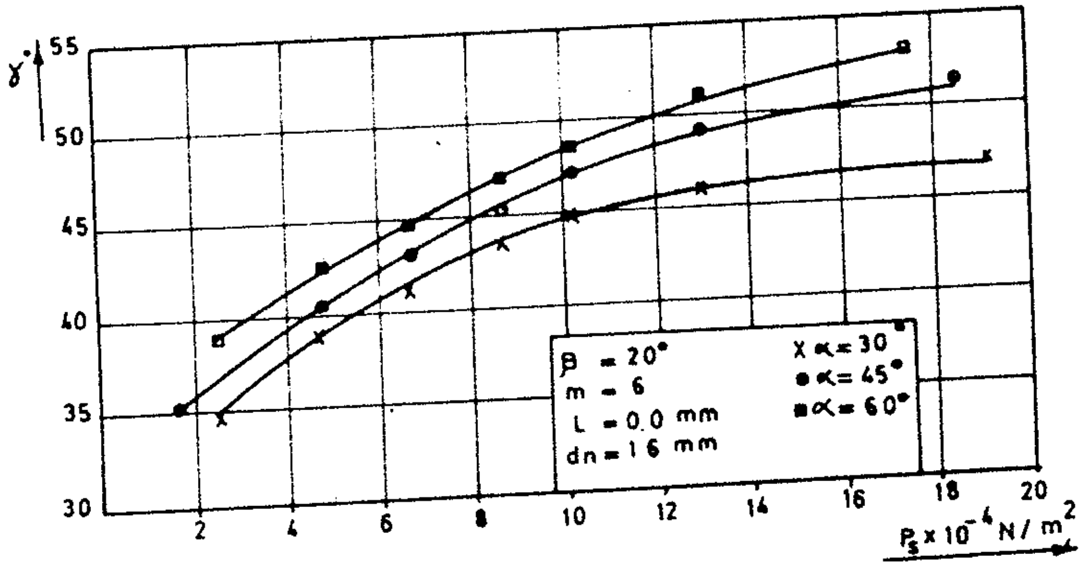
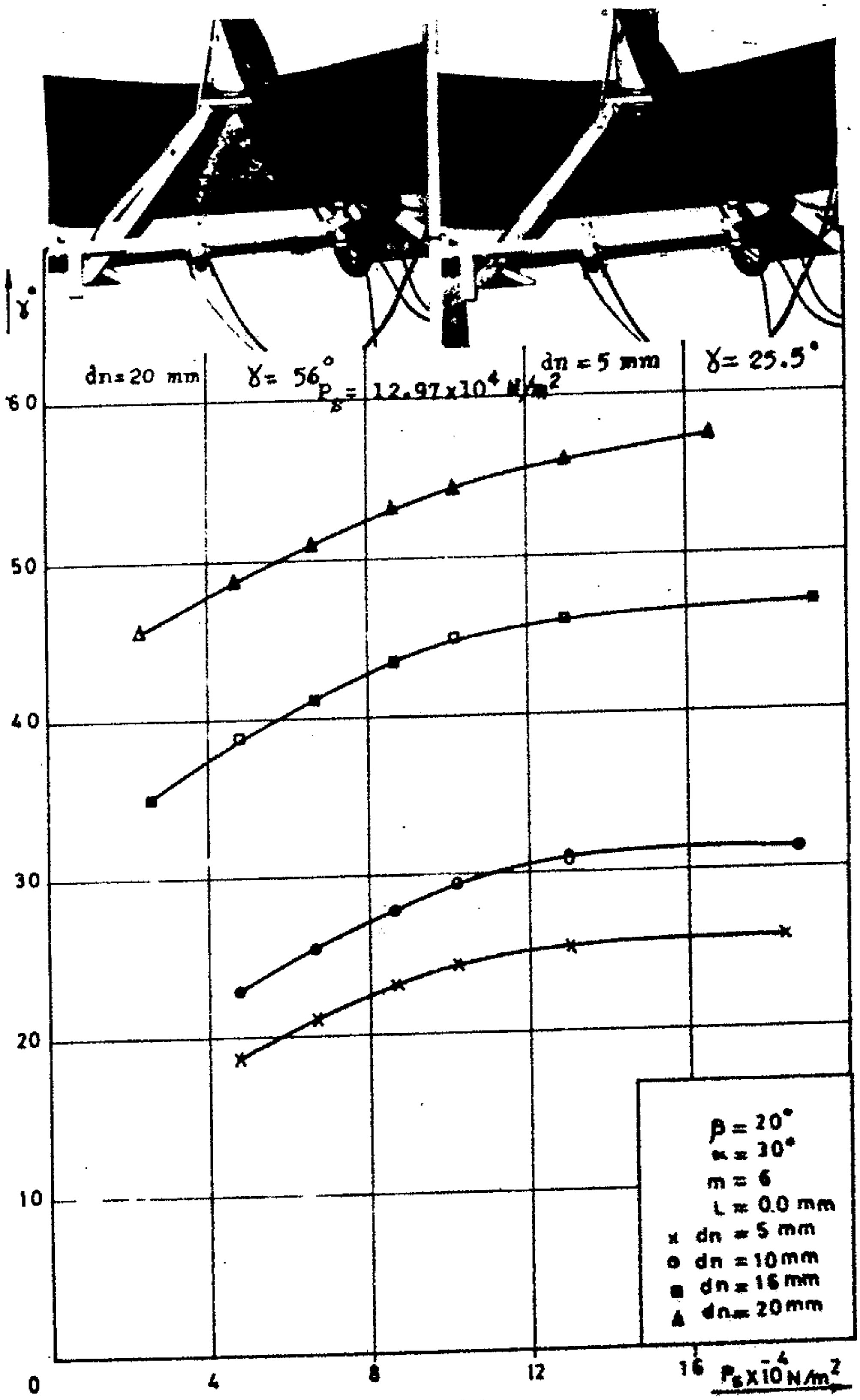
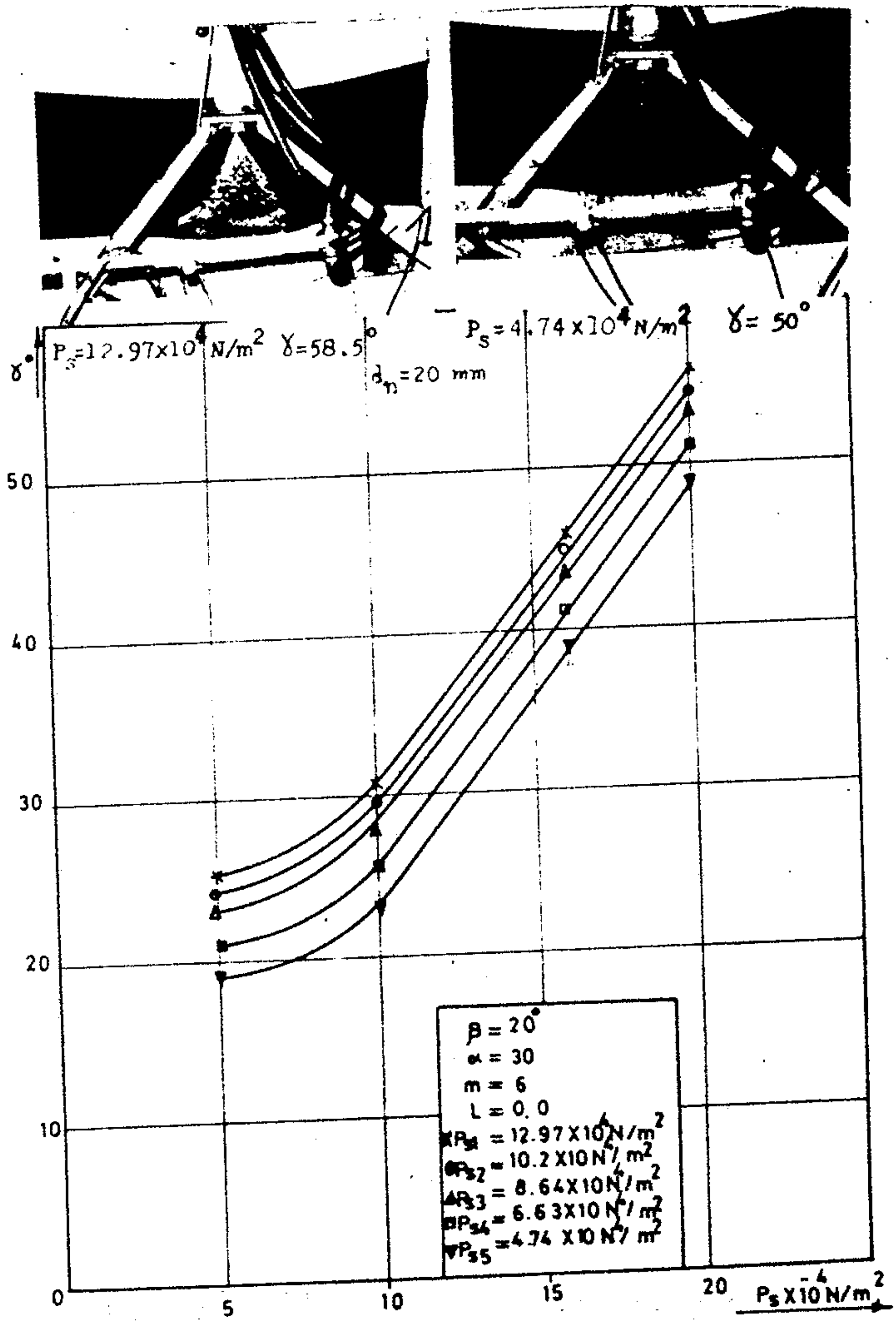


FIG (3)



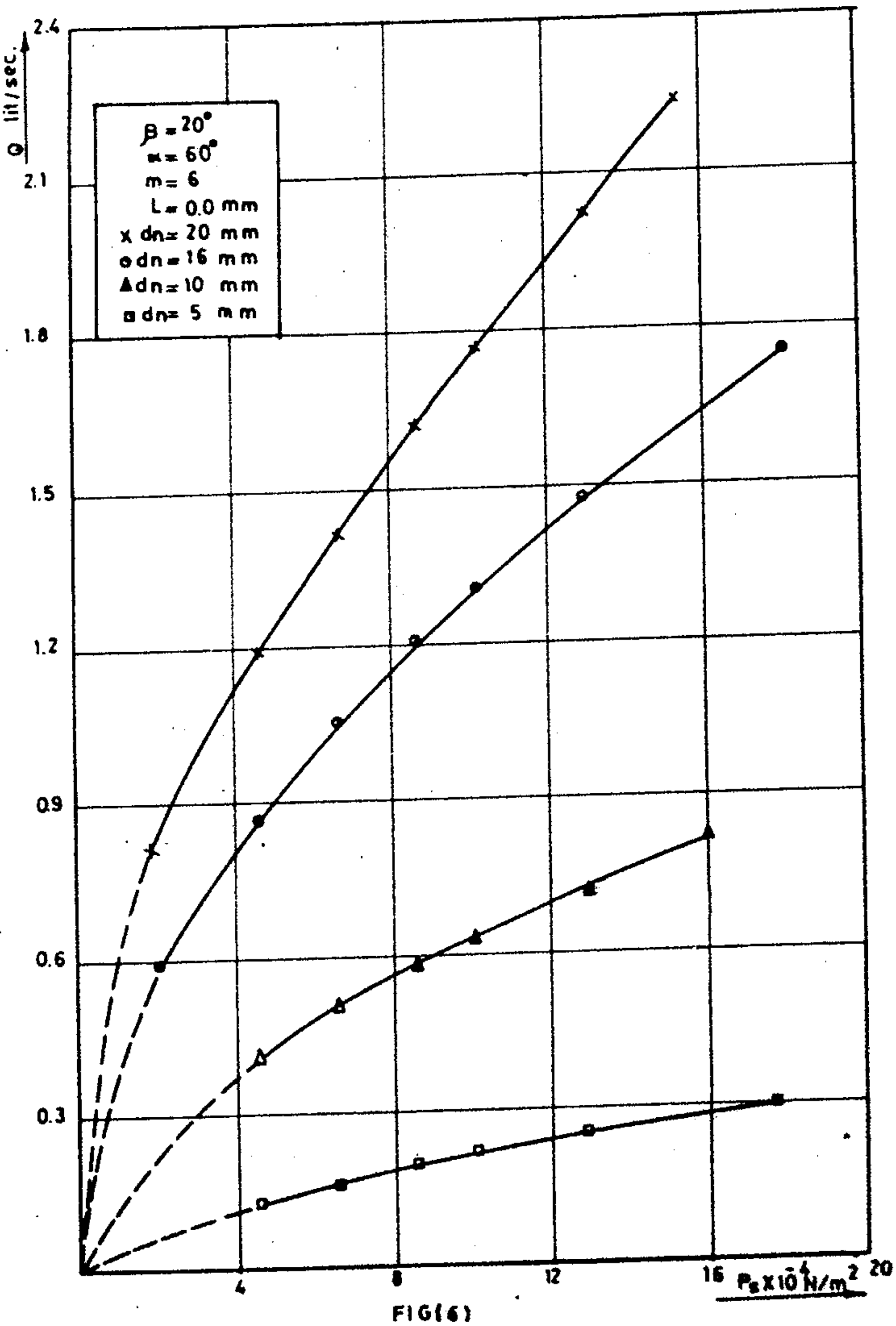
γ°
dn=20 mm
γ= 56°
P_s= 12.97x10⁴ N/m²
dn = 5 mm
γ= 25.5°
60
50
40
30
20
10
0
4
8
12
16
P_s x 10⁻⁴ N/m²
β = 20°
∝ = 30°
m = 6
L = 0.0 mm
x dn = 5 mm
o dn = 10 mm
■ dn = 16 mm
▲ dn = 20 mm

FIG(4)

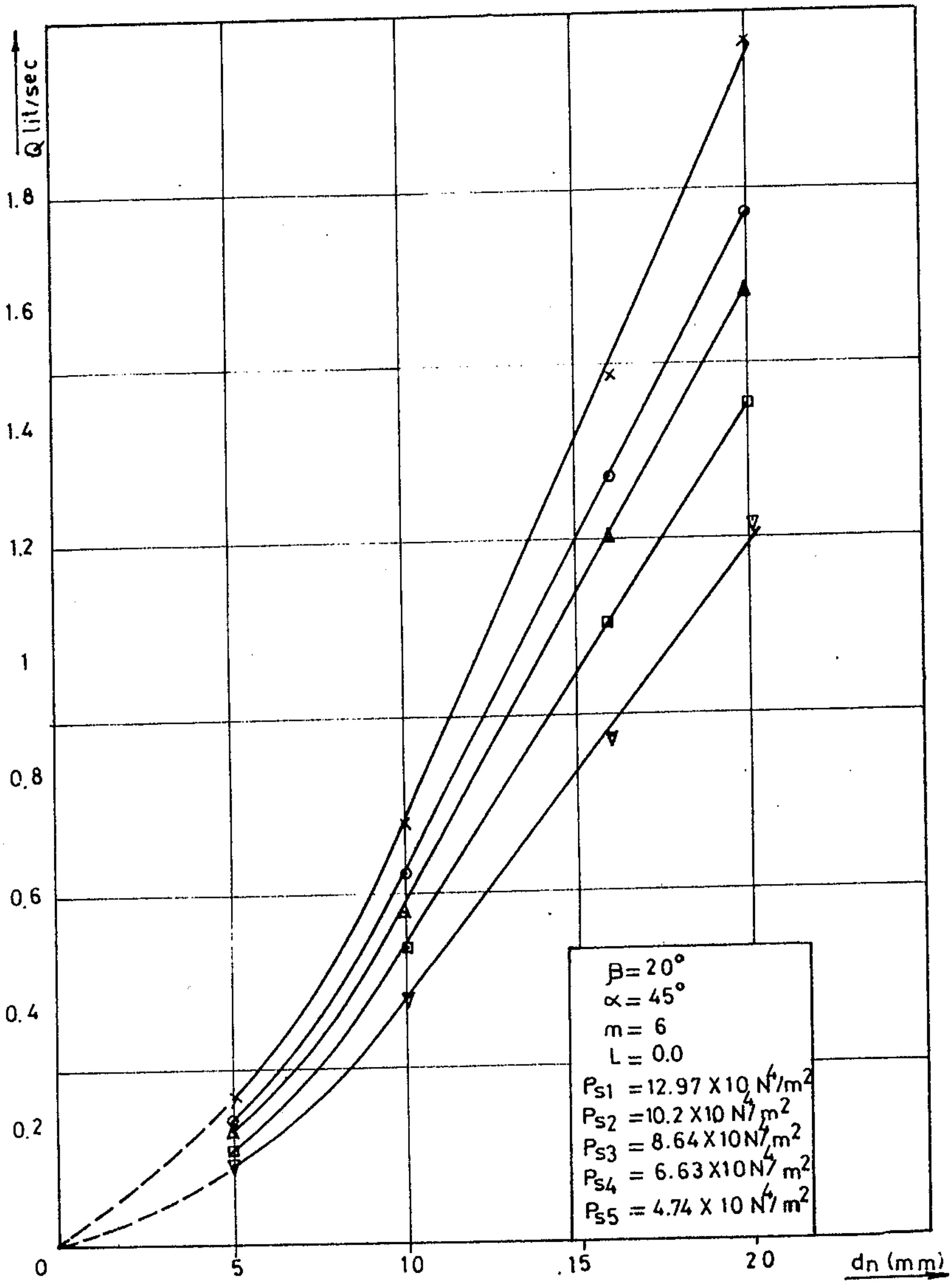


Ps=12.97x10^4 N/m^2 γ=58.5°
Ps=4.74x10^4 N/m^2 γ=50°
dn=20 mm
γ°
50
40
30
20
10
0
5
10
15
20
Ps X 10^-4 N/m^2
β = 20°
α = 30
m = 6
L = 0.0
Ps1 = 12.97 X 10^4 N/m^2
Ps2 = 10.2 X 10^4 N/m^2
Ps3 = 8.64 X 10^4 N/m^2
Ps4 = 6.63 X 10^4 N/m^2
Ps5 = 4.74 X 10^4 N/m^2

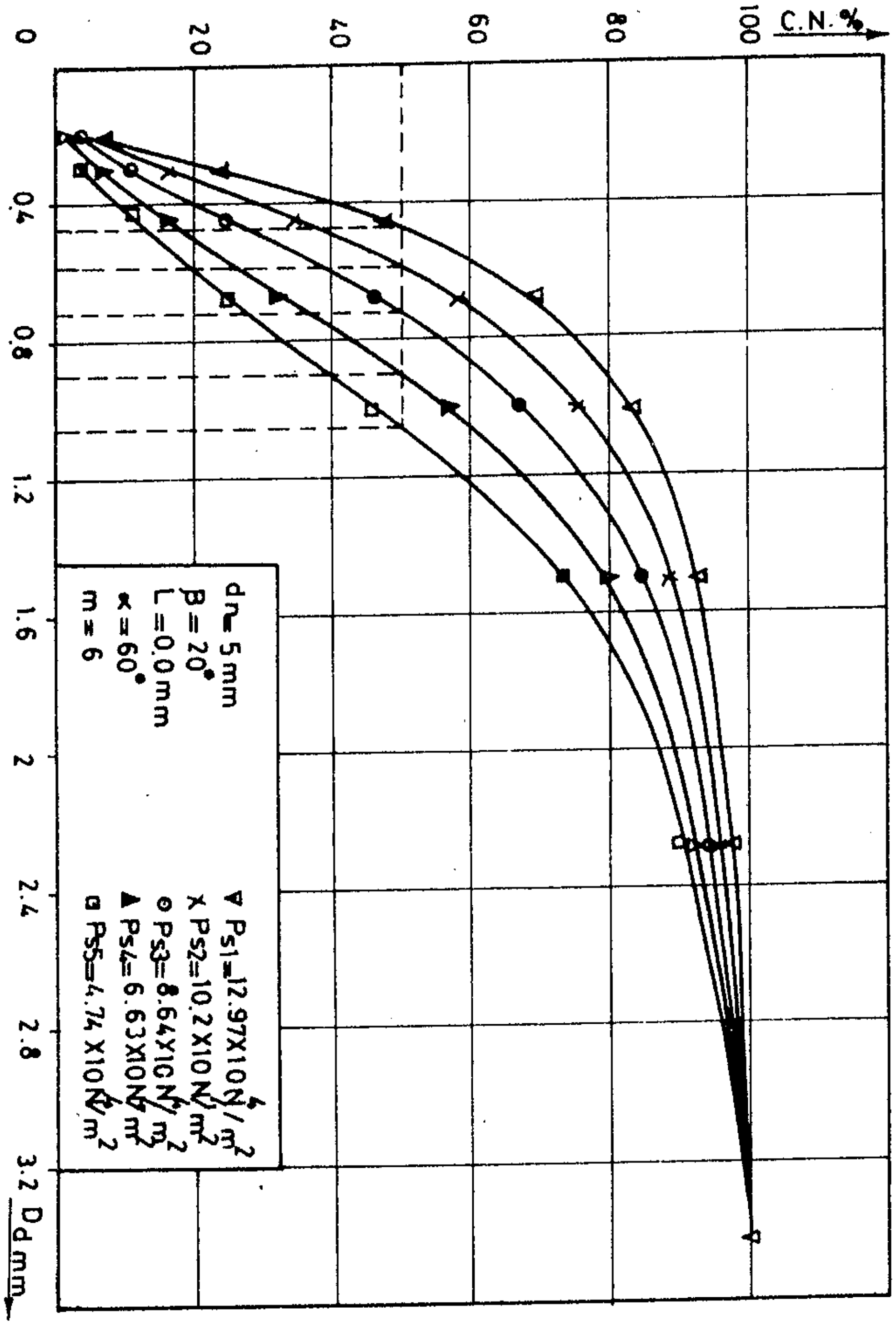
FIG (5)


Q lit/sec.
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
β = 20°
α = 60°
m = 6
L = 0.0 mm
x dn = 20 mm
o dn = 16 mm
Δ dn = 10 mm
□ dn = 5 mm
4
8
12
16
20
Ps x 10^-4 N/m^2

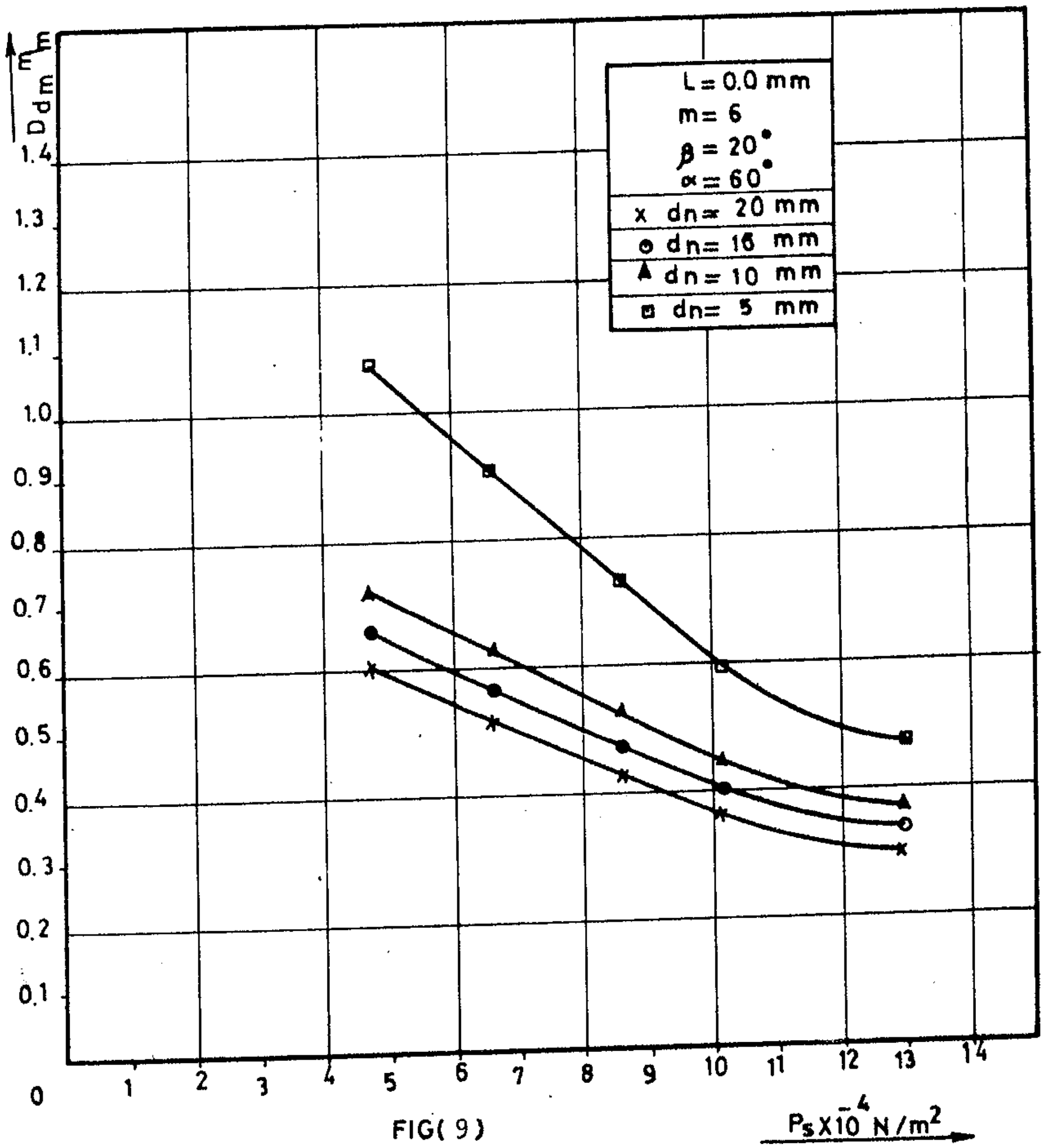
FIG(6)


Q lit/sec
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5
10
15
20
dn (mm)
β= 20°
α = 45°
m = 6
L = 0.0
Ps1 = 12.97 X 10^4 N/m^2
Ps2 = 10.2 X 10^4 N/m^2
Ps3 = 8.64 X 10^4 N/m^2
Ps4 = 6.63 X 10^4 N/m^2
Ps5 = 4.74 X 10^4 N/m^2

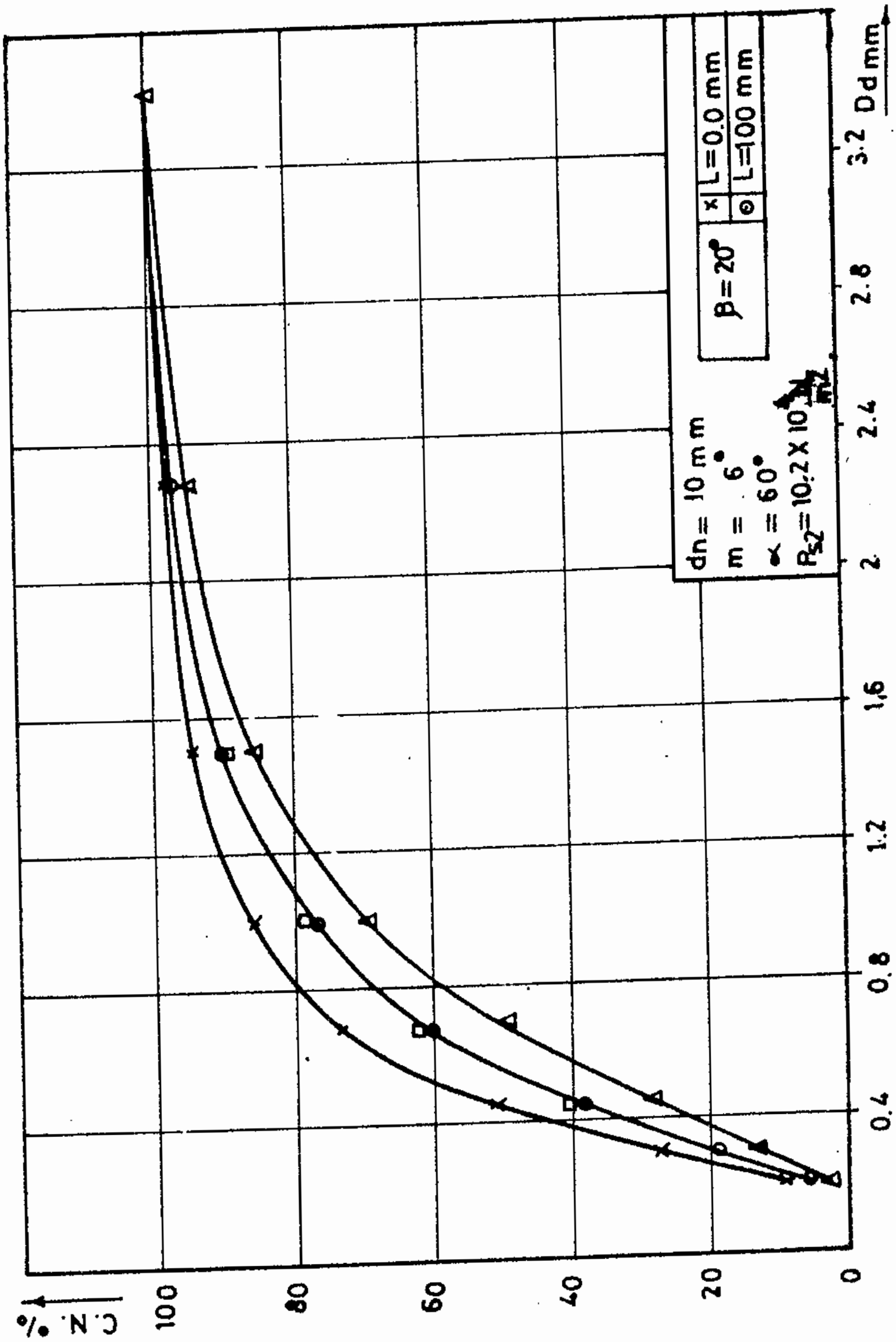
FIG(7)


C.N.%
0
20
40
60
80
100
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
Dd mm
dn= 5mm
β = 20°
L=0.0mm
α = 60°
m = 6
Ps1=12.97X10 N/m2
Ps2=10.2X10 N/m2
Ps3=8.64X10 N/m2
Ps4=6.63X10 N/m2
Ps5=4.74 X10 N/m2

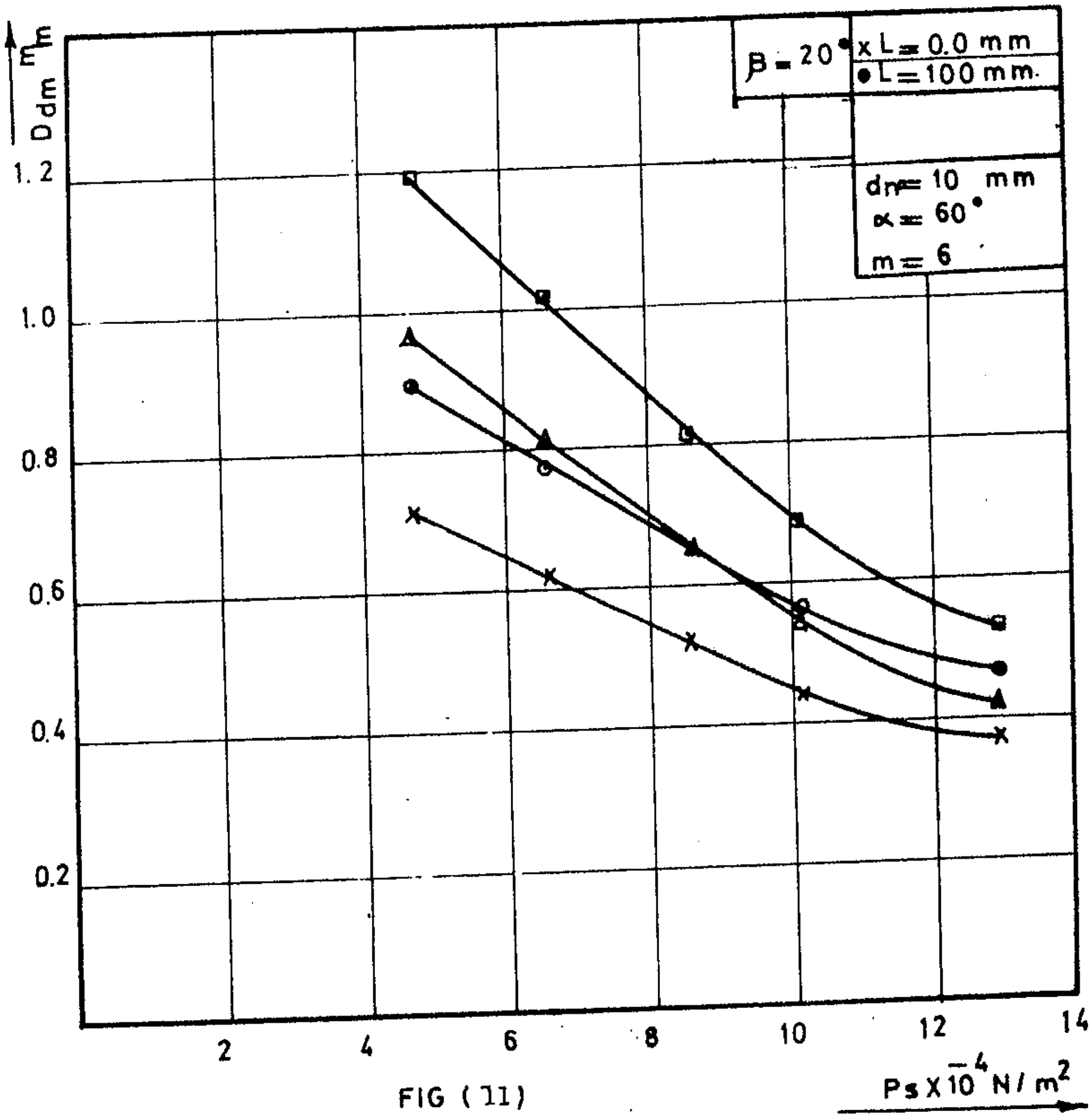
FIG(8)


Ddm mm
L = 0.0 mm
m = 6
β = 20°
α = 60°
x dn = 20 mm
o dn = 16 mm
▲ dn = 10 mm
□ dn = 5 mm
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Ps X 10^-4 N/m²

FIG(9)

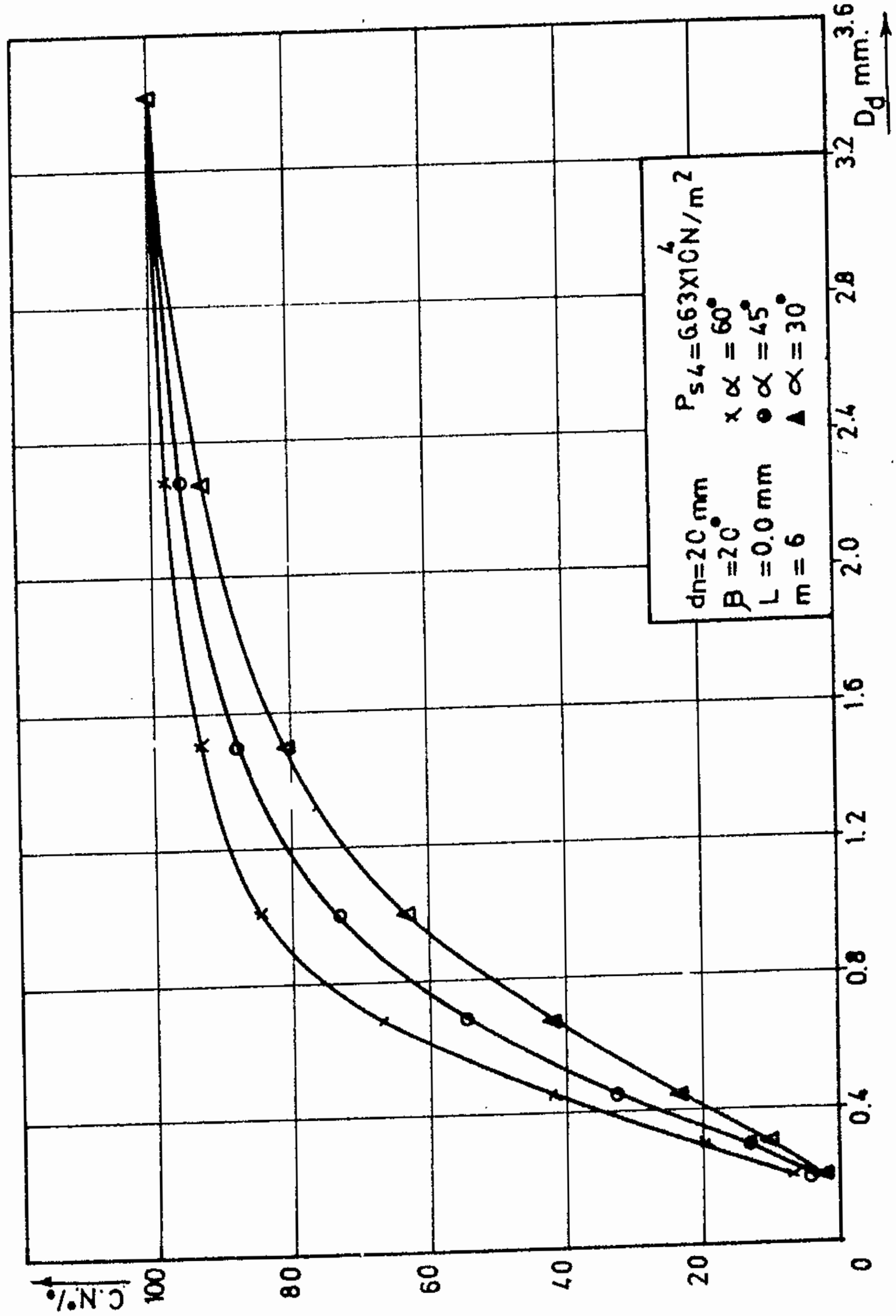

C.N. %
100
80
60
40
20
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
Dd mm
dn = 10 mm
m = 6°
α = 60°
β = 20°
× L = 0.0 mm
⊙ L = 100 mm

FIG(10)



Ddm mm
β = 20°
x L = 0.0 mm
• L = 100 mm.
dn = 10 mm
α = 60°
m = 6
1.2
1.0
0.8
0.6
0.4
0.2
2
4
6
8
10
12
14
Ps x 10^-4 N/m²

FIG (11)



dn=20 mm
B =20°
L =0.0 mm
m = 6
P_{s4} = 6.63X10^4 N/m^2
x α = 60°
● α = 45°
▲ α = 30°
D_d mm.
C.N%
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
3.2
3.6
20
40
60
80
100

FIG. (12)

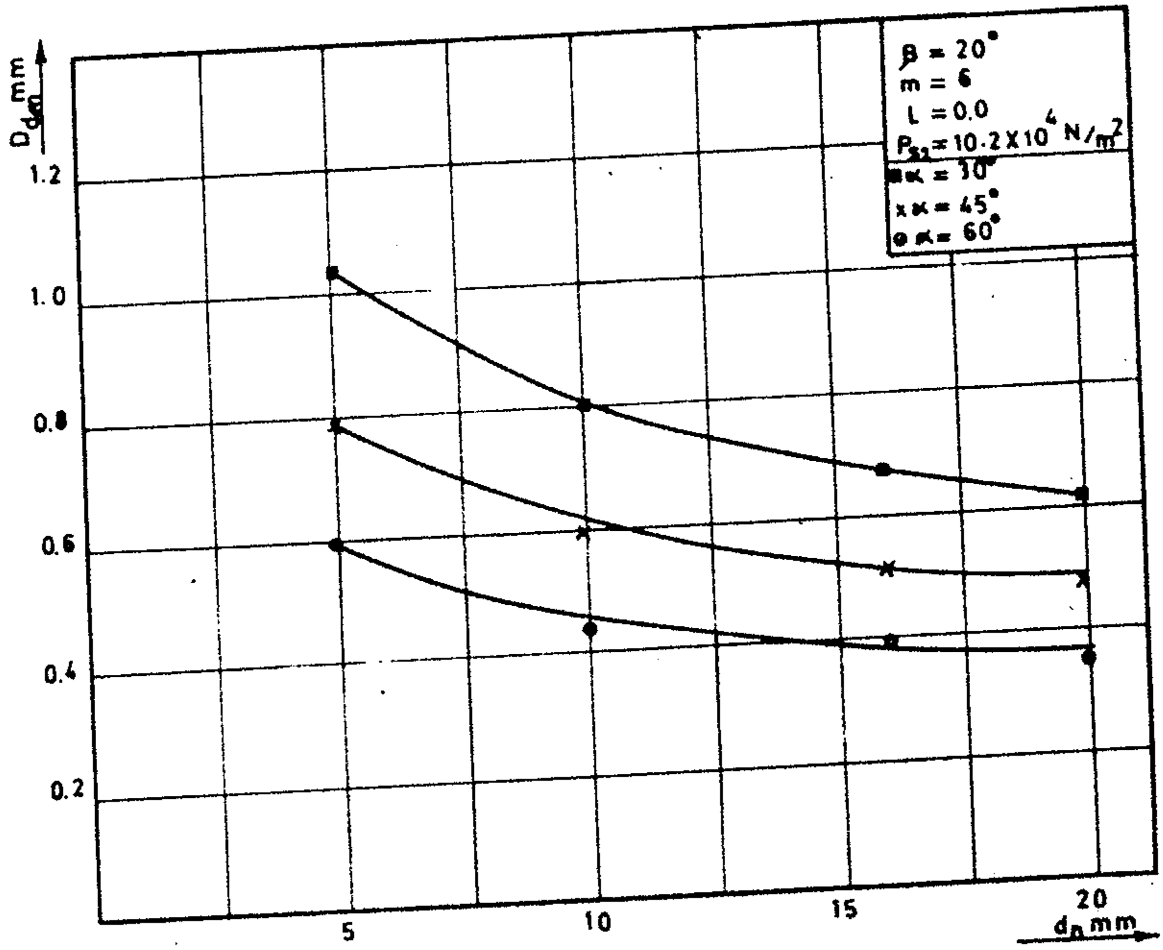
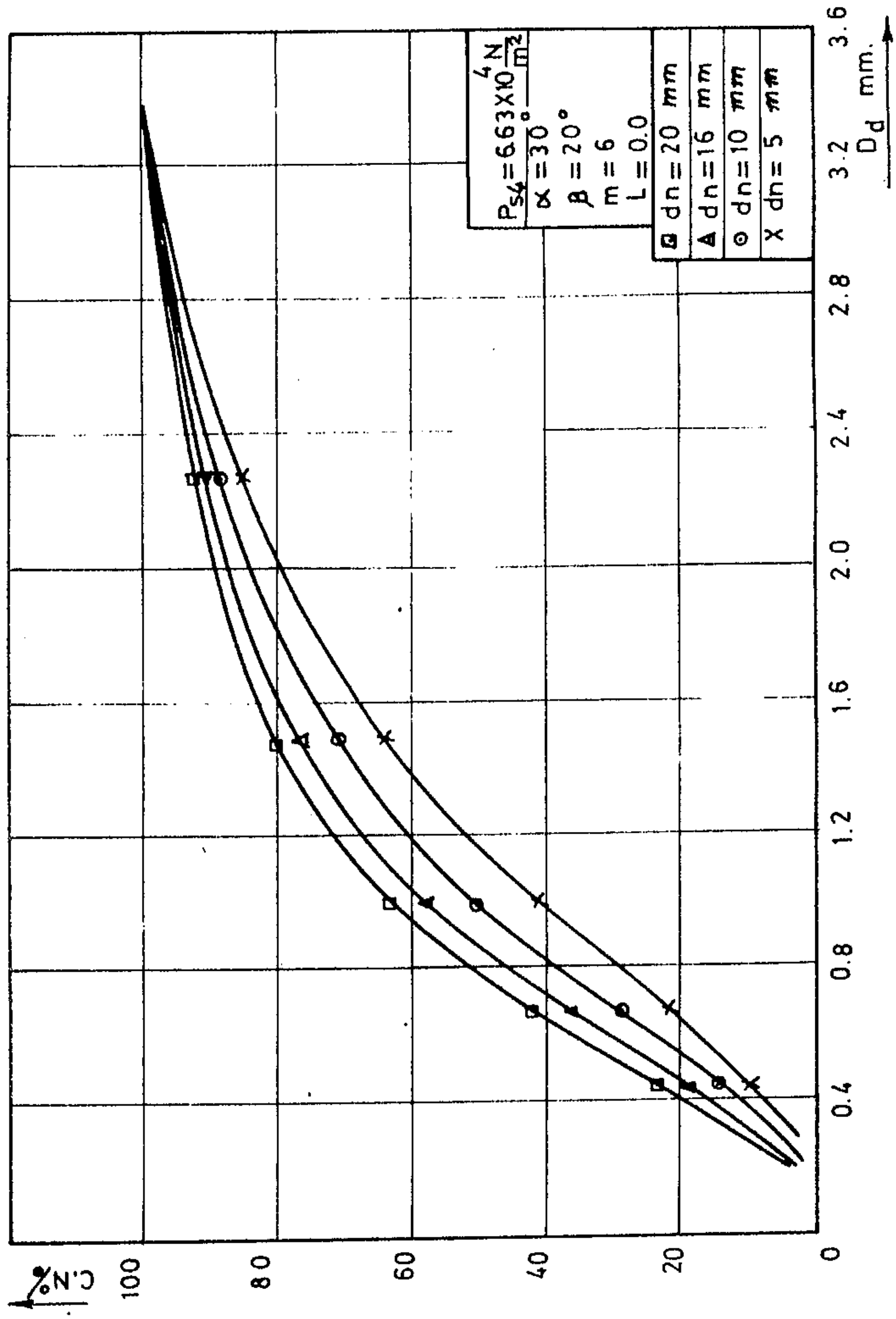

β = 20°
m = 6
L = 0.0
P_{s2} = 10.2 X 10⁴ N/m²
■ α = 30°
x α = 45°
● α = 60°
D_{dm} mm
1.2
1.0
0.8
0.6
0.4
0.2
5
10
15
20
d_n mm

Fig.(13)



$P_{s4} = 6.63 \times 10^{4} \frac{N}{m^2}$
$\alpha = 30°$
$\beta = 20°$
m = 6
L = 0.0
□ dn = 20 mm
▲ dn = 16 mm
⊙ dn = 10 mm
X dn = 5 mm
C.N%
D_d mm.

Fig.(14)

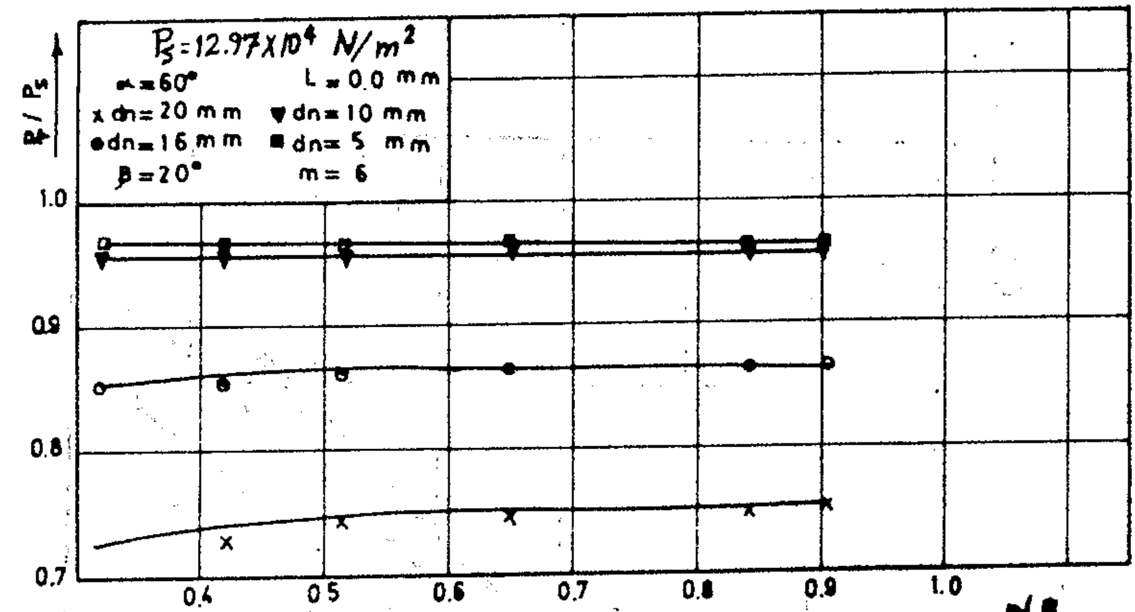

$P_s = 12.97 \times 10^4\ N/m^2$
α = 60°
L = 0.0 mm
x dn = 20 mm
▼ dn = 10 mm
● dn = 16 mm
■ dn = 5 mm
β = 20°
m = 6
P / Ps
1.0
0.9
0.8
0.7
0.4
0.5
0.6
0.7
0.8
0.9
1.0

FIG (15)

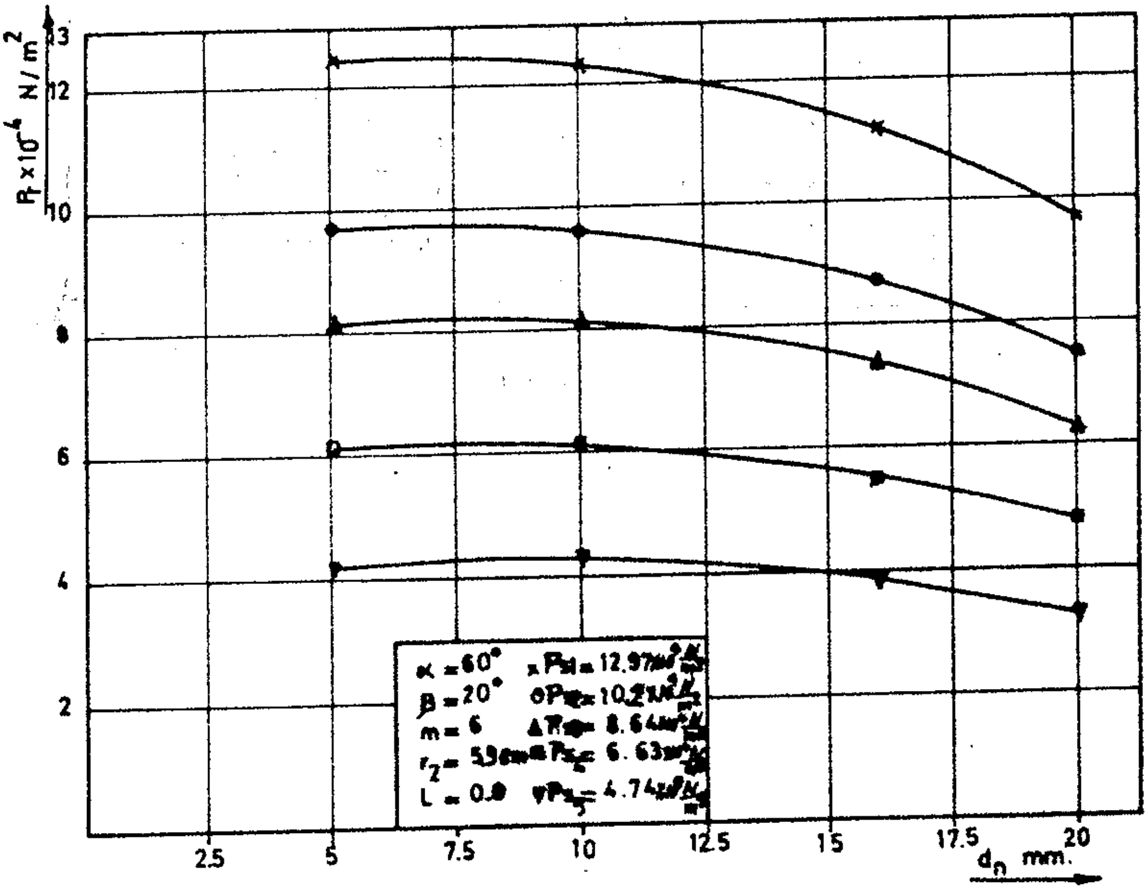
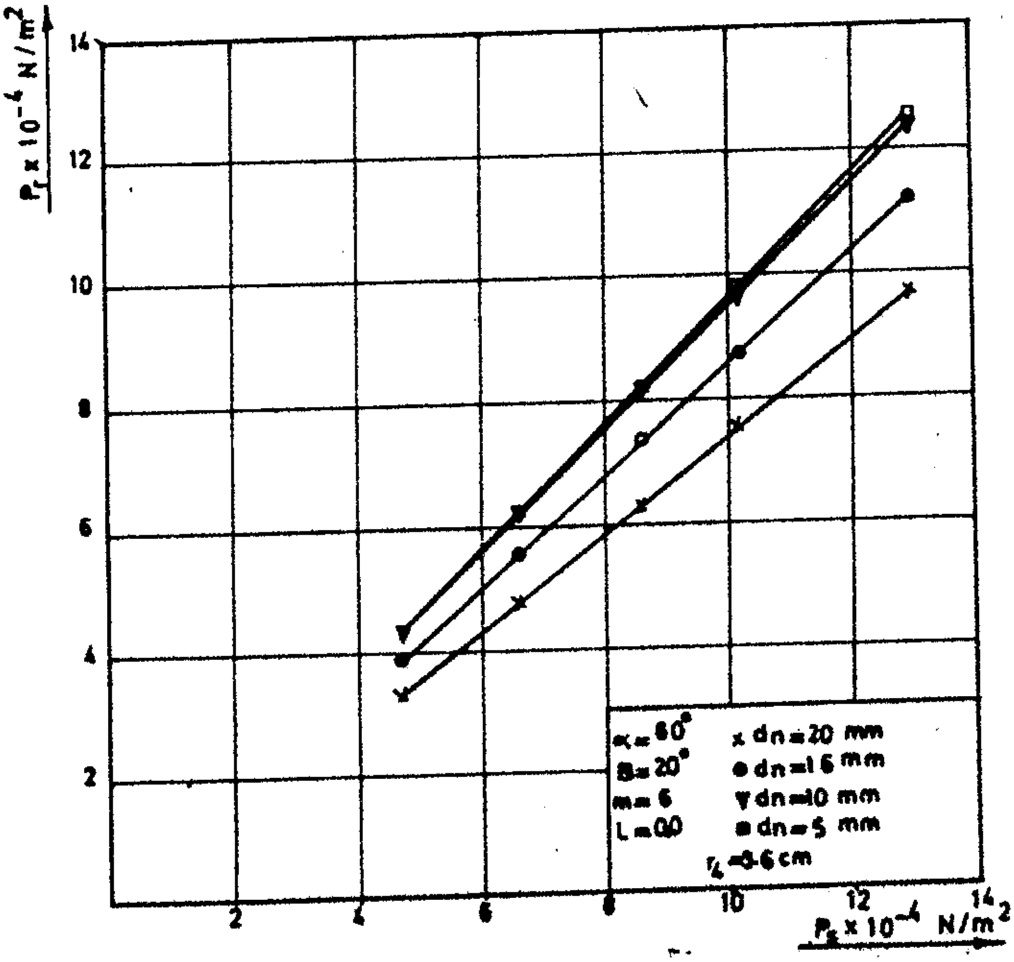

$P_i \times 10^{-4}\ N/m^2$
13
12
10
8
6
4
2
α = 60°
β = 20°
m = 6
L = 0.0
2.5
5
7.5
10
12.5
15
17.5
20
d_n mm.

FIG (15)



14
12
10
8
6
4
2
2
4
6
8
10
12
14
α = 60°
B = 20°
m = 6
L = 0.0
x dn = 20 mm
● dn = 16 mm
▼ dn = 10 mm
■ dn = 5 mm
r_4 = 6.6 cm
$P_s \times 10^{-4}$ N/m²
$P_r \times 10^{-4}$ N/m²

FIG. (17)

Table (1)

$\beta = 20$ $m = 6$ $L = 0.0$ mm

diameter of spray nozzles 20 mm			
Supply pressure x 10^{-4} N/m^2	flow rate (lit/sec)		
	$\alpha = 30^\circ$	$\alpha = 45^\circ$	$\alpha = 60^\circ$
12.97	1.95	2.01	2.03
10.2	1.72	1.75	1.77
8.64	1.59	1.62	1.63
6.63	1.37	1.4	1.42
4.74	1.155	1.175	1.19

diameter of spray nozzle = 16 mm			
Supply pressure x 10^{-4} N/m^2	flow rate (lit/sec)		
	$\alpha = 30^\circ$	$\alpha = 45^\circ$	$\alpha = 60^\circ$
12.97	1.432	1.465	1.48
10.2	1.273	1.3	1.31
8.64	1.17	1.2	1.21
6.63	1.02	1.04	1.055
4.74	0.84	0.86	0.87

diameter of spray nozzle = 10 mm			
Supply pressure x 10^{-4} N/m^2	flow rate (lit/sec)		
	$\alpha = 30^\circ$	$\alpha = 45^\circ$	$\alpha = 60^\circ$
12.97	0.7	0.72	0.72
10.2	0.61	0.635	0.635
8.64	0.565	0.58	0.585
6.63	0.49	0.506	0.508
4.74	0.405	0.412	0.42

diameter of spray nozzle = 5 mm			
Supply pressure x10^{-4} N/m^2	flow rate (lit/sec)		
	$\alpha = 30^\circ$	$\alpha = 45^\circ$	$\alpha = 60^\circ$
12.97	0.25	0.25	0.255
10.2	0.22	0.22	0.22
8.64	0.2	0.2	0.2
6.63	0.15	0.16	0.16
4.74	0.12	0.13	0.13

Table (2)

α°	$P_S x10^{-4}$ N/m^2	L_{mm}	dn mm	P_r x 10^{-4} N/m^2					
				r_1	r_2	r_3	r_4	r_5	r_6
60°	12.97	0.0	20	9.77	9.74	9.72	9.67	9.45	9.4
			16	11.24	11.23	11.23	11.21	11.08	11.06
			10	12.4	12.39	12.41	12.41	12.4	12.4
		50	10	12.3	12.29	12.3	12.31	12.3	12.3
		100	10	12.4	12.4	12.42	12.43	12.43	1243
	10.2	0.0	20	7.58	7.56	7.56	7.53	7.35	7.32
			16	8.76	8.76	8.76	8.74	8.65	8.62
			10	9.63	9.63	9.65	9.66	9.65	9.65
	6.63	0.0	20	4.83	4.83	4.83	4.81	4.70	4.68
			16	5.56	5.56	5.57	5.57	5.52	5.52
			10	6.2	6.2	6.22	6.23	6.23	6.24
45°	10.2	0.0	10	9.84	9.85	9.85	9.85	9.84	9.83
30°	12.97	0.0	20	10.03	9.98	9.93	9.83	9.7	9.51
	10.2	0.0	10	9.51	9.55	9.54	9.53	9.51	9.49

m = 6 , B = 20°

At α = 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

At α = 45°

r_1 = 6.6 cm , r_2 = 5.92 cm , r_3 = 5.125 cm

r_4 = 4.43 cm , r_6 = 3.5 cm , r_6 = 2.9 cm

At α = 30°

r_1 = 6.625 cm , r_2 = 5.31 cm , r_3 = 4.18 cm

r_4 = 3.2 cm , r_5 = 2.4 cm , r_6 = 1.9 cm

"أثر زاوية المخروط وارتفاع الغرفة الحلزونية وقطر البوق على أداء الرشاشات"

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ملخص البحث

لما كان من الاهمية بمكان دراسة خصائص رشاشات المياه وتأثير المتغيرات الهندسية المختلفة عليها لما لهذا الموضوع من اهمية كبيرة في تصميم الرشاشات فقد تعرض هذا البحث لدراسة هذا الموضوع الهام.

ومن ناحية استعراض الابحاث السابقة وجد انها لم تتناول الا تأثير متغير واحد أو اثنين على الاكثر من المتغيرات الهندسية على خصائص السريان.

وعلى هذا الاساس عني البحث بدراسة تأثير المتغيرات الهندسية التالية على خصائص السريان في الرشاشات:

١ - زاوية غرفة الدوران المخروطية.
٢ - قطر بوق الرش.
٣ - ارتفاع غرفة الدوران الاسطوانية.
٤ - ضغط المنبع.

وخصائص السريان التي تم دراسة تأثير المتغيرات الهندسية السابقة عليها هي :-

١ - زاوية الرش
٢ - معدل التصرف
٣ - حجم القطيرات
٤ - توزيع الضغط داخل غرفة الدوران المخروطية.

وقد وضحت النتائج أن :

١ - زاوية الرش ومعدل التصرف يزدادان بينما يقل حجم القطيرات بزيادة قطر بوق الرش وضغط المنبع.
٢ - زيادة زاوية غرفة الدوران المخروطية تؤدي الى زيادة زاوية الرش ونقص حجم القطرات ولا تؤثر على معدل التصرف.
٣ - زيادة ارتفاع غرفة الدوران الاسطوانية تؤدي الى نقص صغير في زاوية الرش وزيادة في حجم القطرات ولا تؤثر على معدل التصرف.
٤ - زيادة قطر بوق الرش ونقص ضغط المنبع يؤدي الى نقص في الضغط عند أي قطر داخل غرفة الدوران المخروطية.