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Acoustic & Emission Technologies

Vacuum Pump Silencers

Technical Literature

Inlet Liquid Separator-Silencers

Discharge Liquid Separator-Silencers

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94-1551 Rev 0

General Information

Vacuum Pump Liquid Separator-Silencers

Vacuum Pump Systems

Separator-silencers are used to remove liquid from gas flow vacuum systems using either liquid-sealed rotary positive blowers or liquid ring vacuum pumps (Fig. 1).

Separator-silencers may be required for both the inlet (vacuum) and the discharge (atmospheric) of a vacuum system. Only the most stringent acoustical environments require significant inlet silencing. An inlet separator provides corrosion protection for the vacuum pump by removing most, if not all, of the process liquid before it enters the vacuum pump.

The vacuum pump or blower discharge is normally extremely noisy and requires a high-performance separator-silencer.

When a vacuum pump starts operating at normal atmospheric pressure, system pressure drop and power requirements are at their maximum. As the vacuum pump continues to evacuate the system, the inlet pressure decreases so the system pressure losses and power requirements decrease. The inlet volume flow in actual cubic feet per minute (ACFM) stays essentially constant throughout system operation, but because of decreasing inlet pressure, the discharge volume decreases until normal operating conditions are reached.

Vacuum pump capacities at operating conditions are expressed by the inlet volume flow of air and the amount that the inlet pressure has been reduced below atmospheric pressure. Thus, vacuum pump capacities are stated in inlet ACFM at a relative vacuum, usually measured in inches of mercury (Hg).

Separator-silencers meet their rated liquid separation efficiency at a nozzle velocity of 5,500 ft/min. At lower velocities their performance improves. At higher velocities their efficiency decreases. The nozzle velocity is the air velocity in the inlet or discharge nozzle and is equal to the actual volume flow rate (ACFM) divided by the nozzle area.

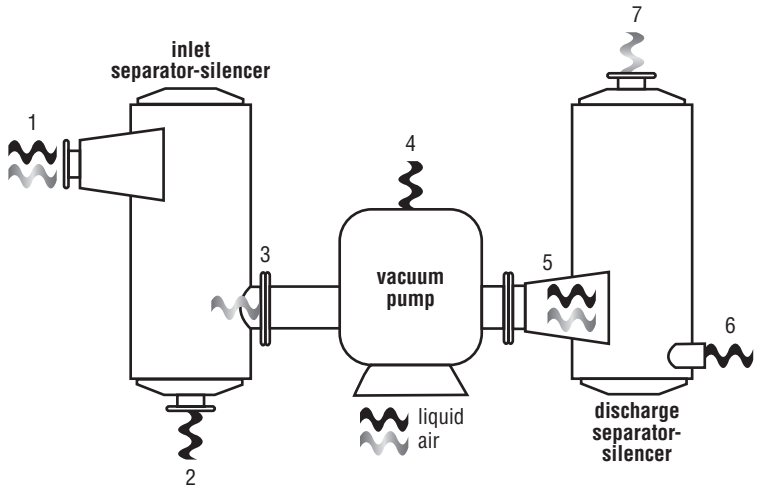
Since the inlet volume flow rate is nearly constant during normal vacuum pump operation, the inlet separator-silencer should be sized so the velocity does not exceed 5,500 ft/min during all phases of operation (Table 1, page 2).

The discharge flow rate decreases from startup to normal operation, and in some applications it may be acceptable to exceed a velocity of 5,500 ft/min during startup.

If it is not acceptable to discharge liquid during startup, the velocity must be reduced.

If some liquid bypass is allowed during startup, the selection of the discharge separator-silencer should be based on pressure drop.

Inlet and discharge separator-silencers require drain systems to remove the liquid. These systems (both inlet and discharge) must provide an adequate drain sealing system or liquid level to offset the vacuum on the inlet side and prevent blowout on the discharge side. See Tables 2 and 3 on the following page for liquid removal data.



∴ This is an example of a vacuum pump and liquid removal system. Air and liquid enter the inlet separator-silencer during processing (1). Process liquid is removed (2), and air enters the vacuum pump (3). The pump takes in seal liquid (4). Air and seal liquid are pumped into the discharge separator-silencer (5), which removes the liquid (6) and sends the air into the atmosphere (7).

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Technical Details

Separator-silencer pressure drop depends on velocity and pressure. In a vacuum system, pressure drop is at a maximum during startup. Under normal atmospheric conditions, the pressure drop at startup, for either an inlet or discharge separator-silencer, is calculated from the following equation:

$$\triangle P = \frac{c}{477}\left(\frac{ACFM}{p^2}\right)^2$$

$$= c\left(\frac{V}{4005}\right)^2$$

ACFM = inlet volume flow rate
c = separator-silencer DP coefficient (see Table 3)
$\triangle P$ = pressure drop in inches of water
p = separator-silencer size (nozzle diameter) in inches
V = velocity in ft/min

If the startup pressure drop is too great, use the flow given for a lower relative vacuum, or calculate a separator-silencer size from this equation:

$$p = 0.214\sqrt{ACFM}\sqrt{\frac{c}{\triangle P}}$$

c = separator-silencer DP coefficient
$\triangle P$ = desired pressure drop in inches of water
p = separator-silencer size (nozzle diameter) in inches

1 Maximum Capacity (Inlet ACFM) for Full Liquid Separation Efficiency at Operating Vacuum

Nominal Size	Operating Vacuum, Inches of Hg						
	0*	5	10	15	18	20	25**
1	30	36	45	60	75	90	98
1.5	70	81	101	135	169	204	221
2	120	144	180	241	301	362	393
2.5	190	225	282	376	471	565	614
3	270	324	406	541	678	814	884
3.5	370	441	552	737	922	1,110	1,200
4	480	576	721	963	1,200	1,450	1,570
5	750	900	1,130	1,500	1,880	2,260	2,450
6	1,080	1,300	1,620	2,170	2,710	3,260	3,530
8	1,920	2,310	2,880	3,850	4,820	5,790	6,280
10	3,000	3,600	4,510	6,020	7,530	9,050	9,800
12	4,300	5,190	6,490	8,660	10,800	13,000	14,100
14	5,900	7,060	8,830	11,800	14,800	17,700	19,200
16	7,700	9,220	11,500	15,400	19,300	23,200	25,100
18	9,700	11,670	14,600	19,500	24,400	29,300	31,800
20	12,000	14,410	18,000	24,100	30,100	36,200	39,300
22	14,500	17,430	21,800	29,100	36,400	43,800	47,500
24	17,300	20,750	26,000	34,700	43,400	52,100	56,500
26	20,300	24,350	30,500	40,700	50,900	61,200	66,400
28	23,500	28,240	35,300	47,200	59,000	70,900	77,000
30	27,000	32,420	40,600	54,100	67,800	81,400	88,400

* This column is used for inlet separator-silencers and discharge separator-silencers with no liquid bypass during startup.
** Capacity at operating vacuum greater than 20" Hg is limited by startup conditions.

2 Maximum Liquid Flow in GPM for Various Drain Sizes*

Drain Size (O)	Models UWVS, UWSI, RWVS, RWSI	Models UVCS, UVRS RVCS, RVRS
1	15	10
1.5	30	20
2	50	35
2.5	75	60
3	120	100
3.5	150	125
4	200	160
5	300	260
6	450	400
8	800	650
10	1,200	1,000

* Values are based on gravity drain and may be larger with a positive drainage system.

3 Pressure Drop Coefficients and Separation Efficiency

Model	Pressure Drop Coefficient (C)	Separation Efficiency
RWVS/UWVS	4.0	99%
RWSI/UWSI	3.0	90%
RVCS/UVCS	4.0	99%
RVRS/UVRS	4.5	>99%

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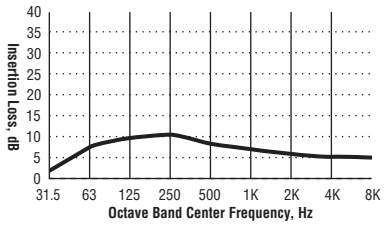
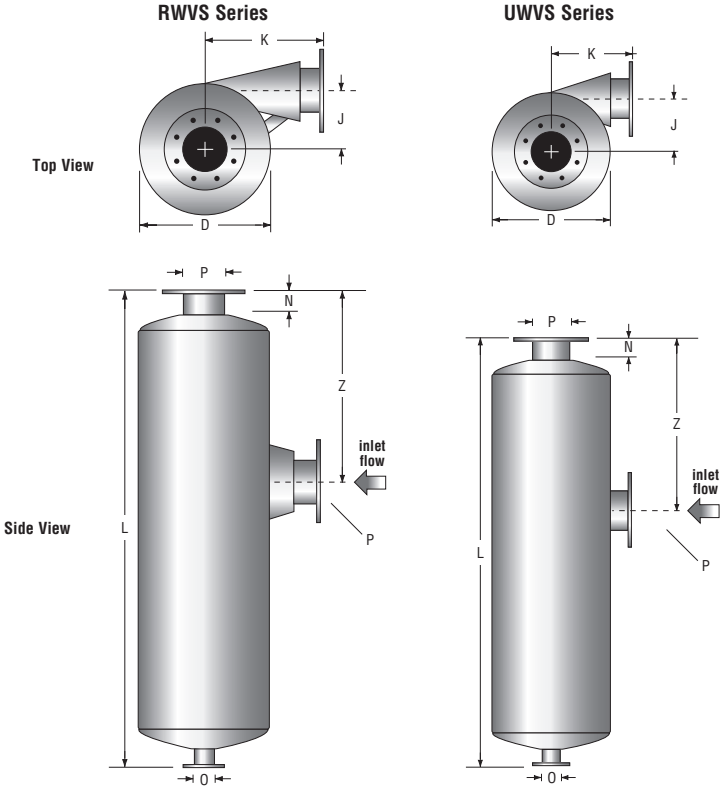
RWVS/UWVS Series

Inlet Liquid Separator-Silencers

Typical Insertion Loss



The RWVS and low profile UWVS inlet liquid separator-silencers provide corrosion protection for vacuum pumps by removing most of the process liquid before it enters the vacuum pump. These separators are best suited for full vacuum conditions under critical applications which require inlet silencing. Exterior surfaces receive a shop coat of rust inhibitive primer.



Model RWVS-	RWVS Part Number 6R-#-AA	Model UWVS-	UWVS Part Number 6U-#-AA	P (nom.)	O (nom.)	N	L	K	K UWVS	Z	J	D	Weight	Rated Capacity* Max. ACFM at Vacuum (Blower Inlet)	Rated Capacity* Liquid GPM**
4	104	4	104	4	2	3	52	13.5	9	19.5	5.625	12.75	76	530	35
5	105	5	105	5	2.5	3	58	14.5	11	23.5	7.125	16	144	830	55
6	106	6	106	6	3	3	66	18	12	30	8	18	189	1,200	80
8	108	8	108	8	3.5	3.5	78	21.5	14	36	9.75	22	355	2,100	150
10	110	10	110	10	4	3.5	85	26	15	37	10.5	24	442	3,300	200
12	112	12	112	12	5	3.5	97	31.5	18	45	13.25	30	630	4,700	300
14	114	14	114	14	6	3.5	105	36.5	21	47	16	36	1,029	6,000	400
16	116	16	116	16	6	3.5	114	41.5	24	50	18.563	42	1,401	7,800	500
18	118	18	118	18	8	3.5	135	47	24	68	18.438	42	1,645	10,000	600
20	120	20	120	20	8	3.5	138	52	27	66	21.125	48	2,925	12,000	800
22	122	22	122	22	10	4.5	149	57	30	70	23.875	54	2,384	15,000	1,000
24	124	24	124	24	10	4.5	158	62	33	74	26.625	60	3,502	18,000	1,200

* Capacities for larger sizes available on request.

** If maximum gas flow is not exceeded for a given separator size, liquid GPM may exceed nominal capacity shown, up to the capacity of the next larger separator.

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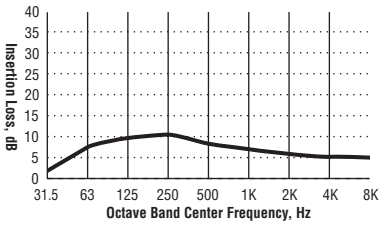
The RWSI and low profile UWSI inlet liquid separator-silencers provide corrosion protection for vacuum pumps by removing most of the process liquid before it enters the vacuum pump. These separators are best suited for full vacuum conditions under critical applications, which require inlet silencing. The RWSI models have a unique profile and larger pipe sizes than the RWVS series. Exterior surfaces receive a shop coat of rust inhibitive primer.

Typical Insertion Loss

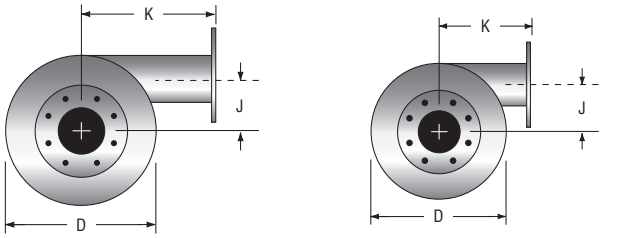


RWSI/UWSI Series

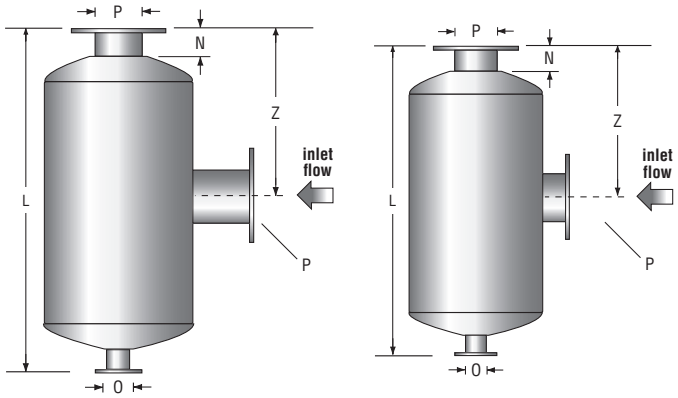
Inlet Liquid Separator-Silencers

RWSI Series **UWSI Series**

Top View



Side View



Model RWSI-	RWSI Part Number 6R-#-AA	Model UWSI-	UWSI Part Number 6U-#-AA	P (nom.)	D	N	L	K	K UWSI	Z	J	O (nom.)	Weight	Rated Capacity* Max. ACFM at Vacuum (Blower Inlet)	Rated Capacity* Liquid GPM**
4	204	4	204	4	12	3	26	11	9	15	3.75	2	40	530	35
5	205	5	205	5	16	3	31	14.25	11	18	5.188	2.5	82	830	55
6	206	6	206	6	18	3	36	15.5	12	21	5.688	3	108	1,200	80
8	208	8	208	8	22	3.5	46	18	14	27	6.688	3.5	202	2,100	150
10	210	10	210	10	24	3.5	58	23	15	34	6.625	4	276	3,300	200
12	212	12	212	12	30	3.5	68	25.5	18	40	8.625	5	403	4,700	300
14	214	14	214	14	36	3.5	78	28	21	46	11	6	708	6,000	400
16	216	16	216	16	42	3.5	88	28	24	52	13	6	950	7,800	500
18	218	18	218	18	42	3.5	98	30.5	24	58	12	8	1,050	10,000	600
20	220	20	220	20	48	4.5	108	33	27	64	14	8	1,308	12,000	800
22	222	22	222	22	54	4.5	120	35	30	71	16	8	1,619	15,000	1,000
24	224	24	224	24	60	4.5	130	38	33	77	18	10	2,481	18,000	1,200
26	226	26	226	26	66	4.5	140	40.5	36	83	20	10	2,986	21,000	1,400
28	228	28	228	28	72	4.5	150	43	39	89	22	10	3,554	24,000	1,600
30	230	30	230	30	78	4.5	160	45.5	42	95	24	10	4,959	28,000	1,800

* Capacities for larger sizes available on request.

** If maximum gas flow is not exceeded for a given separator size, liquid GPM may exceed nominal capacity shown, up to the capacity of the next larger separator.

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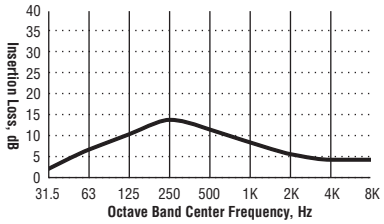
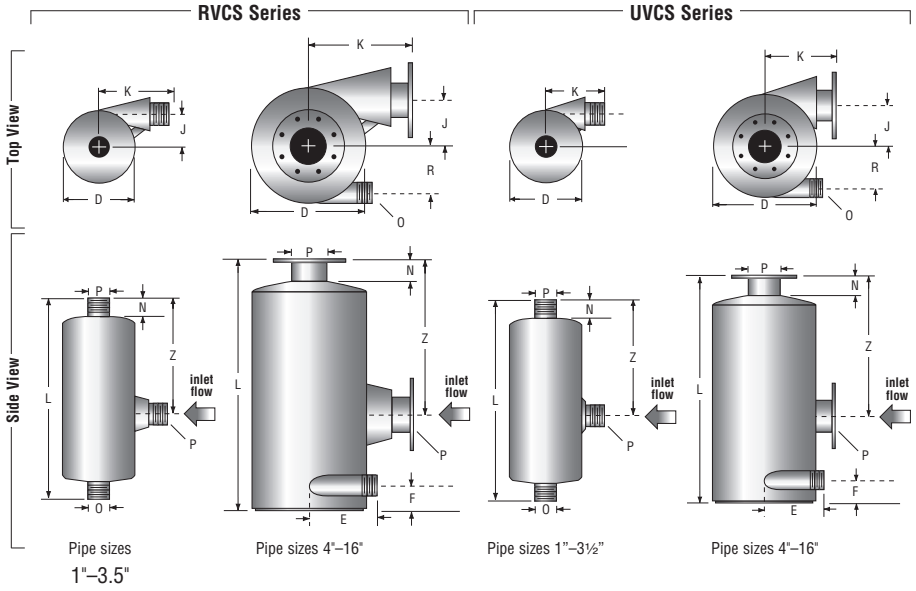
RVCS/UVCS Series

Discharge Liquid Separator-Silencers

Typical Insertion Loss



The RVCS and low profile UVCS models provide high performance liquid separation and noise attenuation. When an inlet separator is not installed, the discharge separator may need to be oversized. Exterior surfaces receive a shop coat of rust inhibitive primer.



Model RVCS-	Part Number 6R-#-AA	Model UVCS-	Part Number 6U-#-AA	P (nom.)	D	N	L	K	Low Profile K	E	F	Z	R	J	O (nom.)	Weight
1	301	1	301	1	4.5	2	14	6	5.25	—	—	8.75	—	2.094	1	4
1.25	317	1.25	317	1.25	4.5	2	14	6	5.25	—	—	8	—	2.063	1	5
1.5	315	1.5	315	1.5	6	2	17	7	6	—	—	10	—	2.75	1.5	10
2	302	2	302	2	8	3	22	9	7	—	—	13	—	3.688	2	15
2.5	325	2.5	325	2.5	10	3	24	10	8	—	—	14	—	4.625	2	20
3	303	3	303	3	10	3	27	11	8	—	—	16	—	4.563	2.5	25
3.5	335	3.5	335	3.5	12	3	30	12	9	—	—	18	—	5.5	2.5	35
4	304	4	304	4	12	3	29	13.5	9	8	3	18.5	4.25	5.438	3	50
5	305	5	305	5	16	3	35	14.5	11	9	3.5	21.5	6.25	7.313	3	95
6	306	6	306	6	18	3	42	18	12	10	3.5	27	7.25	8.188	3	130
8	308	8	308	8	22	3.5	52	21.5	14	12	4	32	9.25	9.938	3	240
10	310	10	310	10	24	3.5	56	26	15	14	4.5	32	10.25	10.688	3	300
12	312	12	312	12	30	3.5	69	31.5	18	16	5	40.5	12.75	13.438	4	445
14	314	14	314	14	36	3.5	75	36.5	21	16	5	43	15.75	16.25	4	620
16	316	16	316	16	42	3.5	88	41.5	24	19	6.5	52	18.75	18.875	4	1,035

All models use a pipe thread connection (MNPT) for the liquid outlet (O).
Sizes **1"–3.5"** are standard with male pipe thread connection (MNPT).
Sizes **4"–16"** are standard with 150# ANSI drilled plate flanges.

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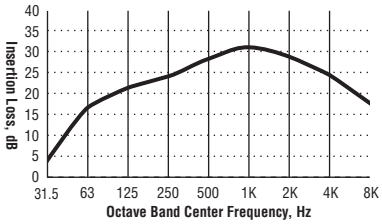
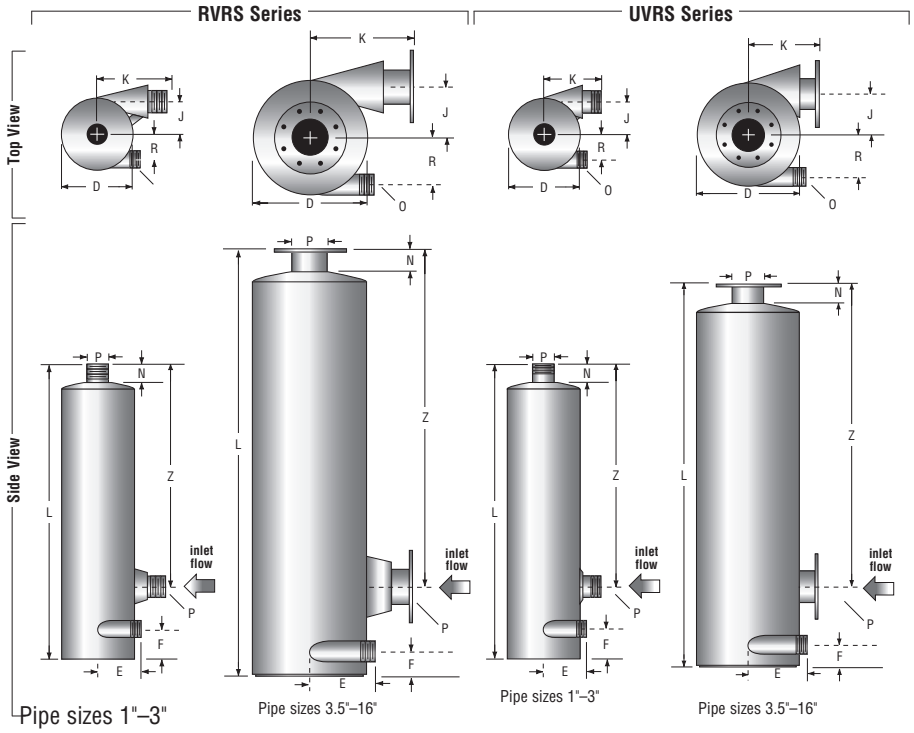
Typical Insertion Loss



The RVRS and low profile UVRS models offer better attenuation than the RVCS and UVCS models. For pipe sizes 1"–3", the RVRS has a side liquid outlet, while the RVCS has a vertical liquid outlet. Exterior surfaces receive a shop coat of rust inhibitive primer.

RVRS/UVRS Series

Discharge Liquid Separator-Silencers



Model RVRS-	Part Number 6R-#-AA	Model UVRS-	Part Number 6U-#-AA	P (nom.)	D	N	L	K	Low Profile K	E	F	Z	R	J	O (nom.)	Weight
1	401	1	401	1	4.5	2	20.75	6	5.25	3.5	1.25	15.5	1.594	2.063	1	10
1.25	417	1.25	417	1.25	4.5	2	20.75	6	5.25	3.5	1.25	14.75	1.594	2.063	1	10
1.5	415	1.5	415	1.5	6	2	25	7	6	4	1.75	19	2.047	2.75	1.5	15
2	402	2	402	2	8	2	32.875	9	7	5	2	25	2.813	3.688	2	30
2.5	425	2.5	425	2.5	10	3	35.5	10	8	6	3	26	3.813	4.625	2	40
3	403	3	403	3	10	3	41	11	8	6	3	31	3.563	4.563	2.5	45
3.5	435	3.5	435	3.5	12	3	44.375	13	9	7	3	33	4.563	5.5	2.5	55
4	404	4	404	4	12	3	47	13.5	9	8	3	36.5	4.25	5.438	3	70
5	405	5	405	5	16	3	59.5	14.5	11	9	3.5	47	6.25	7.313	3	140
6	406	6	406	6	18	3	71.75	18	12	10	3.5	57	7.25	8.188	3	244
8	408	8	408	8	22	3.5	90.25	21.5	14	12	4	71	9.25	9.938	3	355
10	410	10	410	10	24	3.5	103.25	26	15	14	4.5	80	10.25	10.688	3	460
12	412	12	412	12	30	3.5	128.5	31.5	18	16	5	101	12.75	13.875	4	1,092
14	414	14	414	14	36	3.5	141.25	36.5	21	16	5	109.25	15.75	16.25	4	1,678
16	416	16	416	16	42	3.5	154.25	41.5	24	19	6.5	118.25	18.75	18.875	4	2,212

All models use a pipe thread connection (MNPT) for the liquid outlet (O).
Sizes **1"–3.5"** are standard with male pipe thread connection (MNPT).
Sizes **4"–16"** are standard with 150# ANSI drilled plate flanges.

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