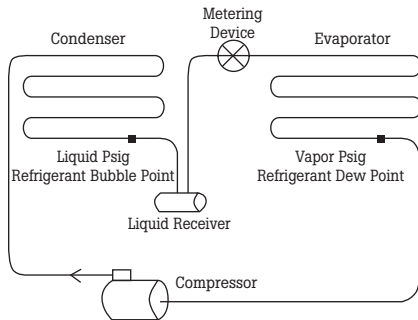


Pressure - Temperature Chart

All pressures shown are in PSIG; Red print = Vacuum (inches of Mercury)

°F	12	22	502	134a	401A (MP39) VAP LIQ DP BP	401B (MP66) VAP LIQ DP BP	402A (HP80) VAP LIQ DP BP	404A (HP62) (FX70)	408A (FX10)	409A (FX56) VAP LIQ DP BP	410A (AZ20)
-40	11.0	0.5	4.1	14.5	14.3	12.8	5.6	4.6	2.8	13.1	11.6
-38	10.0	1.3	5.0	13.7	13.4	11.8	6.7	5.6	3.7	12.1	12.9
-36	8.9	2.2	6.0	12.8	12.4	10.7	7.8	6.6	4.6	11.1	14.2
-34	7.8	3.0	7.0	11.8	11.4	9.6	8.9	7.7	5.6	10.1	15.6
-32	6.7	4.0	8.1	10.8	10.3	8.5	10.0	8.8	6.6	9.1	17.0
-30	5.5	4.9	9.2	9.7	9.2	7.3	11.3	9.9	7.6	8.1	18.5
-28	4.3	5.9	10.3	8.6	8.1	6.0	12.5	11.1	8.7	6.9	20.1
-26	3.0	6.9	11.5	7.7	6.9	4.7	13.8	12.4	9.8	5.6	21.7
-24	1.6	7.9	12.7	6.2	5.6	3.3	15.2	13.3	11.0	4.4	23.4
-22	0.3	9.0	14.0	4.9	4.3	1.9	16.6	15.0	12.2	3.1	25.1
-20	0.6	10.1	15.3	3.6	2.9	0.4	18.0	16.4	13.4	1.9	26.9
-18	1.3	11.3	16.7	2.3	1.5	0.6	19.5	17.8	14.7	1.0	28.9
-16	2.1	12.5	18.1	0.8	0.0	1.3	21.1	19.3	16.1	0.0	30.1
-14	2.8	13.8	19.5	0.3	0.8	2.2	22.7	20.8	17.5	1.0	32.8
-12	3.7	15.1	21.0	1.1	1.6	3.0	24.4	22.4	18.9	1.9	34.8
-10	4.5	16.5	22.6	1.9	2.4	3.9	26.1	24.0	20.4	2.8	36.8
-8	5.4	17.9	24.2	2.8	3.2	4.8	27.9	25.7	22.0	3.7	39.1
-6	6.3	19.3	25.8	3.6	4.1	5.8	29.7	27.4	23.6	4.6	41.4
-4	7.2	20.8	27.5	4.5	5.0	6.8	31.6	29.2	25.2	5.4	43.8
-2	8.2	22.4	29.3	5.5	6.0	7.8	33.5	31.1	26.9	6.3	46.2
0	9.2	24.0	31.1	6.5	7.0	8.9	35.6	33.0	28.7	7.2	48.6
2	10.2	25.6	32.9	7.5	8.0	10.0	37.6	35.0	30.5	8.3	51.2
4	11.2	27.3	34.9	8.5	9.1	11.1	39.8	37.0	32.3	9.3	53.9
6	12.3	29.1	36.9	9.6	10.2	12.3	42.0	39.1	34.3	10.4	56.6
8	13.5	30.9	38.9	10.8	11.3	13.5	44.3	41.3	36.3	11.4	59.5
10	14.6	32.8	41.0	12.0	12.5	14.8	46.6	43.5	38.3	12.5	62.3
12	15.8	34.7	43.2	13.1	13.7	16.1	49.0	45.8	40.4	13.7	65.4
14	17.1	36.7	45.4	14.4	15.0	17.4	51.5	48.2	42.6	15.0	68.5
16	18.4	38.7	47.7	15.7	16.3	18.8	54.0	50.6	44.9	16.2	71.6
18	19.7	40.9	50.0	17.0	17.6	20.3	56.7	53.1	47.2	17.5	75.0
20	21.0	43.0	52.5	18.4	19.0	21.8	59.4	55.7	49.5	18.7	78.3
22	22.4	45.3	54.9	19.9	20.5	23.3	62.2	58.4	52.0	20.2	81.9
24	23.9	47.6	57.5	21.4	22.0	24.9	65.0	61.1	54.5	21.6	85.5
26	25.4	49.9	60.1	22.9	23.5	26.5	68.0	63.9	57.1	23.1	89.2
28	26.9	52.4	62.8	24.5	25.1	28.2	71.0	66.8	59.8	24.5	93.0
30	28.5	54.9	65.6	26.1	26.7	30.0	74.1	69.7	62.5	26.0	96.8
32	30.1	57.5	68.4	27.8	28.4	31.8	77.3	72.8	65.3	27.7	100.9
34	31.7	60.1	71.3	29.5	30.1	33.6	80.5	75.9	68.2	29.4	105.0
36	33.4	62.8	74.3	31.3	31.9	35.5	83.9	79.1	71.2	31.1	109.2
38	35.2	65.6	77.4	33.2	33.7	37.5	87.3	82.4	74.2	32.8	113.6
40	36.9	68.5	80.5	35.1	35.6	39.5	90.9	85.7	77.4	34.5	118.0
42	38.8	71.5	83.8	37.0	37.6	41.6	94.5	89.2	80.6	36.5	122.8
44	40.7	74.5	87.0	39.1	39.6	43.7	98.2	92.7	83.9	38.4	127.6
46	42.7	77.6	90.4	41.1	41.7	45.9	102.0	96.4	87.3	40.4	132.4
48	44.7	80.7	93.9	43.3	43.8	48.2	106.0	100.1	90.7	42.3	137.2
50	46.7	84.0	97.4	45.5	46.0	50.5	110	104.5	95.8	44.3	142.0
52	48.8	87.3	101.0	47.7	47.0	52.3	115	109.5	99.7	46.6	147.2
54	51.0	90.8	104.8	50.1	49.0	54.7	119	113.5	103.5	48.8	152.4
56	53.2	94.3	108.6	52.3	51.5	57.3	124	117.7	107.4	51.1	158.0
58	55.4	97.9	112.4	55.0	54.0	60.0	128	121.9	111.2	53.3	164.0
60	57.7	101.6	116.4	57.5	56.0	62.5	133	126.2	115.1	55.6	170.0
62	60.1	105.4	120.4	60.1	73.8	79.2	140.7	130.7	119.4	77.5	176.0
64	62.5	109.3	124.6	62.7	76.7	82.3	145.4	135.2	123.8	80.5	182.0
66	65.0	113.2	128.8	65.5	79.7	85.5	150.3	139.9	128.1	83.5	188.2
68	67.6	117.3	133.2	68.3	82.8	88.7	155.4	144.7	132.5	86.5	194.4
70	70.2	121.4	137.6	71.2	85.9	92.0	160.5	149.5	136.8	89.5	201.0
72	72.9	125.7	142.2	74.2	89.1	95.4	165.7	154.5	141.7	92.9	207.4
74	75.6	130.0	146.8	77.2	92.4	98.9	171.1	159.6	146.6	96.3	213.8
76	78.4	134.5	151.5	80.3	95.8	102.4	176.6	164.8	151.4	99.6	220.6
78	81.3	139.0	156.3	83.5	99.2	106.0	182.2	170.1	156.3	103.0	227.8
80	84.2	143.6	161.2	86.8	102.7	109.7	187.9	175.6	161.2	106.4	235.0
82	87.2	148.4	166.2	90.2	106.3	113.5	193.7	181.2	166.6	110.2	242.6
84	90.2	153.2	171.4	93.6	110.0	117.4	199.7	186.8	172.1	114.0	250.2
86	93.3	158.2	176.6	97.1	113.8	121.4	205.8	192.7	177.5	117.8	258.0
88	96.5	163.2	181.9	100.7	117.7	125.4	212.0	198.6	183.0	121.6	266.0
90	99.8	168.4	187.4	104.4	121.6	129.6	218.3	204.6	188.4	125.2	274.0
92	103.1	173.7	192.9	108.2	125.6	133.8	224.8	210.8	194.5	129.4	282.4
94	106.5	179.1	198.6	112.1	129.7	138.2	231.4	217.2	200.5	133.5	290.8
96	110.0	184.6	204.3	116.1	133.9	142.6	238.2	223.6	206.6	137.7	299.4
98	113.5	190.2	210.2	120.1	138.2	147.1	245.1	230.2	212.6	141.8	308.2
100	117.2	195.9	216.2	124.3	142.6	151.7	252.1	236.9	218.7	146.0	317.0
102	120.9	201.8	222.3	128.5	147.1	156.4	259.3	243.8	225.4	150.6	326.2
104	124.7	207.7	228.5	132.9	151.7	161.2	266.6	250.8	232.1	155.2	335.4
106	128.5	213.8	234.9	137.3	156.4	166.1	274.0	257.9	238.7	159.8	345.0
108	132.4	220.0	241.3	142.8	161.1	171.1	281.6	265.2	245.4	164.4	355.0
110	136.4	226.4	247.9	146.5	166.0	176.3	289.4	272.6	252.1	169.0	365.0
112	140.5	232.8	254.6	151.3	171.0	181.5	297.3	280.2	259.5	174.1	375.4
114	144.7	239.4	261.5	156.1	176.0	186.8	305.3	287.9	266.9	179.2	385.8
116	148.9	246.1	268.4	161.1	181.2	192.2	313.6	295.7	274.3	184.2	396.4
118	153.2	252.9	275.5	166.1	186.5	197.7	321.9	303.8	281.7	189.3	407.2
120	157.7	259.9	282.7	171.3	191.8	203.1	330.4	311.9	289.1	194.4	418.0
122	162.2	267.0	290.1	176.6	197.3	209.1	339.1	320.3	297.2	200.0	429.2
124	166.7	274.3	297.6	182.0	202.9	215.0	348.0	328.8	305.3	205.6	440.4
126	171.4	281.6	305.2	187.5	208.6	221.0	357.0	337.4	313.5	211.1	452.0
128	176.2	289.1	312.9	193.1	214.4	227.1	366.2	346.2	321.6	216.7	464.0
130	181.0	296.8	320.8	198.9	220.3	233.3	375.5	355.2	329.7	222.3	476.0
132	185.9	304.6	328.9	204.7	226.3	239.6	385.0	364.3	338.6	228.4	488.4
134	191.0	312.5	337.1	210.7	232.5	246.0	394.7	373.6	347.5	234.5	500.8
136	196.1	320.6	345.4	216.8	238.7	252.6	404.5	383.1	356.5	240.7	513.4
138	201.3	328.9	353.9	223.0	245.1	259.3	414.6	392.8	365.4	246.8	526.2
140	206.6	337.3	362.6	229.4	251.6	266.1	424.8	402.6	374.3	252.9	539.0

Refrigeration Cycle



Measuring superheat and subcooling using Fluke meters:

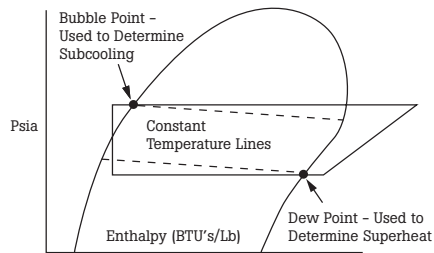
To measure superheat:

- 1) Measure suction pressure with the Fluke PV350 Pressure Module and your digital multimeter (DMM). Convert pressure to temperature using your PT chart.
- 2) Measure the pipe temperature at the outlet of the evaporator with the Fluke 80PK-8 Pipe Clamp and your temperature meter.
- 3) Subtract the difference in temperatures to obtain superheat.

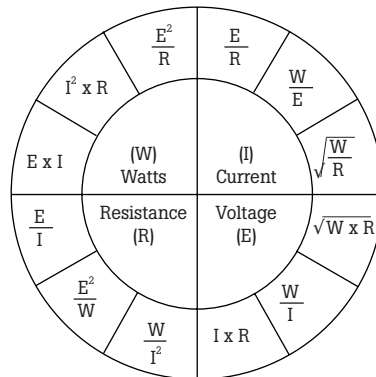
To measure subcooling:

- 1) Measure liquid line pressure (or discharge pressure if there is no liquid line access valve) with the Fluke PV350 Pressure Module and your DMM. Convert the pressure to temperature using your PT chart.
- 2) Measure the pipe temperature at the outlet of the condenser with the Fluke 80PK-8 Pipe Clamp and your temperature meter.
- 3) Subtract the difference in temperatures to obtain subcooling.

Pressure-Enthalpy (PH) Diagram for Refrigerant Blends



Ohms Law Wheel



Handy electrical formulas

Single Phase (1Ø) Power

$$KW = \frac{I \times E \times PF}{1000} \quad I = \frac{Hp \times 746}{\{E \times (\% \text{ effic.}) \times PF\}}$$

Three Phase (3Ø) Power

$$\text{Watts} = E \times I \times \sqrt{3} \times \text{Power Factor (PF)}$$

$$I = \frac{\text{Watts}}{E \times \sqrt{3} \times PF} \quad E = \frac{\text{Watts}}{I \times \sqrt{3} \times PF}$$

FLUKE®

Handy HVAC Formulas

$$\text{BTUH (sensible heat)} = \text{CFM} \times 1.08 \times \Delta T$$

$$\text{BTUH (latent heat)} = \text{CFM} \times 4750 \times (\text{Humidity Ratio Diff.})$$

$$\text{BTUH (total heat)} = \text{CFM} \times 4.5 \times (\text{Enthalpy Difference})$$

$$\text{BTUH (hydronic)} = 500 \times \text{GPM} \times \Delta T$$

$$\text{CFM} = \text{FPM} \times (\text{Duct Area in square feet})$$

$$\text{FPM} = 4005 \times (\sqrt{VP}) \quad VP = TP - SP$$

$$\text{Motor Sheave Pitch} = \frac{\text{Required Fan RPM} \times \text{Fan Sheave Pitch}}{\text{Motor RPM}}$$

$$\text{CFM2} = \text{CFM1} \times \frac{\text{RPM2}}{\text{RPM1}} \quad \text{RPM2} = \text{RPM1} \times \frac{\text{CFM2}}{\text{CFM1}}$$

$$\text{RPM2} = \text{RPM1} \times \sqrt[3]{\frac{\text{BHP2}}{\text{BHP1}}} \quad \text{BHP2} = \text{BHP1} \times \left(\frac{\text{RPM2}}{\text{RPM1}}\right)^3$$

$$\text{RPM2} = \text{RPM1} \times \sqrt{\frac{\text{SP2}}{\text{SP1}}} \quad \text{SP2} = \text{SP1} \times \left(\frac{\text{RPM2}}{\text{RPM1}}\right)^2$$

BTUH = British Thermal Units per Hour

CFM = Cubic Feet Per Minute

FPM = Feet Per Minute

RPM = Revolutions Per Minute

VP = Velocity Pressure

SP = Static Pressure

TP = Total Pressure

BHP = Brake Horsepower

ΔT = Temperature Difference ($T_1 - T_2$)