Air Flow Through an Orifice

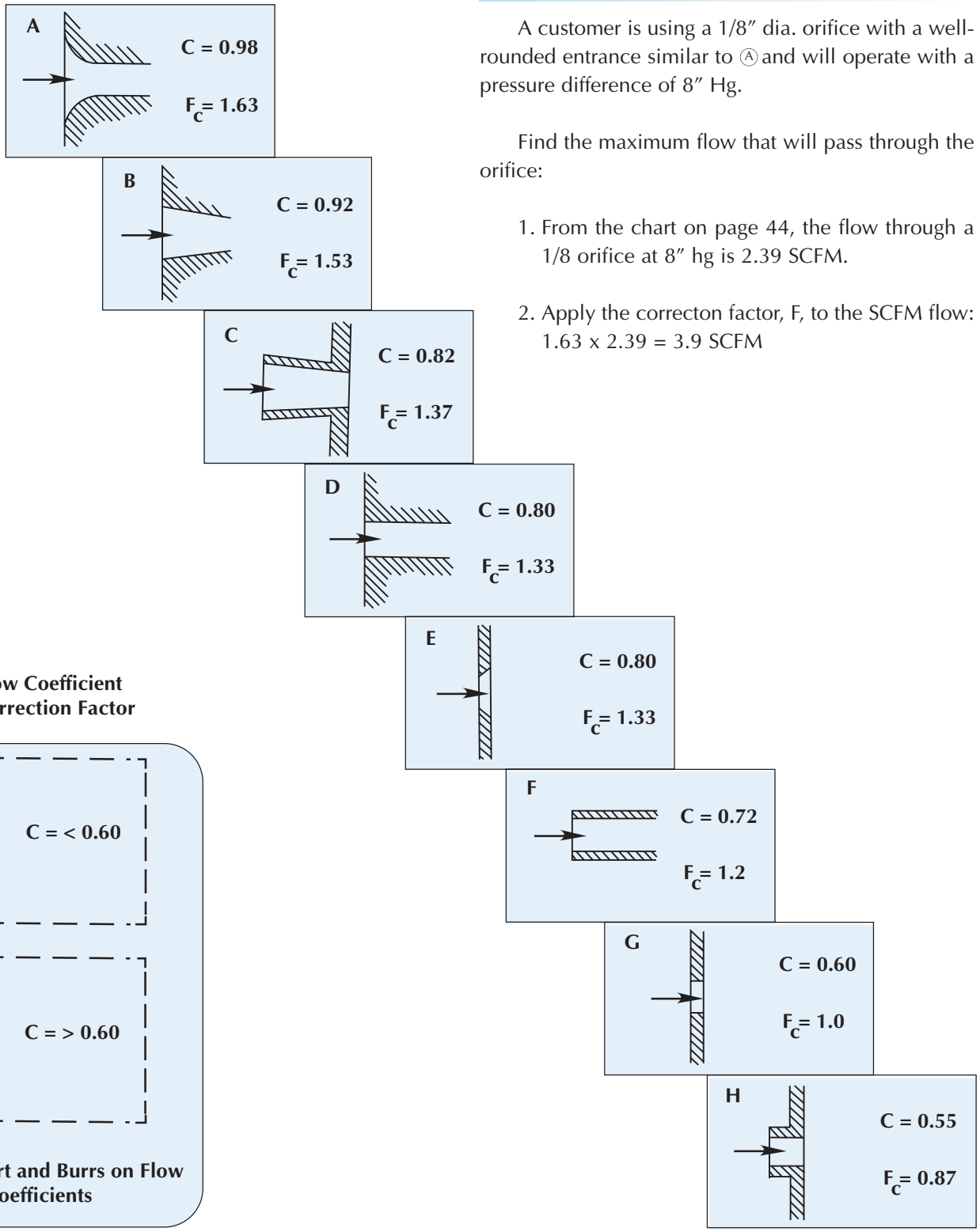
Since many applications involve air flow through an orifice, the following table may be used to determine the amount of SCFM that passes through orifices at specific pressure differences.

Blower Selection Chart

Orifice Size	Area ($in.^2$)	Pressure Difference (inches Hg)												
		0.1	0.2	0.5	1	2	3	4	5	6	7	8	9	10
3/64	.0017	0.039	0.059	0.088	0.115	0.181	0.22	0.246	0.27	0.291	0.312	0.329	0.344	0.352
1/16	.003	0.07	0.10	0.154	0.212	0.321	0.386	0.439	0.483	0.523	0.559	0.591	0.615	0.633
3/32	.007	0.15	0.215	0.335	0.483	0.718	0.881	1.013	1.116	1.199	1.263	1.326	1.377	1.411
1/8	.012	0.28	0.42	0.62	0.87	1.32	1.60	1.84	2.04	2.18	2.3	2.39	2.48	2.55
5/32	.019	0.44	0.65	0.99	1.35	2	2.47	2.81	3.1	3.31	3.5	3.66	3.81	3.93
3/16	.028	0.6	0.9	1.35	1.88	2.85	3.51	3.98	4.37	4.68	4.94	5.16	5.35	5.56
7/32	.038	.843	1.25	1.89	2.62	3.73	4.59	5.28	5.87	6.31	6.66	7	7.27	7.52
1/4	.049	1.09	1.62	2.44	3.38	4.76	5.89	6.8	7.54	8.15	8.66	9.05	9.40	9.72
9/32	.062	1.35	2.02	3.04	4.16	5.97	7.29	8.32	9.24	10	10.72	11.2	11.74	12.11
5/16	.077	1.64	2.44	3.68	5.12	7.28	8.73	9.96	11.07	11.99	12.79	13.48	14.05	14.64
3/8	.11	2.34	3.48	5.25	6.86	10.17	12.59	14.46	16.07	17.26	18.30	19.19	20.2	20.9
7/16	.15	3.22	4.79	7.23	9.95	14.55	17.54	19.92	22.1	23.8	25.3	26.7	27.7	28.8
1/2	.196	4.21	6.26	9.45	13.04	19.03	23.3	26.4	28.9	30.9	32.8	34.6	36.2	37.6
9/16	.249	5.46	8.11	12.25	17.59	25.0	30.3	34.4	37.7	40.5	43.1	45.2	47.1	48.7
5/8	.307	7.28	10.82	16.33	22.6	31.8	39.4	45.5	50.4	54.5	57.9	60.5	62.9	65
11/16	.371	9.076	13.48	20.4	28.2	39.7	49.1	56.7	62.8	67.9	72.1	75.4	78.4	81
3/4	.442	10.36	15.4	23.2	32.2	45.3	56.1	64.7	71.7	77.6	82.4	86.1	89.5	92.5
13/16	.518	12.33	18.31	27.6	38.3	53.9	66.7	76.9	85.3	92.3	98	102.4	106.4	110
7/8	.601	14.45	21.5	32.4	44.9	63.2	78.2	90.2	100	108.2	114.9	120.1	124.8	129
15/16	.69	16.14	24	36.2	50.1	70.5	87.3	100.7	111.7	120.8	128.2	134	139.3	144
1	.785	19.27	28.6	43.2	59.9	84.2	104.3	120.3	133.4	144.3	153.2	160.1	166.4	172
1 1/4	1.23	30.3	44.9	67.9	94	132.2	163.7	188.9	209	227	240	251	261	270
1 1/2	1.77	44.8	66.6	100.5	139.2	195.8	242	280	310	336	356	372	387	400
1 3/4	2.41	60.5	89.9	135.7	187.9	264	327	378	419	453	481	502	522	540
2	3.14	81.8	121.5	183.4	254	357	443	511	566	612	650	679	706	730
2 1/4	3.98	100.8	150	226	313	441	546	630	698	755	802	838	871	900
2 1/2	4.91	123.3	183.1	276	382	538	667	769	853	923	980	1024	1064	1110
2 3/4	5.94	149	221	334	462	651	806	930.5	1031	1115	1184	1238	1287	1330
3	7.07	175.4	260	393	545	766	949	1095	1214	1313	1394	1457	1514	1565

SCFM with orifice flow coefficient = 0.60

Flow Coefficients For Orifices



C = Flow Coefficient
F_c= Correction Factor

Effect of Dirt and Burrs on Flow Coefficients

Example 1

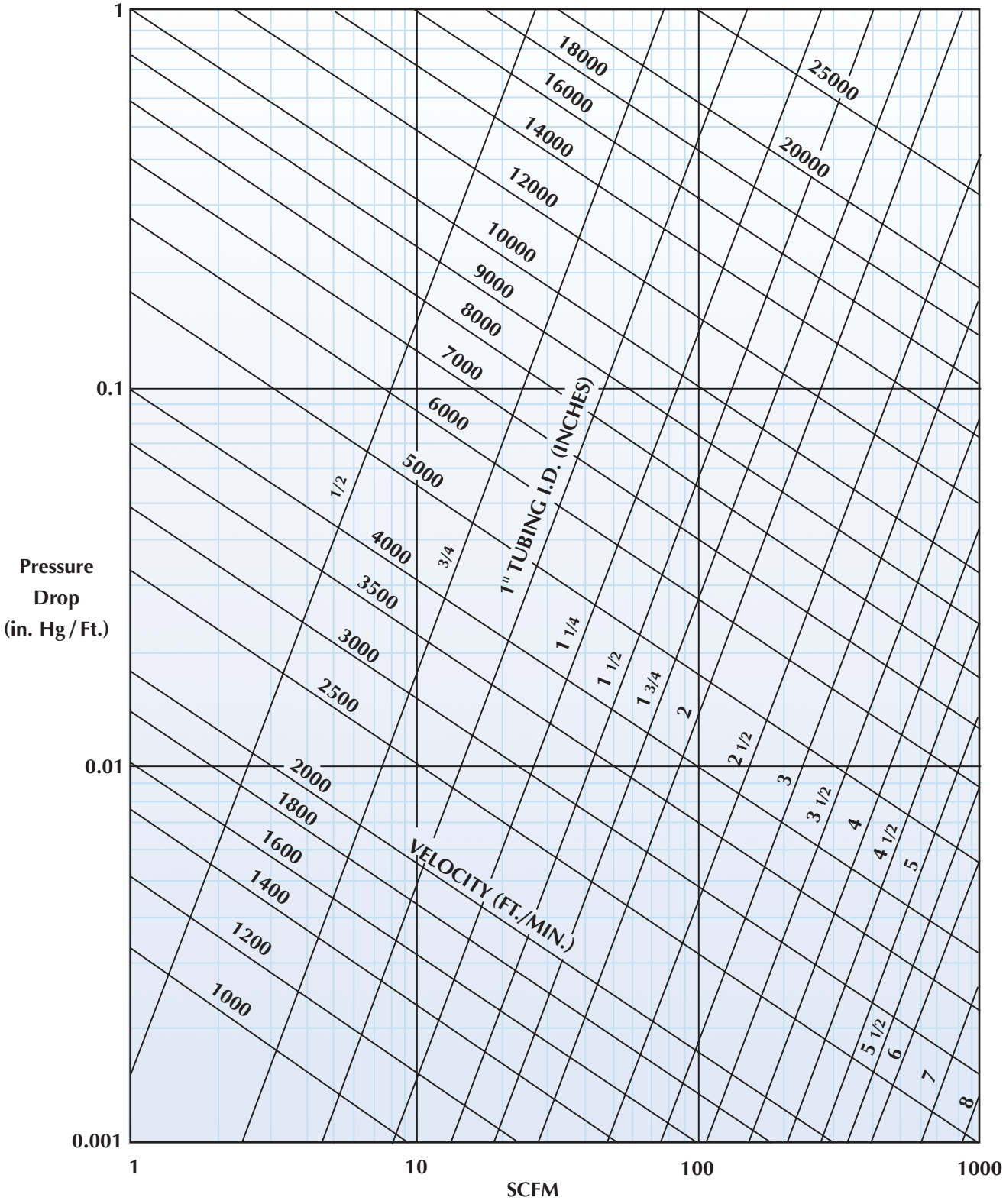
A customer is using a 1/8″ dia. orifice with a well-rounded entrance similar to Ⓐ and will operate with a pressure difference of 8″ Hg.

Find the maximum flow that will pass through the orifice:

1. From the chart on page 44, the flow through a 1/8 orifice at 8″ hg is 2.39 SCFM.

2. Apply the correcton factor, F, to the SCFM flow: 1.63 x 2.39 = 3.9 SCFM

Pressure Drop of Air per Foot of Tubing



Read **up** from SCFM to the lines indicating tubing size, then **left** to read pressure drop.

Altitude -vs- Barometric Pressure

Altitude (Feet)	Barometric Pressure (in. Hg)	Altitude (Feet)	Barometric Pressure (in. Hg)	Altitude (Feet)	Barometric Pressure (in. Hg)
0	29.92	1800	28.02	4200	25.65
100	29.81	1900	27.92	4400	25.46
200	29.70	2000	27.82	4600	25.27
300	29.60	2100	27.72	4800	25.08
400	29.49	2200	27.62	5000	24.90
500	29.38	2300	27.52	5200	24.71
600	29.28	2400	27.42	5400	24.52
700	29.17	2500	27.32	5600	24.34
800	29.07	2600	27.21	5800	24.16
900	28.96	2700	27.11	6000	23.98
1000	28.86	2800	27.01	6500	23.53
1100	28.75	2900	26.91	7000	23.09
1200	28.65	3000	26.82	7500	22.65
1300	28.54	3200	26.62	8000	22.22
1400	28.44	3400	26.42	8500	21.80
1500	28.33	3600	26.23	9000	21.39
1600	28.23	3800	26.03	9500	20.98
1700	28.13	4000	25.84	10000	20.58

A blower is required to produce 100 SCFM at 3.5 PSI (97″ H_2O) at an altitude of 4000 feet. At sea level the correct blower would be a VFC704A. Which is the correct blower at the 4000 foot altitude?

Determine the equivalent sea level pressure:

$$PSI_{SL} = P_O \times \frac{29.92}{P_B}$$

Where PSI_{SL} = Sea level reference pressure (PSI)
P_O = Operating pressure at altitude (PSI)
P_B = Barometric pressure at altitude (in.Hg)

$$PSI_{SL} = 3.5 \times \frac{29.92}{25.84} = 4.05 \text{ PSI } (112″ H_20)$$

Determine the flow required at altitude:

$$Q_{SL} = Q_O \times \frac{29.92}{P_B}$$

Where Q_{SL} = Sea level airflow (SCFM)
Q_O = Airflow at altitude (SCFM)
P_B = Barometric pressure at altitude (in.Hg)

$$Q_{SL} = 100 \times \frac{29.92}{25.84} = 115.8 \text{ SCFM}$$

At 112″ H_2O, the VFC704A blower only produces about 40 SCFM and would operate in the intermittent operation region of the performance curve. Checking the VFC804A blower performance data on page 25, it produces about 210 SCFM at 112″ H_2O–more than the required airflow of 115.8 SCFM–and can operate continuously. The correct blower, therefore, is a model **VFC804A.**

Temperature Conversion Chart

°F = 9/5 (°C+32)
°C = 5/9 (°F-32)
Rankin (R) = °F+460
Kelvin (K) = °C+273

°C	TEMP.	°F	°C	TEMP.	°F	°C	TEMP.	°F
-34.4	-30	-22	15.6	60	140.0	110	230	446
-28.9	-20	-4	16.7	62	143.6	116	240	464
-23.3	-10	14	17.8	64	147.2	121	250	482
-17.8	0	32	18.9	66	150.8	127	260	500
-16.7	2	35.6	20.0	68	154.4	132	270	518
-15.6	4	39.2	21.1	70	158.0	138	280	536
-14.4	6	42.8	22.2	72	161.6	143	290	554
-13.3	8	46.4	23.3	74	165.2	149	300	572
-12.2	10	50.0	24.4	76	168.8	154	310	590
-11.1	12	53.6	25.6	78	172.4	160	320	608
-10.0	14	57.2	26.7	80	176.0	166	330	626
-8.9	16	60.8	27.8	82	179.6	171	340	644
-7.8	18	64.4	28.9	84	183.2	177	350	662
-6.7	20	68.0	30.0	86	186.8	182	360	680
-5.6	22	71.6	31.1	88	190.4	188	370	698
-4.4	24	75.2	32.2	90	194.0	193	380	716
-3.3	26	78.8	33.3	92	197.6	199	390	734
-2.2	28	82.4	34.4	94	201.2	204	400	752
-1.1	30	86.0	35.6	96	204.8	210	410	770
0	32	89.6	36.7	98	208.4	216	420	788
1.1	34	93.2	37.8	100	212.0	221	430	806
2.2	36	96.8	43	110	230	227	440	824
3.3	38	100.4	49	120	248	232	450	842
4.4	40	104.0	54	130	266	238	460	860
5.6	42	107.6	60	140	284	243	470	878
6.7	44	111.2	66	150	302	249	480	896
7.8	46	114.8	71	160	320	254	490	914
8.9	48	118.4	77	170	338	260	500	932
10.0	50	122.0	82	180	356	266	510	950
11.1	52	125.6	88	190	374	271	520	968
12.2	54	129.2	93	200	392	277	530	986
13.3	56	132.8	99	210	410	282	540	1004
14.4	58	136.4	104	220	428	288	550	1022

Conversion Charts

PRESSURE CONVERSION					
PSI	In. H_2O	In. Hg	mm H_2O	mm Hg	ATM
1	27.73	2.306	704.49	51.71	0.06804
0.03605	1	0.0734	25.4	1.8627	0.00245
0.49116	13.623	1	346.02	25.4	0.03342
0.00142	0.03937	0.00289	1	0.07341	0.0000966
0.01934	0.53632	0.03937	13.623	1	0.001316
14.696	407.61	29.921	10353	760	1

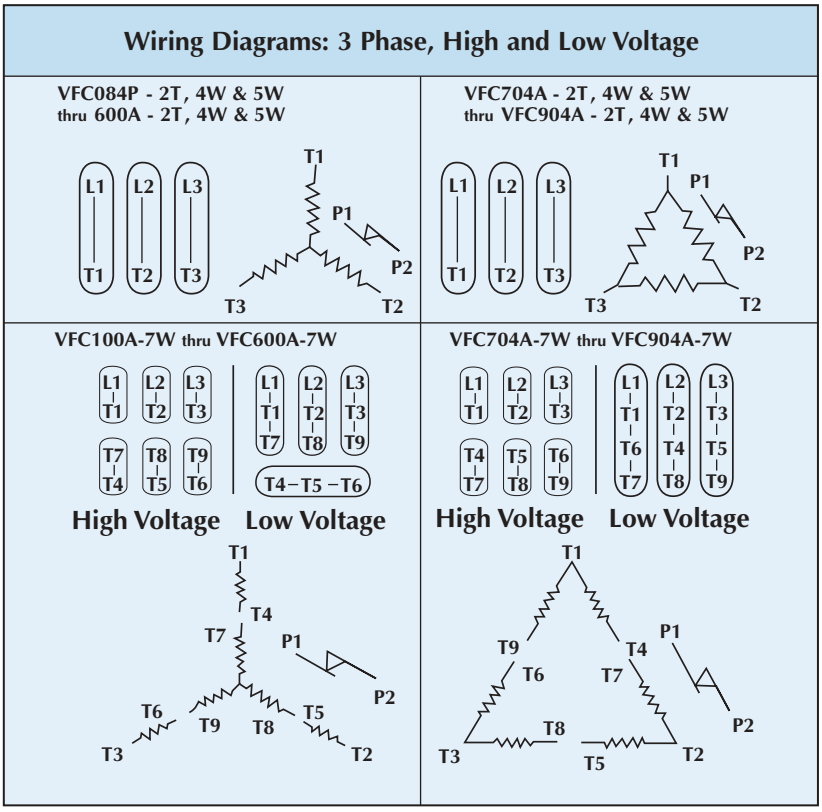
FLOW CONVERSION			
CFM	L / SEC.	M^3/MIN.	M^3/ HR.
1	0.47195	0.02832	1.6990
2.1189	1	0.06	3.6
35.314	16.666	1	60
0.58861	0.27778	0.01667	1

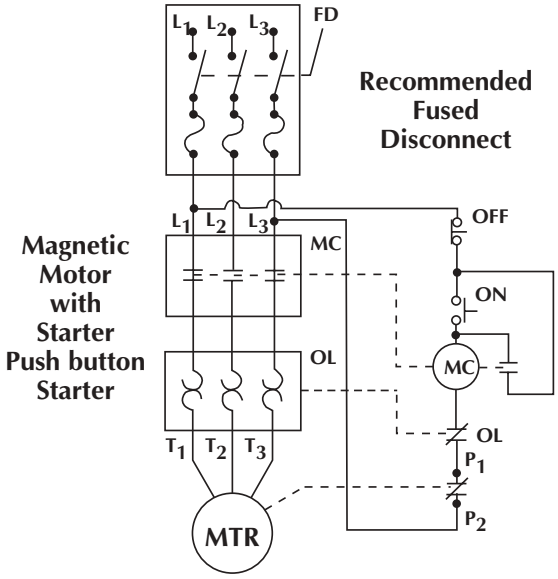
VELOCITY				
FT. / SEC.	FT. / MIN.	CM. / SEC.	METER / SEC.	METER. / MIN.
1	60	30.48	0.3048	18.29
0.01667	1	0.5080	0.005080	0.3048
0.03281	1.9685	1	0.01	0.600
3.281	196.85	100	1	60
0.0547	3.281	1.667	0.0167	1

LENGTH				
FEET	INCHES	METERS	CENTIMETERS	MILLIMETERS
1	12	0.3048	30.48	304.8
0.0833	1	0.0254	2.54	25.4
3.281	39.37	1	100	1000
0.03281	0.3937	0.01	1	10
0.003281	0.03937	0.001	0.1	1

Instructions: Read down from the known factor to "1", then across to the desired conversion factor.
Example: Pressure – 1 in. H2O = 0.0734 in. Hg.

3 Phase Wiring Diagrams





Motor Control Wiring Diagram for all 3 Phase Models for Maximum Protection

Automatic Thermal Protection

In models VFC063P, VFC084P, VFC100P, VFC200P, and VFC300P the thermal protector is in direct line with the power to the motor windings. If a thermal overload occurs, the thermal switch opens at 135° ± 5°C (275° ± 9°F). Power is interrupted to the motor winding; power will be restored when the thermal switch measures 88° ± 15°C (190° ± 27°F). The motor will resume full speed.

Pilot Duty Thermal Protection

In models VFC400P and VFC504P, VFC100A – VFC600, VFC084A – VFC904A, the thermal switch must be put in series with the magnetic starter coil (low current circuit). The thermal switch opens at 135° ± 5°C (275° ± 9°F) and closes at 88° ± 15°C (190° ± 27°F). Magnetic contactors and magnetic starters must be reset manually in most cases. Some electrical circuits may vary. Please contact system electrical drawings or a qualified electrician to trouble shoot the circuit.

Operating Limits

60 Hz Operation

Model	TEMPERATURE		PRESSURE		VACUUM	
	Maximum Outlet Temperature**		Maximum Time at Dead-head (Seconds)①	Minimum Airflow (SCFM)	Maximum Time at Dead-head (Seconds)①	Minimum Airflow (SCFM)
	°C	°F				
VFC063P	70	158	Cont.	0	Cont.	0
VFC084P/A	70	158	Cont.	0	Cont.	0
VFC100P/A	80	176	600	3.5	600	3.5
VFC200P/A	80	176	240	3.5	240	3.5
VFC300P/A	70	158	120	17*	120	16*
VFC400P/A	105	223	120	3.5*	120	3.2*
VFC504P/500A	80/95	176/205	60	45*	60	40*
VFC600A	110	230	60	56*	60	50*
VFC704A	115	241	30	88*	30	70*
VFC804A	115	241	30	135*	30	106*
VFC904A	130	266	30	195*	30	140*

50 Hz Operation

Model	TEMPERATURE		PRESSURE		VACUUM	
	Maximum Outlet Temperature**		Maximum Time at Dead-head (Seconds)①	Minimum Airflow (SCFM)	Maximum Time at Dead-head (Seconds)	Minimum Airflow (SCFM)①
	°C	°F				
VFC063P	70	140	Cont.	0	Cont.	0
VFC084P/A	70	140	Cont.	0	Cont.	0
VFC100P/A	75	169	600	1.75	600	1.7
VFC200P/A	75	169	240	3.5	240	3.5
VFC300P/A	65	151	120	10*	120	9*
VFC400P/A	95	208	120	3.5*	120	3.2*
VFC504P/500A	75/80	169/176	60	25*	60	23*
VFC600A	100	212	60	28*	60	24*
VFC704A	100	212	30	63*	30	62*
VFC804A	115	241	30	88*	30	87*
VFC904A	125	259	30	140*	30	139*

* Use of pressure or vacuum relief valves are recommended. See page 33.

**Max. outlet temp. = max. temp rise + 40°C (104°F) ambient temp.

① Maximum time (seconds) at dead-head starting at ambient temperature.