Orifice Plates
Model NOP

Introduction

Orifice plates are widely used for flow measurement as they provide the simplest and the most economical means of flow detection. Orifice plates are available in the concentric type that the round opening (bore) of the orifice plate is positioned concentrically with the center of the pipe; and the opening edge (bore edge) is available either in the regular edge type (sharp, square edge type) or in the quardrant edge type (round edge type). Orifice plates are available also in the eccentric type that the opening of the orifice is shifted from the center of the pipe. They also are available in the segmental type that the opening is a circular segment and the orifice is comparable to a partically opened gate valve.

Standard Specification

Types of orifice bores:

Regular-edge concentric type, quardrant-edge concentric type, eccentric type, and segmental type

Flow calculation standards:

Regular-edge concentric orifies; JIS Z 8762-1988(*8) (ISO 5167-1980)

(Contraction (vena) tap and 2.5D-8D (pipe) tap are as per "ASME Fluid Meters, Their Theory and Application, 5th Edition, 1959.")

Quardrant-edge orifices; Shell Flow Meter Engineering Handbook 1968

Eccentric orifices; } ASME Fluid Meters, Their Theory and
Segmental orifices; } Application, 5th Edition, 1959

Flange ratings:

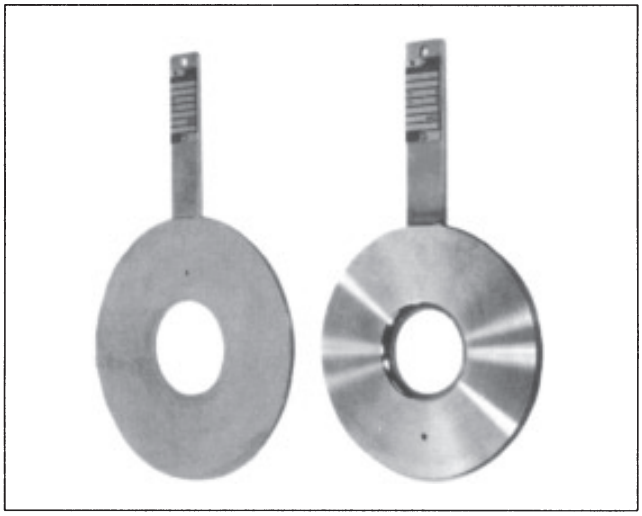
JIS 2, 5, 10, 16, 20, 30, 40, 63 kgf/cm^2 RF
ANSI (or JPI) 150, 300, 600, 900 lb RF (*1)
(Note: Flange dimensions are identical between ANSI and JPI)

Plate material: SUS304, SUS316 (*2)

Plate thickness: 2, 3, 5, 8, 10 mm

(Select an appropriate thickness for the size and temperature range, referring to the table of dimensoins.)

Surface finish processing: As per JIS Z 8762 (1988)



Notes:

(*1) Orifices plates for RTJ flanges are available. Refer to the Specification Sheet (No. SS2-5680-0500) for Holder Ring Assembly (Model: NOH).

(*2) Even when the plate is made of SUS316, the handle (the orifice identification tab) is made of SUS304.

(*3) Orifice plates for pipes of 40 mm (1 1/2") diameter and of 760 mm and over of radius taps are available although they are not covered in the standard specification range.

(*4) In the case of Vena-Contracta taps or 1D-1/2D (radius) taps,it is possible that the downstream-side pressure tap is positioned just on the flange location or on the welding position of the pipes. In such a case, the type of tapping method must be changed.

(*5) For the orifice plates for 25 mm (1") diameter pipes, refer to Specification Sheet (No. SS2-5680-0600) for Smaller-bore Orifice Assembly (Model: NOS).

(*6) The limit of radius ratio (β) is checked using a nomograph. Please request it if such is required. In any case the ratio should be within a range of β = 0.3 to 0.7.

(*7) The drain hole or vent hole is provided when the orifice bore is 25.4 mm or over. If no such hole is required, please specify so when ordering.

(*8) Flow calculation standards are as per JIS Z 8762-1988. However, post standard JIS Z 8762-1969 can also be used. In this case, specify the post standard.

Types and ranges of orifice plates

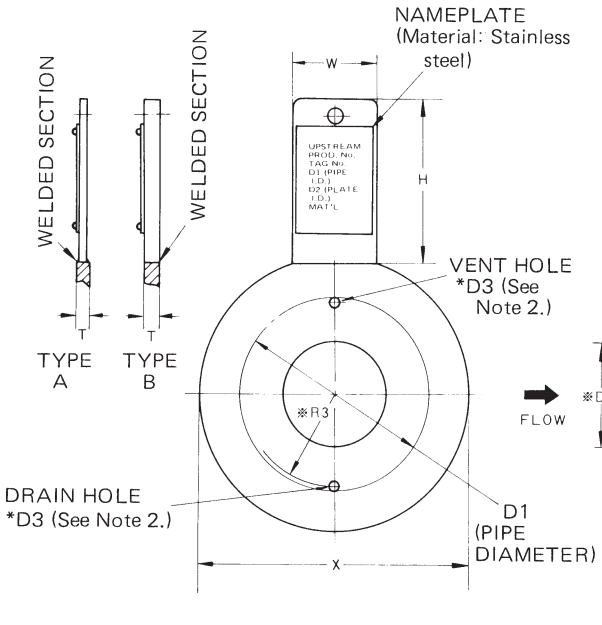
Type of orifice	Tapping system	Nominal pipe diameter	β: Limit of diameter ratio (D2/D1) (*6)	Remarks
Regular-edge concentric type	Flange taps	40mm (1 1/2") (*3) to 350mm (14")	β = 0.20 to 0.75	• High accuracy in high range of Reynods numbers.
	Corner taps	40mm (1 1/2") (*3) to 400mm (16")	β = 0.20 to 0.80	• Suitable for flow measurement of large pipes.
	1D-1/2D (radium) taps	150mm (6") to 1500mm (60") (*4)	β = 0.20 to 0.75	• Economical than other types as compared for the same nominal diameter.
	Vena-Contracta taps	150mm (6") to 1500mm (60") (*3, *4)	β = 0.10 to 0.80	
	2.5D-8D (pipe) taps	50mm (2") to 400mm (16")	D1 ≦ 80mm (3") β = 0.10 to 0.70 D1 ≧ 100mm (4") β = 0.10 to 0.75	
Quadrant-edge concentric type	Flange taps Corner taps	40mm (1 1/2") (*5) to 250mm (10")	β = 0.25 to 0.60	• High accuracy in low range of Reynolds numbers (lower than approximately 20,000).
Eccentric type	Flange taps Bena-Contracta taps	100mm (4") to 350mm (14")	β = 0.30 to 0.80	• Effective for measurement of flows containing sediments and suspension which cannot be processed through drain hole or vent hole.
Segment type	Flange taps Vena-Contracta taps	100mm (4") to 350mm (14")	β = 0.30 to 0.80	• The basic purpose is the same as that of the eccentric orifice, but with higher functional performance at higher cost.

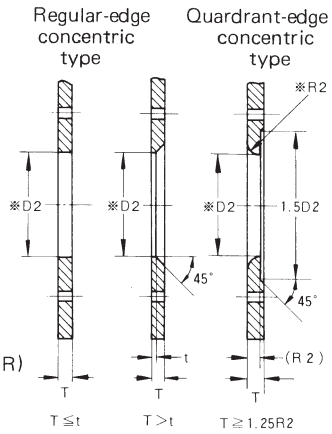
Model Number Table

Basic model no.	I Spec.	II Pressure rating	III Nominal pipe diameter	III Available range	IV Type of orifice	V Tapping system	V Available range	VI Material	VII Thickness	Description
NOP										Orifice plate
	–J	002		┐						For JIS 2K flange
		005		┐						For JIS 5K flange
		010		┐						For JIS 10K flange
		016		┐						For JIS 16K flange
		020		┐						For JIS 20K flange
		030		┐						For JIS 30K flange
		040		┐						For JIS 40K flange
		063		┐						For JIS 63K flange
	–P	150		┐						For JPI 150 flange
		300		┐						For JPI 300 flange
		600		┐						For JPI 600 flange
		900		┐						For JPI 900 flange
	–A	150		┐						For ANSI 150 flange
		300		┐						For ANSI 300 flange
		600		┐						For ANSI 600 flange
		900		┐						For ANSI 900 flange
			040	○○○○○○			●●●○			Pipe diameter 40 mm (1½")
			050	○○○○○○			○○○○○			Pipe diameter 50 mm (2")
			065	○○○○○○			○○○○○			Pipe diameter 65 mm (2½")
			080	○○○○○○			○○○○○			Pipe diameter 80 mm (3")
			090	○○○○○			○○○○○			Pipe diameter 90 mm (3½")
			100	○○○○○○			○○○○○○○			Pipe diameter 100 mm (4")
			125	○○○○○○			○○○○○○○			Pipe diameter 125 mm (5")
			150	○○○○○○			○○○○○○○			Pipe diameter 150 mm (6")
			175	○			○○○○○○○			Pipe diameter 175 mm (7")
			200	○○○○○○			○○○○○○○			Pipe diameter 200 mm (8")
			225	○			○○○○○○○			Pipe diameter 225 mm (9")
			250	○○○○○○			○○○○○○○			Pipe diameter 250 mm (10")
			300	○○○○○○			○○○○○ ○○			Pipe diameter 300 mm (12")
			350	○○○○○○			○○○○○ ○○			Pipe diameter 350 mm (14")
			400	○○○○○○			○○○○○			Pipe diameter 400 mm (16")
			450	○○○ ○○○			○ ○			Pipe diameter 450 mm (18")
			500	○○○ ○○○			○ ○			Pipe diameter 500 mm (20")
			550	○○○			○ ○			Pipe diameter 550 mm (22")
			600	○○○ ○○○			○ ○			Pipe diameter 600 mm (24")
			650	○○ ○			○ ○			Pipe diameter 650 mm (26")
			700	○○ ○			○ ○			Pipe diameter 700 mm (28")
			750	○○ ○			○ ○			Pipe diameter 750 mm (30")
			800	○○ ○			●			Pipe diameter 800 mm (32")
			850	○○ ○			●			Pipe diameter 850 mm (34")
			900	○○ ○			●			Pipe diameter 900 mm (36")
			950	○			●			Pipe diameter 950 mm (38")
			101	○○ ○			●			Pipe diameter 1000 mm (40")
			106	○			●			Pipe diameter 1050 mm (42")
			111	○○ ○			●			Pipe diameter 1100 mm (44")
			116	○			●			Pipe diameter 1150 mm (46")
			121	○○ ○			●			Pipe diameter 1200 mm (48")
			136	○○ ○			●			Pipe diameter 1350 mm (54")
			151	○○ ○			●			Pipe diameter 1500 mm (60")
					C	1	┘			Regular-edge concentric type, Vena-Contracta taps
						2	┘			Regular-edge concentric type, flange taps
						3	┘			Regular-edge concentric type, corner taps
						7	┘			Regular-edge concentric type, radius taps
						8	┘			Regular-edge concentric type, pipe taps
					Q	2	┘			Quardrant-edge concentric type, flange taps
						3	┘			Quardrant-edge concentric type, corner taps
					E	1	┘			Eccentric type, Vena-Contracta taps
						2	┘			Eccentric type, flange taps
					S	1	┘			Segment type, Vena-Contracta taps
						2	┘			Segment type, flange taps
								2		SUS316
								7		SUS304
									02	2 mm
									03	3 mm
									05	5 mm
									08	8 mm
									10	10 mm

Notes: The orifice plates of regular-edge concentric type for 40 mm diameter pipes and those of Radius taps for 760 mm or over of diameters (the ones indicated by the ● marks in the above table) are not within the standard specification ranges but they are available for similar specifications.

Dimension Drawings

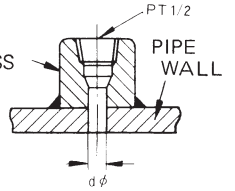




Notes: 1) For the items (D2, D3, R2 and R3) indicated by the asterisks, refer to the orifice calculation manual.

2) For an orifice plate with a bore of 25.4 mm (1") or over, a drain hole or a vent hole is drilled as a standard feature.

Details of the tapping section of the Vena-Contracta type, radius type or pipe tap system



Pipe diameter	dϕ MAX.
65 mm or less	6.5
80 mm only	10
90 mm or over	13

Table of Dimensions

JIS 2K Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate	Thickness				Tab handle		Type
		Plate (T)			Edge t	Width W	Height H	
		≦200°C	≦300°C	≦400°C				
450	532	5	8	10	5	30	120	
500	582	5	8	10	8	30	120	
550	640	5	8	–	8	30	120	
600	690	5	8	–	8	50	120	
650	745	8	10	–	10	50	120	
700	795	8	10	–	10	50	120	
750	853	8	10	–	10	50	140	B
800	903	8	10	–	10	50	140	
850	953	8	10	–	10	50	140	
900	1003	8	10	–	10	50	140	
1000	1103	10	10	–	10	50	140	
1100	1213	10	–	–	10	50	140	
1200	1323	10	–	–	10	50	140	
1350	1478	10	–	–	10	50	140	
1500	1633	10	–	–	10	50	140	

JIS 5K Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate	Thickness				Tab handle		Type
		Plate (T)			Edge t	Width W	Height H	
		≦200°C	≦300°C	≦400°C				
40	83	2	3	3	0.5	25	110	
50	93	2	3	3	0.5	25	110	
65	118	3	3	3	0.5	25	110	
80	129	3	3	3	1.0	25	110	
90	139	3	3	3	1.0	25	110	
100	149	3	3	3	1.0	25	110	
125	184	3	3	5	1.5	25	110	A
150	214	3	5	5	1.5	25	110	
175	240	3	5	5	2.0	25	110	
200	260	3	5	5	2.0	25	110	
225	285	3	5	8	2.0	25	110	
250	325	3	5	8	2.0	25	110	
300	370	3	5	8	3.0	25	110	
350	413	5	8	10	3.0	25	110	
400	473	5	8	10	5.0	30	120	
450	530	5	8	10	5.0	30	120	
500	580	5	8	10	8.0	30	120	
550	638	5	8	–	8.0	30	120	
600	688	5	8	–	8.0	50	120	
650	743	8	10	–	10.0	50	120	
700	793	8	10	–	10.0	50	120	B
750	847	8	10	–	10.0	50	140	
800	897	8	10	–	10.0	50	140	
850	947	8	10	–	10.0	50	140	
900	997	8	10	–	10.0	50	140	
1000	1097	10	10	–	10.0	50	140	
1100	1207	10	–	–	10.0	50	140	
1200	1317	10	–	–	10.0	50	140	
1350	1472	10	–	–	10.0	50	140	
1500	1627	10	–	–	10.0	50	140	

Notes) Type A: Such orifice that its plate is thicker than its tab handle.

Type B: Such orifice that its plate and tab handle are of the same thickness.

JIS 10K Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate ×	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
40	89	2	3	3	0.5	25	110	A
50	104	2	3	3	0.5	25	110	
65	124	3	3	3	0.5	25	110	
80	134	3	3	3	1.0	25	110	
90	144	3	3	3	1.0	25	110	
100	159	3	3	3	1.0	25	110	
125	190	3	3	5	1.5	25	110	
150	220	3	5	5	1.5	25	110	
175	245	3	5	5	2.0	25	110	
200	270	3	5	5	2.0	25	110	
225	290	3	5	8	2.0	25	110	
250	333	3	5	8	2.0	25	110	
300	378	3	5	8	3.0	25	110	
350	423	5	8	10	3.0	25	110	B
400	486	5	8	10	5.0	30	120	
450	538	5	8	10	5.0	30	120	
500	593	5	8	10	8.0	30	120	
550	647	5	8	–	8.0	30	140	
600	697	5	8	–	8.0	50	140	
650	747	8	10	–	10.0	50	140	
700	807	8	10	–	10.0	50	140	
750	867	8	10	–	10.0	50	140	
800	917	8	10	–	10.0	50	140	
850	967	8	10	–	10.0	50	140	
900	1017	8	10	–	10.0	50	140	
1000	1121	10	10	–	10.0	50	140	
1100	1231	10	–	–	10.0	50	140	
1200	1341	10	–	–	10.0	50	160	
1350	1495	10	–	–	10.0	50	160	
1500	1655	10	–	–	10.0	50	160	

JIS 16K, 20K Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate ×	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
40	89	2	3	3	0.5	25	110	A
50	104	2	3	3	0.5	25	110	
65	124	3	3	3	0.5	25	110	
80	140	3	3	3	1.0	25	110	
90	150	3	3	3	1.0	25	110	
100	165	3	3	3	1.0	25	110	
125	203	3	3	5	1.5	25	110	
150	238	3	5	5	1.5	25	110	
200	283	3	5	5	2.0	25	110	
250	356	3	5	8	2.0	25	110	
300	406	3	5	8	3.0	25	110	
350	450	5	8	10	3.0	25	110	B
400	510	5	8	10	5.0	30	140	
450	572	5	8	10	5.0	30	140	
500	627	5	8	10	8.0	30	140	
550	681	5	8	–	8.0	30	140	
600	731	5	8	–	8.0	50	140	

JIS 30K Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate ×	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
40	100	2	3	3	0.5	25	110	A
50	114	2	3	3	0.5	25	110	
65	140	3	3	3	0.5	25	110	
80	150	3	3	3	1.0	25	110	
90	163	3	3	3	1.0	25	110	
100	173	3	3	5	1.0	25	110	
125	208	3	3	5	1.5	25	110	
150	251	3	5	5	1.5	25	110	
200	296	3	5	5	2.0	25	110	
250	360	3	5	8	2.0	25	110	
300	420	3	5	8	3.0	25	120	B
350	465	5	8	10	3.0	25	120	
400	524	5	8	10	5.0	30	140	

JIS 40K Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate ×	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
40	100	2	3	3	0.5	25	110	A
50	114	2	3	3	0.5	25	110	
65	140	3	3	3	0.5	25	110	
80	150	3	3	3	1.0	25	110	
90	163	3	3	3	1.0	25	110	
100	183	3	3	3	1.0	25	110	
125	226	3	3	5	1.5	25	110	
150	265	3	5	5	1.5	25	110	
200	315	3	5	5	2.0	25	120	B
250	380	3	5	8	2.0	25	120	
300	434	3	5	8	3.0	25	120	
350	479	5	8	10	3.0	25	120	
400	534	5	8	10	5.0	30	140	

JIS 63K Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate ×	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
40	108	2	3	3	0.5	25	110	A
50	125	2	3	3	0.5	25	110	
65	153	3	3	3	0.5	25	110	
80	163	3	3	3	1.0	25	110	
90	181	3	3	3	1.0	25	110	
100	196	3	3	3	1.0	25	110	
125	235	3	3	5	1.5	25	110	
150	275	3	5	5	1.5	25	110	
200	330	3	5	5	2.0	25	120	B
250	394	3	5	8	2.0	25	120	
300	449	3	5	8	3.0	25	120	
350	488	5	8	10	3.0	25	120	
400	548	5	8	10	5.0	30	160	

ANSI (or JPI) 150 Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate x	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
1½	86	2	3	3	0.5	25	110	A
2	105	2	3	3	0.5	25	110	
2½	124	3	3	3	0.5	25	110	
3	137	3	3	3	1.0	25	110	
3½	162	3	3	3	1.0	25	110	
4	175	3	3	3	1.0	25	110	
5	197	3	3	5	1.5	25	110	
6	222	3	5	5	1.5	25	110	
8	279	3	5	5	2.0	25	110	
10	340	3	5	8	2.0	25	110	
12	410	3	5	8	3.0	25	110	
14	451	5	8	10	3.0	25	110	B
16	514	5	8	10	5.0	30	120	
18	546	5	8	10	5.0	30	120	
20	603	5	8	10	8.0	30	140	
24	715	5	8	–	8.0	50	140	
26	723	8	10	–	10.0	50	140	
28	773	8	10	–	10.0	50	140	
30	824	8	10	–	10.0	50	140	
32	878	8	10	–	10.0	50	140	
34	932	8	10	–	10.0	50	140	
36	985	8	10	–	10.0	50	140	
38	1035	8	10	–	10.0	50	140	
40	1092	10	10	–	10.0	50	140	
42	1143	10	–	–	10.0	50	140	
44	1201	10	–	–	10.0	50	140	
46	1252	10	–	–	10.0	50	140	
48	1303	10	–	–	10.0	50	140	
54	1460	10	–	–	10.0	50	140	
60	1627	10	–	–	10.0	50	140	

ANSI (or JPI) 300 Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate x	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
1½	95	2	3	3	0.5	25	110	A
2	111	2	3	3	0.5	25	110	
2½	130	3	3	3	0.5	25	110	
3	149	3	3	3	1.0	25	110	
3½	165	3	3	3	1.0	25	110	
4	181	3	3	3	1.0	25	110	
5	216	3	3	5	1.5	25	110	
6	251	3	5	5	1.5	25	110	
8	308	3	5	5	2.0	25	110	
10	362	3	5	8	2.0	25	110	
12	422	3	5	8	3.0	25	120	B
14	486	5	8	10	3.0	25	120	
16	540	5	8	10	5.0	30	140	
18	594	5	8	10	5.0	30	140	
20	651	5	8	10	8.0	30	140	
24	772	5	8	–	8.0	50	160	
26	768	8	10	–	10.0	50	160	
28	822	8	10	–	10.0	50	160	
30	883	8	10	–	10.0	50	160	
32	937	8	10	–	10.0	50	160	
34	991	8	10	–	10.0	50	160	
36	1044	8	10	–	10.0	50	160	
38	1095	8	10	–	10.0	50	160	
40	1146	10	10	–	10.0	50	160	
42	1197	10	–	–	10.0	50	160	
44	1247	10	–	–	10.0	50	160	
46	1314	10	–	–	10.0	50	160	
48	1365	10	–	–	10.0	50	160	
54	1527	10	–	–	10.0	50	160	
60	1704	10	–	–	10.0	50	160	

ANSI (or JPI) 600 Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate x	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
1½	95	2	3	3	0.5	25	110	A
2	111	2	3	3	0.5	25	110	
2½	130	3	3	3	0.5	25	110	
3	149	3	3	3	1.0	25	110	
3½	162	3	3	3	1.0	25	110	
4	194	3	3	3	1.0	25	110	
5	241	3	3	5	1.5	25	110	
6	267	3	5	5	1.5	25	110	
8	320	3	5	5	2.0	25	120	B
10	400	3	5	8	2.0	25	120	
12	457	3	5	8	3.0	25	120	
14	492	5	8	10	3.0	25	120	
16	565	5	8	10	5.0	30	140	
18	609	5	8	10	5.0	30	160	
20	679	5	8	10	8.0	30	160	
24	787	5	8	–	8.0	50	160	

ANSI (or JPI) 900 Flange (Unit: mm)

Nominal dia. (mm)	O.D. of orifice plate x	Thickness Plate (T) ≦200°C	≦300°C	≦400°C	Edge t	Tab handle Width W	Height H	Type
1½	99	2	3	3	0.5	25	110	A
2	143	2	3	3	0.5	25	110	
2½	165	3	3	3	0.5	25	110	
3	168	3	3	3	1.0	25	110	
4	206	3	3	3	1.0	25	110	
5	248	3	3	5	1.5	25	120	B
6	289	3	5	5	1.5	25	120	
8	359	3	5	5	2.0	25	120	
10	435	3	5	8	2.0	25	120	
12	499	3	5	8	3.0	25	120	
14	521	5	8	10	3.0	25	120	
16	575	5	8	10	5.0	30	160	
18	635	5	8	10	5.0	30	160	
20	696	5	8	10	8.0	30	160	
24	835	5	8	–	8.0	50	190	

When ordering an orifice plate, please specify the following for orifice calculations.

No.	Item			Calculation	Unit
1	Material of plate			—	—
2	Type of orifice bore			—	—
3	Tapping system			—	—
4	Type of fluid			—	—
5(*1)	Maximum flow rate (instrument scale)			W	kg/h
				Q	m^3/h
					Nm^3/h
6(*2)	Normal flow rate			W_A	kg/h
				Q_A	m^3/h
					Nm^3/h
(*3) 7(*4)	Scale reference (Specify in the case of volumetric flow measurement)	Liquid	at 15°C or at □°C	—	—
		Gas	at 0°C, 1 atm. Reference for wet gas measurement: DRY BASE / WET BASE / TOTAL BASE; or at □°C, □ kg/cm²G	—	—
8	Pipe diameter			D_1	mm
9	Maximum differential pressure			H	mmH_2O
10	Normal temperature			T_1	°C
11	Specific weight			P_1	kg/cm^2G
					mmH_2O
12(*4)	Specific weight	Liquid	When in scale reference state	R_N	kg/m^3
			When in operation state	R_1	kg/m^3
		Gas	Mole weight — DRY / WET — or	MW	g/22.406ℓ
			S.W. at 0°C, 1 atm. — DRY / WET — or	R_N	kg/Nm^3
13	Normal viscosity			U	cp
14(*4)	Compressibility factor	For gas only	at 0°C, 1 atm.	Z_N(*5)	—
			When in operation state	Z_1	—
15(*4)	Relative humidity	For gas only	When in operating state or at □°C, □ kg/cm²G	RH	%
16	Specific heat ratio	Gas or steam	When in operation state	I_Z	—
17(*6)	Roughness of inside wall of pipe			K	mm

Notes:

(*1) The maximum flow rate of No. 5 means the maximum value of the instrument scale.

(*2) For the normal flow rate of No. 6, 80% of the maximum flow rate will be assumed unless specified otherwise by the customer.

(*3) If no specification is given by the customer for the scale reference of No. 7, 16°C will be assumed for a liquid or the WET BASE will be used for a wet gas.

(*4) Refer to the following formulas for conversion of a volumetric flow of No. 7 into a weight flow, and for relationships among specific weight of No. 12, compressibility factor of No. 14, and relative humidity of No. 15.

1) Liquid

$$W = Q_N \cdot R_N \quad \cdots\cdots (1)$$

$$W = Q_1 \cdot R_1 \quad \cdots\cdots (2)$$

2) Gas

DRY BASE

$$W = \frac{Q_N(D) \cdot R_1(W)}{\frac{(P_1 + 1.0332) - \phi \cdot P_V}{1.0332} \cdot \frac{273.15}{T_1 + 273.15} \cdot \frac{1}{Z_R}} \quad \cdots\cdots (3)$$

$$R_1(W) = R_N(D) \cdot \frac{P_1 + 1.0332}{1.0332} \cdot \frac{273.15}{T_1 + 273.15} \cdot \frac{1}{Z_R}\left[1 + \frac{\phi \cdot P_V}{P_1 + 1.0332}\left(\frac{0.6225}{G(D)} - 1\right)\right] \quad \cdots (4)$$

WET BASE

$$W = Q_N(W) \cdot R_N(D) \quad \cdots\cdots (5)$$

R_1 = (4)

TOTAL BASE

$$W = Q_N(T) \cdot R_N(W) \quad \cdots\cdots (6)$$

$$R_1(W) = R_N(W) \cdot \frac{P_1 + 1.0332}{1.0332} \cdot \frac{273.15}{T_1 + 273.15} \cdot \frac{1}{Z_R} \quad \cdots\cdots (7)$$

$$G(D) = \frac{MW(D)}{28.97} \quad \cdots\cdots (8)$$

$$R_N(D) = \frac{1.2929 \cdot G(D)}{Z_N} \quad \cdots\cdots (9)$$

$$G(W) = \frac{MW(W)}{28.97} \quad \cdots\cdots (10)$$

$$R_N(W) = \frac{1.2929 \cdot G(W)}{Z_N} \quad \cdots\cdots (11)$$

$$Z_R = \frac{Z_1}{Z_N} \quad \cdots\cdots (12)$$

Where,

W: Weight flow rate [kgf/hr]

Q_N: Volumetric flow rate when in reference state [m^3/hr or Nm^3/hr]

Q_1: Volumetric flow rate when in operating state [m^3/hr)

R_N: Specific weight when in reference state [kgf/m^3 or kgf/Nm^3)

R_1: Specific weight when in operating state [kgf/m^3]

P_V: Saturated steam pressure [kgf/cm^2 abs]

ϕ: Relative humidity = $\frac{RH}{100}$

Z_R: Compressibility factor ratio

G: Specific gravity of gas with respect to air as 1.0 at 0°C and 1 atm.

Letters D, W and T enclosed in the parentheses stand for DRY, WET, and TOTAL, respectively.

(*5) Unless specified otherwise by the customer, 1.0 will be assumed for the compressibility factor (Z_N) of No. 14.

(*6) Unless specified otherwise by the customer, 0.05 (mm) will be assumed for the roughness of pipe inside surface of No. 17.

(7) When no data are indicated by the customer properties and data are well known to Yamatake, such for orifice calculation.

Special Orifice Plates Available

Special types of orifice plates also are available from **Azbil Corporation** as follows:

1) Regular-edge concentric-type orifice plates of nominal diameters 1500 mm (60 in.) to 3000 mm (120 in.) designed with respect to the flange bolt circle and bolt hole diameter. Appropriate orifice plate thickness selected taking the operating conditions into consideration.
2) Orifice plates of non-standard thickness or non-standard materials (such as SUS316L, hastelloy B, C, Monel, Titanium, PVC, etc.)
3) Orifice bore calculation under predetermined tap positions.
4) Reversible-direction orifice plates.
5) Integral orifice assembly with differential pressure transmitter for low flow rate measurement. (Refer to No. SS2-519-010.)
6) If you have any problems regarding orifice plates in particular or flow measurement in general, please consult your **Azbil Corporation** agent.

Azbil Corporation
Advanced Automation Company

1-12-2 Kawana, Fujisawa
Kanagawa 251-8522 Japan
URL: http://www.azbil.com/

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