Schutte & Koerting

Performance Data on Water Jet Exhausters and Compressors

INTRODUCTION

This supplemental data should be used in conjunction with S&K Bullletin 4P which describes the construction, operation, and application of Schutte & Koerting Water Jet Exhausters and Compressors.

Bulletin 4P contains general information on all types and sizes, together with dimensional data. This Supplement contains complete information on sizing this equipment.

For sizing information on this S&K equipment, refer to the following index:

Fig. 464 Single-Nozzle Water Jet Exhauster

Fig. 488 Multi-Nozzle Water Jet Exhauster

Fig. 489 Multi-Nozzle Water Jet Exhauster

Fig. 485 Single-Nozzle Water Jet Exhauster

Fig. 484 Single-Nozzle Water Jet Exhauster

Index

FIG. 484 SINGLE NOZZLE WATER JET EXHAUSTER (HANDLING FREE AIR)

SIZING AND WATER CONSUMPTION DATA

Example: To determine the size of S&K Fig. 484 Water Jet Exhauster required, and the water consumption rate, to meet the following conditions:

Water Pressure = 60 psig
Suction Pressure = 80°F
Suction Pressure = 20 in. Hg. abs.
Air Handling Capacity = 15 scfm

Solution: Refer to Curve 1. Select horizontal line at base of curve representing water temperature of 80°F (1). Read horizontally across until water temperature line intersects 20 in. Hg. abs. suction pressure line (2). Project line vertically up to the proper water pressure curve representing 60 psig (3). Read horizontally from intersection and note that the capacity of a 1" Fig. 484 Exhauster is 1.9 scfm (4). Divide required capacity (15 scfm) by capacity of a 1" size (1.9 scfm) to find capacity ratio, as

$$\frac{15 \text{ scfm}}{1.9 \text{ scfm}} = 7.9 \text{ capacity ratio}$$

Refer to Capacity Ratio Table and note that the 2 1/2" size has a capacity ratio of 6.25 and the 3" size has a capacity ratio of 9.00. The larger size exhauster (5) should be selected to meet service conditions.

To find the water consumption rate for this size exhauster, refer to Table 2 and note that a 3" size operating with a water pressure of 60 psig will consume 86 gpm (6).

Chart 1. Suction Pressure And Capacities of 1" Single Nozzle Water Jet Exhauster (Atmospheric Discharge), Fig. 484.

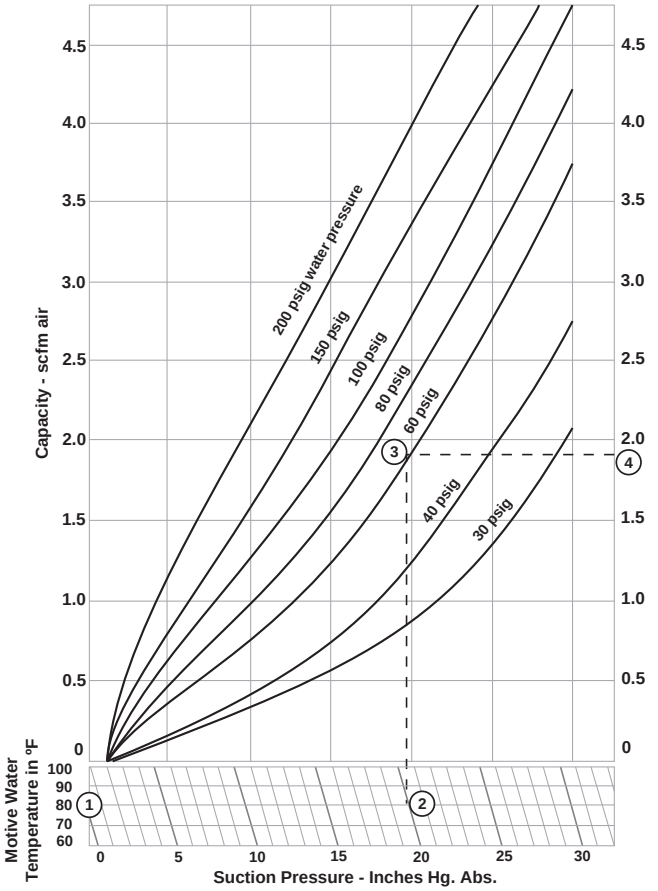


Table 1. Relative Capacities of Single Nozzle Water Jet Exhauster, Fig. 484.

Exhauster Size (Inches)	Capacity Ratio
1/2	0.36
3/4	0.64
1	1.00
1 1/2	2.89
2	4.00
2 1/2	6.25
3	9.00 (5)

Table 2. Capacities of Single Nozzle Water Jet Exhauster, Fig. 484.

Size in Inches	Water Pressure - psig						
	30	40	60	80	100	150	200
1/2	*	2.9	3.4	3.8	4.2	5	6
3/4	*	5.3	6.4	7.4	8.3	10	12
1	*	6.8	8.1	9	10	12	14
1 1/2	20	23	27	30	32	38	45
2	28	31	36	41	45	54	63
2 1/2	46	51	60	67	73	88	102
3	66	73	86 (6)	96	106	127	148

Approximate Water Consumption in GPM
Note: All Flows at 15" Hg. abs.
*Require 40 psig minimum.

FIG. 484 SINGLE NOZZLE WATER JET EXHAUSTER

SIZE DETERMINATION (EVACUATING TIME, PUMP PRIMING, CLOSED TANK EVACUATION)

How to Size Exhauster for Priming

Example: Determine proper size Exhauster and amount of water required for priming a pump and suction line in an allowable time of two minutes if the total volume is 50 cu. ft. The lift is 10' and the water pressure available is 40 psig.

Solution: (See solid lines, Chart 3):

1. Divide time allowable in seconds by the volume in cu. ft.

$$\frac{2 \times 60}{50} = 2.4 \text{ sec./cu. ft.}$$

2. Enter Table 5 at 10' of water and read below it the equivalent in. Hg. In this case 8.8" (1).

3. Enter Chart 3 at 8.8" Hg. vacuum (2) and read over to 40 psig water curve. Read vertically downward to evacuation rate of 3.5 sec./cu. ft. (3).

4. Divide answer in Step 3 by answer in Step 1.

$$\frac{3.5}{2.4} = 1.46 \text{ - This is the Size Factor}$$

5. Enter Table 4 and find size factor equal to or greater than that determined in Step 4. Read directly above it the size Exhauster required. In this case a 2 1/2" (4).

6. See Table 2 on page 2 for water consumption for a 2 1/2" Exhauster at 40 psig water pressure. Note that this is 51 gpm.

How to Size Exhauster for Closed Tank Evacuation

Example: Determine the size Exhauster and amount of water required to evacuate a 10 cu. ft. tank to 20" Hg. vacuum in 15 minutes, with 40 psig water pressure available.

Solution: (See dotted lines, Chart 3):

1. Enter Chart 3 at 20 in. Hg. vacuum (1), go horizontally to the 40 psig water curve. Go vertically downward and read evacuation rate of 20 sec./cu. ft. (2).

2. Multiply the evacuation rate found in Step 1 by the volume of the tank.

$$20 \times 10 = 200$$

3. Divide number determined in Step 2 by the allowed time in seconds.

$$\frac{200}{15 \times 60} = .20 \text{ Size Factor}$$

4. Enter Table 4 and find size factor equal to or greater than that determined in Step 3. Read directly above it the size Exhauster required. In this case a 3/4" (3).

5. See Table 2 on page 2 for water consumption for a 3/4" Exhauster at 40 psig water pressure. Note that this is 5.3 gpm.

Table 4. Relative Capacities of Single Nozzle Water Jet Exhauster, Fig. 484.

	③				④	
Size (in Inches)	3/4	1	1 1/2	2	2 1/2	3
Capacity Ratio	.20	.306	1.0	1.38	2.28	3.26

Chart 3. Evacuating and Priming Curves of Single Nozzle Water Jet Exhauster, Fig. 484.

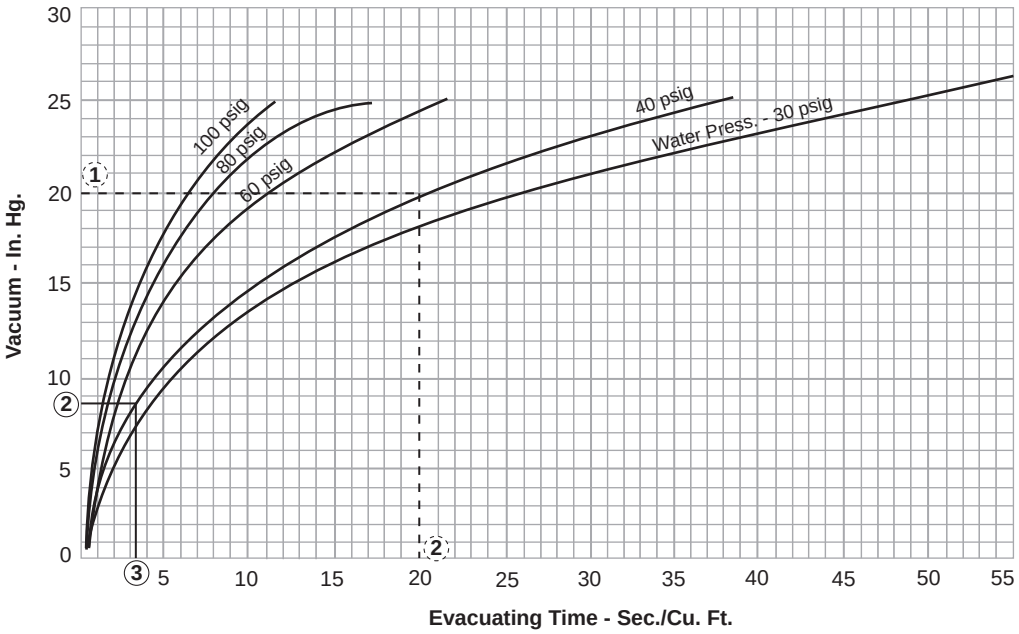


Table 5. Conversion Table From Feet of Water to In. Hg. of Single Nozzle Water Jet Exhauster, Fig. 484.

Water (Feet)	Vacuum (In. Hg.)	
5’	4.4”	
10’	8.8”	①
15’	13.2”	
20’	17.6”	

FIG. 488 (THREADED) AND FIG. 489 (FLANGED) MULTI-NOZZLE WATER JET EXHAUSTERS (HANDLING FREE AIR)

SIZE DETERMINATION AND WATER CONSUMPTION DATA

Example: To size an Exhauster for handling 15 scfm of air at 10" Hg. abs., using 30 psig water at 80°F.

Solution: Refer to Chart 6 below. At the 80°F water temperature line (point 1), read horizontally to a suction pressure of 10" Hg abs. (2), then vertically up to the 30 psig water pressure curve (3). From that point, read horizontally to the first size of Exhauster that will handle 15 scfm (4). Read vertically down to determine the required size as a 6 inch Exhauster (5). From Table 7, note that a 6 inch Exhauster operating at 30 psig water pressure has a water consumption of 488 gpm (6).

Chart 6. Air Handling Capacity of Multi-Nozzle Water Jet Exhausters (Atmospheric Discharge), Fig. 488 (Threaded) and Fig. 489 (Flanged).

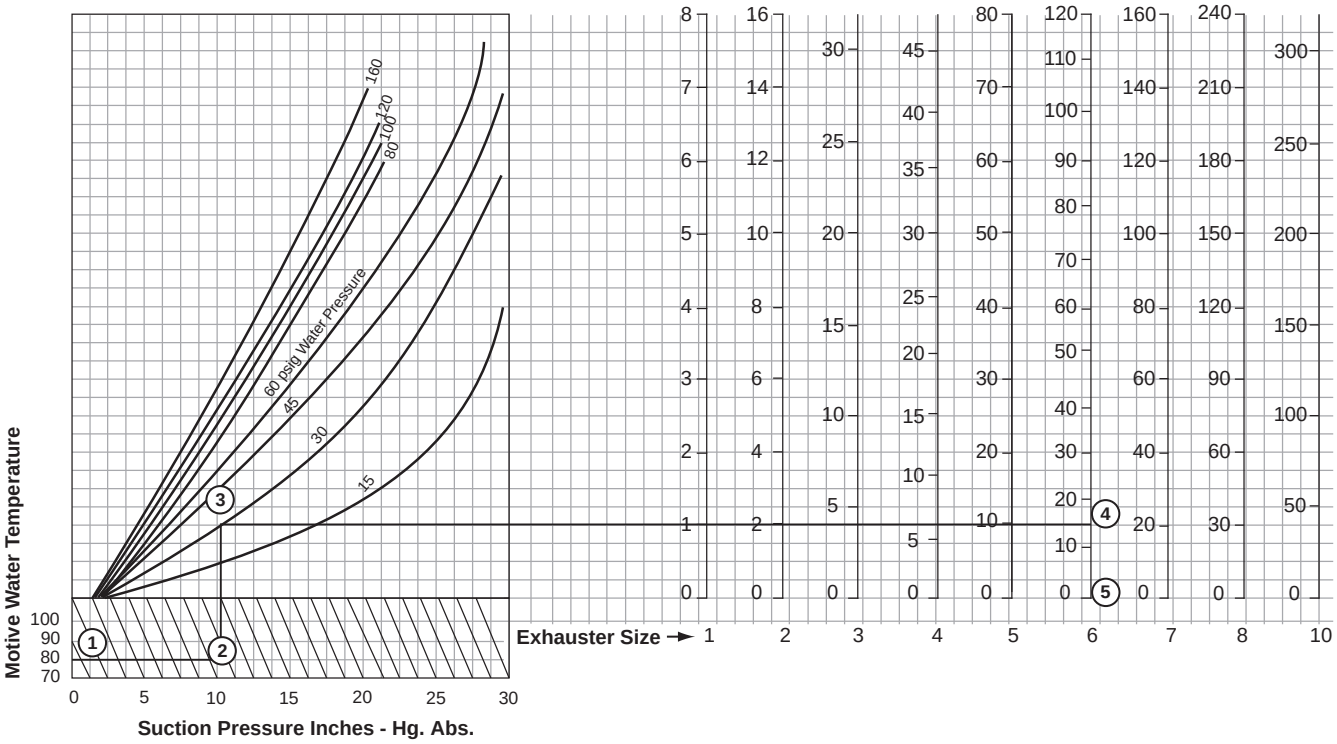


Table 7. Approximate Water Consumption in GPM of Multi-Nozzle Water Jet Exhausters, Fig. 488 (Threaded) and Fig. 489 (Flanged).

Water Pressure (psig)	Exhauster Size, Inches								
	1	2	3	4	5	6	7	8	10
15	26	51	102	153	255	383	510	765	1020
30	33	65	130	195	325	488	650	975	1300
45	40	79	158	237	395	593	790	1185	1580
60	45	89	178	267	445	668	890	1335	1780
80	50	100	200	300	500	750	1000	1500	2000
100	56	112	224	336	560	840	1120	1680	2240
120	61	122	244	366	610	915	1220	1830	2440
160	69	138	276	414	690	1035	1380	2070	2760

FIG. 488 (THREADED) AND FIG. 489 (FLANGED) MULTI-NOZZLE WATER JET EXHAUSTERS

SIZE DETERMINATION (EVACUATING TIME, PUMP PRIMING, CLOSED TANK EVACUATION)

How to Size Exhauster for Priming

Example: Determine proper size Exhauster and quantity of water required for priming a pump and suction line in an allowable time of two minutes if the total volume is 40 cu. ft. The lift is 15' and the water pressure available is 30 psig.

Solution: (See solid lines in Chart 8):

1. Divide time allowable in seconds by the volume in cu. ft.

$$\frac{2 \times 60}{40} = 3.0 \text{ sec./cu. ft}$$

2. Enter Table 10 at 15' of water and read below it the equivalent in. Hg. In this case 13.2" (1).

3. Enter Chart 8 at 13.2" Hg. vacuum (2) and read over to 30 psig water curve. Read vertically downward to evacuation rate of 4.0 sec./cu. ft. (3).

4. Divide answer in Step 3 by answer in Step 1.

$$\frac{4.0}{3.0} = 1.33 \text{ Size Factor}$$

5. Enter Table 9 and find size factor equal to or greater than that determined in Step 4. Read directly above it the size Exhauster required. In this case a #3 (4).

6. See Water Consumption Curves for a #2 Exhauster (inset Chart 8). Locate intersection of 13.2" Hg. line with 30 psig water pressure line (5) and read down. Water consumption for a #2 Exhauster is 64 gpm (6). Note that the size factor for a #3 Exhauster (in Table 9) is 2.0. Multiply 64 x 2.0 = 128 gpm for a #3 Exhauster.

How to Size Exhauster for Closed Tank Evacuation

Example: Determine the size Exhauster and quantity of water required to evacuate a 50 cu. ft. tank to 20" Hg. vacuum in 15 minutes, with 15 psig water pressure available.

Solution (See dotted lines in Chart 8):

1. Enter Chart 8 at 20" Hg. vacuum (1), go horizontally to the 15 psig water curve. Go vertically downward and read evacuation rate of 17 sec./cu. ft. (2).

2. Multiply the evacuation rate found in Step 1 by the volume of the tank.

$$17 \times 50 = 850 \text{ seconds}$$

3. Divide number determined in Step 2 by the allowed time in seconds.

$$\frac{850}{15 \times 60} = .944 \text{ - This is the Size Factor}$$

4. Enter Table 9 and find size factor equal to or greater than that determined in Step 3. Read directly above it the size Exhauster required. In this case a #2 (3).

5. See Water Consumption Curves for a #2 Exhauster (inset Chart 8). Locate intersection of 20" Hg. line with 15 psig water pressure line (4) and read down. Water consumption for a #2 Exhauster is 52.6 gpm (5).

Table 9. Relative Capacities of Multi-Nozzle Water Jet Exhausters, Fig. 488 (Threaded) and Fig. 489 (Flanged).

Size (in Inches)	1	2	3 ③	4 ④	5	6	7	8	10
Capacity Ratio	.5	1.0	2.0	3.0	5.0	7.5	10.0	15.0	20.0

Chart 8. Water Consumption and Evauation Time of Multi-Nozzle Water Jet Exhausters, Fig. 488 (Threaded) and Fig. 489 (Flanged).

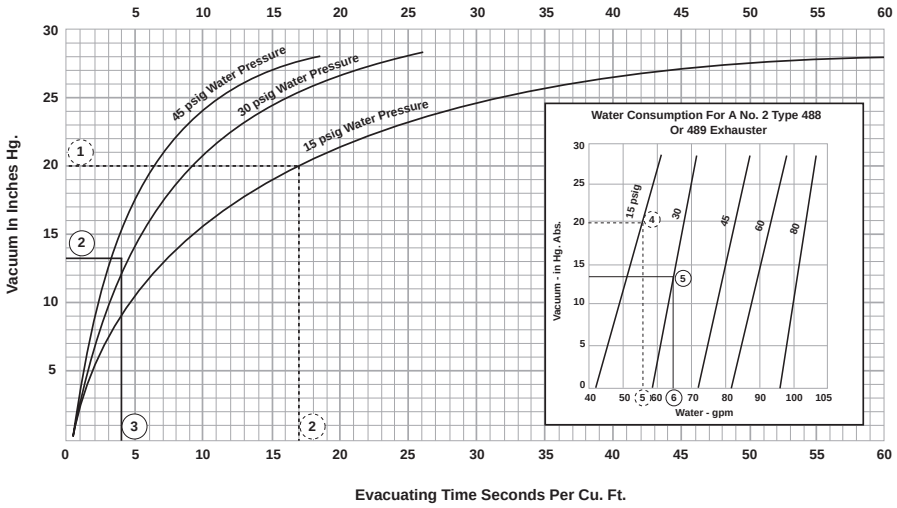


Table 10. Conversion Table From Feet of Water to In. Hg. of Multi-Nozzle Water Jet Exhausters, Fig. 488 (Threaded) and Fig. 489 (Flanged).

Water (Feet)	Vacuum (In. Hg.)
5'	4.4"
10'	8.8"
15'	13.2" ①
20'	17.6"

FIG. 464 SINGLE NOZZLE WATER JET EXHAUSTER

SIZE DETERMINATION AND WATER CONSUMPTION DATA

Example: Determine size and water requirement for following conditions:

Water pressure - 60 psig
Vacuum requirement - 10" Hg. (20" Hg. abs.)
Air handling - 8 pounds per hour

Solution: From Chart 11 at vacuum of 10" (point 1) and water pressure 60 psig (point 2), read suction capacity of 2.25 PPH (point 3) for a 1" Fig. 464. Divide required capacity (8 PPH) by 2.25 to get capacity factor:

$$\frac{8}{2.25} = 3.56$$

The nearest capacity factor is 4.0 (point 4) or a 2" Fig. 464 Water Jet Exhauster. Select 2" Fig. 464 Exhauster. Water requirement is: 9 GPM (point 5) x 4 = 36 GPM at 60 psig.

Table 12. Relative Capacities of Single Nozzle Water Jet Exhauster, Fig. 464.

Size (in Inches)	1/2	3/4	1	1 1/2	2	2 1/2	3
Capacity Ratio	0.36	0.64	1.00	2.89	4.00 (4)	6.25	9.0

Table 13. Approximate Water Consumption in GPM, 1" Size Single Nozzle Water Jet Exhauster, Fig. 464.

Water Pressure (psig)	10	20	40	60	80	100
Flow (gpm)	4.0	5.5	7.5	9.0 (5)	11.0	12.0

Chart 11. Air Handling Capacity of 1" Single Nozzle Water Jet Exhauster, Fig. 464 .

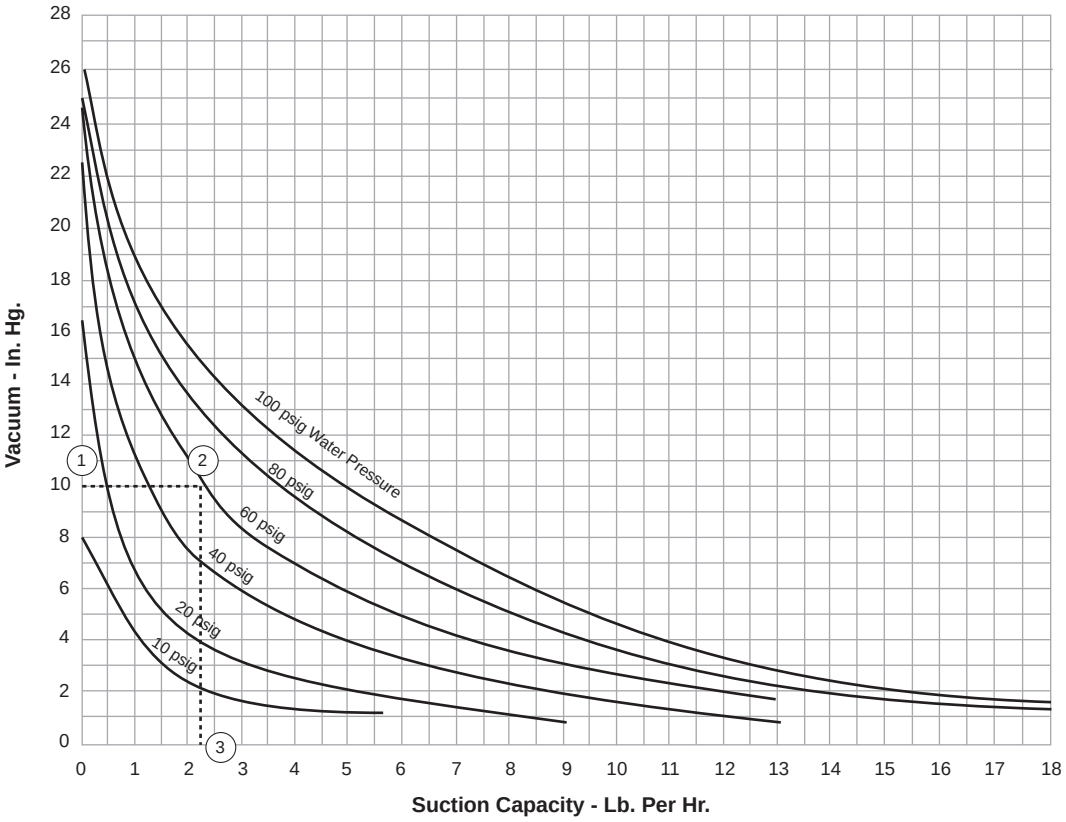
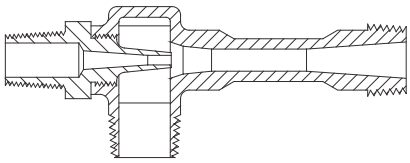


Fig. 265 & Fig. 485 Water Jet Exhauster Performance

Operating Pressure P1 _____(psig)
Operating Flow Q1 _____(gpm)
Specific Gravity _____
Viscosity _____



Discharge Head P2 _____ (ft)

*Note: Sizing information is based on water. If liquids are other than water please refer to *"Determination of Operating Conditions for Fluids other than Water"* on this page below.

Fig. 265/485 Gas Handling

Suction Pressure Ps _____ (in Hg abs)
Suction Flow Qs _____ (SCFM) or
Volume to be
Evacuated _____(ft^3) and
Required Time _____(Min)

Fig. 265 & Fig. 485 Water Jet Exhauster Selection Procedures

Evacuating

1. Determine the evacuation time in minutes per 100 $ft.^3$

   $$\frac{\text{Evacuation time (min)}}{\text{Volume Evacuated } (ft.^3)}$$

2. Enter Table 4 at the available operating water pressure P1 (psig) and required suction pressure Ps (in HG abs). Read across the table on the line closest to the Ps to the value closest to the evacuation time determined in step 1. Note unit size & Fig. # listed at the top of the table.

3. Continue across the table to the last two columns to determine the water consumption for Fig # chosen. Multiply this value times the capacity factor list in Table 5 for the unit size chosen.

Exhausting

1. Refer to Table 6 Air Handling Capacity for 265/485. Find the Suction Pressure Required (Ps) and the Operating Pressure (P1) on the left side of the chart.

2. Follow the row across the table to the column corresponding to the discharge pressure (P2). Note the Capacities in (SCFM) for each unit. Continue across the row to the last two columns to determine the water consumption.

3. Calculate the CF for each unit by dividing Ws Required/Ws from table. Select the unit size from Table 7 for the unit having the CF equal to or greater than the value determined.

4. Determine water consumption by multiplying the CF selected by the water consumption determined in step 2.

5. Determine Fig. # and size unit to use based on performance and operating water consumption.

Fig. 265 & Fig. 485 Water Jet Exhauster Performance

Table 485-4. 1" Single Nozzle Water Jet Exhauster Evacuation Time, Fig. 265 & Fig. 485

Operating Water Pressure (P1)	Suction Pressure Hg. Abs. (Ps)	Time in Minutes Per 100 Cubic Feet of Air										Operating Water Used GPM (QM)	
		3/4"		1"		1-1/2"		2"		3"		1" Unit GPM	
		265	485	265	485	265	485	265	485	265	485	265	485
20 PSIG	25"	33.7	18.8	20.8	10.9	7.0	3.9	3.9	2.1	1.2	0.7	6.0	5.9
	20"	123.8	71.3	75.2	42.6	25.7	14.9	13.9	8.1	4.4	2.5	6.3	6.2
	15"	257.4	152.5	155.4	92.1	53.5	31.7	29.7	17.8	9.0	5.3	6.6	6.5
	10"	476.2		288.1		99.0		54.5		16.8		6.9	
40 PSIG	25"	11.9	8.6	7.2	5.1	2.5	1.8	1.4	1.0	0.4	0.3	8.3	7.9
	20"	47.5	31.7	28.7	18.8	9.9	6.6	12.2	3.7	1.7	1.1	8.5	8.1
	15"	119.8	71.3	72.3	42.6	24.8	14.9	13.9	8.1	4.2	2.5	8.7	8.3
	10"	225.7	128.7	136.6	77.2	46.5	26.7	25.7	14.9	7.9	4.5	8.9	8.5
	5"	456.4	233.6	276.2	141.6	95.0	48.5	52.5	26.7	15.8	8.2	9.2	8.7
60 PSIG	25"	5.2	6.6	3.2	4.1	1.1	1.4	0.6	0.8	0.2	0.2	10.1	9.4
	20"	23.8	20.8	13.9	11.9	5.0	4.3	2.7	2.4	0.8	0.7	10.3	9.6
	15"	63.4	42.6	38.6	25.7	12.9	8.8	7.2	4.9	2.2	1.5	10.5	9.7
	10"	137.6	71.3	83.2	43.6	28.7	14.9	15.8	8.1	4.9	2.5	10.6	9.9
	5"	295.0	123.8	178.2	75.2	61.4	25.7	33.7	13.9	9.9	4.4	10.8	10.0
80 PSIG	25"	3.4	5.2	2.0	3.2	0.7	1.1	0.4	0.6	0.1	0.2	11.6	10.6
	20"	15.7	15.8	9.5	9.4	3.3	3.3	1.8	1.8	0.5	0.5	11.8	10.8
	15"	37.1	30.7	22.8	18.8	7.7	6.4	4.3	3.6	1.3	1.1	11.9	10.9
	10"	88.1	52.5	53.5	30.7	17.8	10.9	9.9	5.8	3.1	1.8	12.1	11.0
	5"	204.9	86.1	123.8	53.5	42.6	17.8	23.8	9.9	7.1	3.1	12.2	11.2
100 PSIG	25"	3.1	4.8	1.9	2.9	0.6	1.0	0.4	0.5	0.1	0.2	13.0	11.7
	20"	10.9	12.9	6.6	7.8	2.3	2.7	1.3	1.5	0.4	0.5	13.1	11.8
	15"	27.7	24.8	16.8	14.9	5.7	5.2	3.2	2.9	1.0	0.9	13.2	11.9
	10"	57.4	41.6	34.7	24.8	11.9	8.7	6.5	4.8	2.0	1.5	13.4	12.1
	5"	143.6	71.3	87.1	43.6	29.7	14.9	16.8	8.2	5.0	2.5	13.5	12.2
140 PSIG	25"	2.9	3.8	1.7	2.3	0.6	0.8	0.3	0.4	0.1	0.1	15.3	13.6
	20"	6.6	9.9	4.1	6.1	1.4	2.1	0.8	1.2	0.2	0.4	15.4	13.6
	15"	15.8	18.8	9.5	11.9	3.4	4.0	1.9	2.2	0.6	0.7	15.5	13.8
	10"	34.7	32.7	20.8	19.8	7.1	6.7	4.0	3.7	1.2	1.1	15.7	13.8
	5"	68.3	57.4	40.6	33.7	13.9	11.9	7.8	6.3	2.4	2.0	15.8	14.0

Table 485-5. Capacity Factor of Single Nozzle Water Jet Exhauster, Fig. 265 & Fig. 485

Size in Inches	3/4	1	1 1/2	2	3
Factor	0.605	1	2.91	5.29	17.21

Unit Description:
Fig. 265 & Fig. 485 Water Jet Exhauster utilizes spiral in the motive liquid nozzle to achieve better air handling qualities.

Conversions:

SCFM - Q_{gas} (ACFM) x 530°R x $Pressure_{gas}$ (PSIA)
$Temp_{gas}$ (°R) x 14.7 (PSIA)

$$SCFM = \frac{W_{gas}\ (lb./hr) \times 29 \times 1}{Molecular\ weight_{gas} \times 4.5}$$

Fig. 265 & Fig. 485 Water Jet Exhauster Performance

Table 485-6. 1" Air Handling Capacities of Single Nozzle Water Jet Exhauster, Fig. 265 & Fig. 485

Suction Pressure Hg. Abs. (Ps)	Operating Water Pressure PSIG (P1)	Capacity in SCFM at Discharge Pressure Qs										Operating Water Used GPM (QM)	
		0 PSIG		5 PSIG		10 PSIG		15 PSIG		20 PSIG		GPM	
		265	485	265	485	265	485	265	485	265	485	265	485
25"	20	0.6	1.0									6.0	5.9
	40	1.2	1.9	0.6	1.2							8.3	7.9
	60	2.0	2.8	1.0	2.0	0.8	1.6					10.1	9.4
	80	2.9	3.5	1.3	2.8	1.0	2.3	0.9	2.0	0.8		11.6	10.6
	100	3.4	3.9	2.1	3.5	1.4	3.1	1.2	2.7	1.0	2.5	13.0	11.7
	140	4.4	5.0	2.9	4.7	2.1	4.5	1.7	4.1	1.6	3.9	15.3	13.6
	200	5.8	6.0	4.9	5.9	3.7	5.8	3.0	5.6	2.4	5.4	17.5	15.5
20"	20	0.3	0.6									6.3	6.2
	40	0.7	1.2	0.4	0.8							8.5	8.1
	60	1.1	2.0	0.7	1.5	0.6	1.2					10.3	9.6
	80	1.7	2.7	1.0	2.2	0.8	1.8	0.7	1.6	0.6		11.8	10.8
	100	2.1	3.0	1.4	2.7	1.1	2.5	0.9	2.2	0.8	2.1	13.1	11.8
	140	3.1	3.9	1.9	3.7	1.5	3.5	1.3	3.3	1.2	3.1	15.4	13.6
	200	4.5	4.8	3.6	4.7	2.6	4.6	2.2	4.5	1.8	4.4	17.6	15.6
15"	20	0.2	0.3									6.6	6.5
	40	0.4	0.8	0.3	0.5							8.7	8.3
	60	0.6	1.3	0.5	1.1	0.4	0.9					10.5	9.7
	80	0.9	1.8	0.7	1.7	0.6	1.3	0.5	1.2	0.4		11.9	10.9
	100	1.3	2.2	0.9	2.0	0.8	1.9	0.7	1.7	0.6	1.6	13.2	11.9
	140	1.8	2.9	1.2	2.8	1.0	2.6	0.9	2.5	0.8	2.5	15.5	13.8
	200	3.0	3.6	2.2	3.6	1.7	3.5	1.5	3.4	1.2	3.4	17.6	15.7
10"	40	0.2	0.4	0.2								8.9	8.5
	60	0.3	0.9	0.3	0.7	0.2	0.5					10.6	9.9
	80	0.4	1.2	0.4	1.0	0.3	0.9	0.3	0.8	0.2		12.1	11.0
	100	0.7	1.3	0.5	1.3	0.4	1.3	0.4	1.2	0.4	1.1	13.4	12.1
	140	0.9	2.0	0.7	1.9	0.6	1.9	0.6	1.8	0.5	1.8	15.7	13.8
	200	1.8	2.4	1.3	2.4	1.0	2.4	0.8	2.3	0.8	2.3	17.9	15.8
5"	40	0.1	0.2	0.1								9.2	8.7
	60	0.1	0.6	0.1	0.4	0.1						10.8	10.0
	80	0.2	0.7	0.2	0.6	0.2	0.5	0.1	0.3	0.1		12.2	11.2
	100	0.3	0.8	0.2	0.7	0.2	0.7	0.2	0.7	0.2	0.7	13.5	12.2
	140	0.4	1.1	0.3	1.0	0.3	1.0	0.3	1.0	0.3	1.0	15.8	14.0
	200	0.7	1.2	0.5	1.2	0.4	1.2	0.3	1.2	0.3	1.2	17.9	15.9