Run Around Heat Recovery

PRODUCT DATA

Bulletin K70-RA-PDS-11

We are on the Internet

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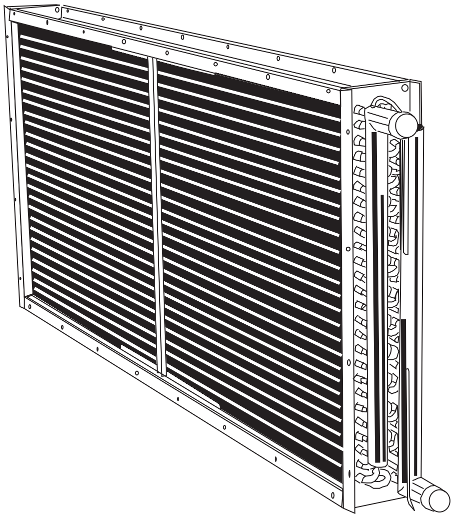
Quick Selection Data
8 Row Coils



GENERAL SELECTION INFORMATION

APPLICATION

The KeepRite Refrigeration Run-Around cycle of heat recovery can be used on systems where exhaust air temperatures do not exceed 300 °F. The Run-Around method of heat recovery utilizes the KeepRite Refrigeration high-efficiency coil surface: Coils are interconnected by a system of piping in which a 50% ethylene glycol solution is circulated. Coils may be remotely located and exhaust and supply air streams kept entirely separate.

SELECTION CRITERIA

This Run-Around cycle selection data is based on the following criteria:

1. 8 - Row deep coils only.
2. Sensible heat recovery only.
3. Glycol flow rate of 3 USGPM/Feed.
4. 50% Glycol solution.
5. face velocity and fin spacing is determined by the type of system, the degree of fouling expected and the general space limitations.
6. Ten basic steps are outlined to make a complete selection with all necessary air and fluid side data. However, Step 9 (fluid temperatures) may be omitted unless specifically required.
7. Coil row depths are the same for the exhaust and supply side with the fluid conditions balancing to suit.
8. Data based on minimum supply air temp. of 0 °F.

AIR VELOCITY

Selection Charts show performance from 400 to 600 S.F.P.M. and are based on an 8 row deep coil. Low velocities result in increased recovery performance; however, coil size and initial costs will be greater.

FIN SPACING

For standard Heating and Ventilation applications, a fin spacing of 12 fins per inch is recommended. For applications where heavy deposits of foreign matter are present, a fin spacing of 8 fins per inch should be used.

MASS FLOW RATIO AND RECOVERY FACTOR

The mass Flow Ratio is:

$$\frac{\text{Larger Air Flow (SCFM)}}{\text{Small Air Flow (SCFM)}}$$

The recovery Factor, R_a, (Fig. 1) is always for the smaller air flow. The Recovery factor, R_a, divided by the mass flow ratio equals the recovery factor, R_b, for the larger air flow.

EXHAUST AIR TEMPERATURES

For exhaust air temperatures lower than 200 °F the recovery factor must be corrected accordingly as shown in Fig. 1, Page 5.

LIMITATIONS

The method of selection will result in an approximate capacity only. In the interest of simplicity, some degree of accuracy must be forfeited.

For more accurate selections for various row depths, consult the local KeepRite Refrigeration Sales Office.

TERMS AND DEFINITIONS

ITD = Initial temperature difference between supply and exhaust entering air, °F.
ITD_f = Initial temperature difference between entering supply air and hot glycol, °F.
ΔT_s = Supply air temperature difference, °F.
ΔT_e = Exhaust air temperature difference, °F.
ΔT_g = Glycol temperature difference, °F.

$$\Delta_g = \frac{\text{Supply air temperature difference, °F}}{\text{Glycol temperature difference, °F}}$$

SCFM = Actual air, cubic feet per minute.
ACFM = Actual air, cubic feet per minute.
M = Mass flow ratio.
R_a = Recovery factor for smaller air flow.
R_b = recovery factor for larger air flow.
GPM = U.S. gallons per minute

SAMPLE RUN AROUND COIL SELECTION

GIVEN: Exhaust Air: 20,000 A.C.F.M. (Actual Cubic feet per minute) at 200 °F.

Supply Air: 10,000 A.C.F.M. at 0 °F.

NOTES:
- Exhaust air is relatively clean
- Altitude is 2,000 ft. above sea level
- Glycol solution is 50% (by weight)
- Face velocity to be used is 400 F.P.M.

GENERAL REQUIREMENTS AND ASSUMPTIONS:
- 8 Row coils only (circuiting to be determined) using 12 F.P.I. fin spacing.

1. CONVERT TO S.C.F.M.

(Air frlow at 70 °F, sea level)
For exhaust air at 200 °F. Altitude density ratio is .75 (Table 1) Converted exhaust air flow is therefore 20,000 A.C.F.M. x .75 = 15,000 S.C.F.M.

For supply air at 0 °F. Altitude density ratio is 1.08 (Table 1) Converted supply air flow is therefore 10,000 A.C.F.M. x 1.08 = 10,800 S.C.F.M.

2. CALCULATE MASS FLOW RATIO (M)

$$\text{Mass flow ratio} = \frac{\text{Large Air Flow S.C.F.M.}}{\text{Small Air Flow S.C.F.M.}}$$

$$M = \frac{15{,}000}{10{,}800} = 1.38$$

3. RECOVERY FACTOR (R_a)

The Recovery Factor (R_a) for small air flow, using 12 F.P.I. fin spacing, 400 S.F.P.M. face velocity and mass flow ratio (M) = 1.38, Ra = .62 (Fig. 1, Page 5).
Temperature Correction Factor =-1.0
The recovery Factor (R_b) for the large air flow =

$$\frac{Ra}{M} = \frac{.62}{1.38} = .45$$

4. ESTABLISH LEAVING AIR TEMPERATURES

Initial temperature difference (I.T.D.) is entering exhaust air temperature minus entering supply air temperature:
200 °F - 0 °F = 200 °F I.T.D.

TEMPERATURE DIFFERENCE (ΔT)

(a) Supply side ΔT_S = I.T.D. X (R_a) Recovery Factor
= 200 °F x .62
= 124 °F

(b) Exhaust side ΔT_e = I.T.D. x (R_b) Recovery factor
= 200 °F x .45
= 90 °F

(c) Supply side leaving temperature = Supply air entering temperature plus supply side ΔT_S
= 0 °F + 124 °F
= 124 °F

(d) Exhaust side leaving temperature = Exhaust air entering temperature minus Exhaust side ΔT_e
= 200 °F - 90 °F
= 110 °F

5. BTU/HR AND PERCENTAGE HEAT RECOVERY

(a) Supply S.C.F.M. x Supply side ΔT_S x 1.09
= 10,800 x 124 x 1.09
= 1,459,728 BTU/HR.

(b) Heat Recovery Effectiveness

$$\frac{\text{Supply Side } \Delta Ts}{\text{I.T.D.}} = \frac{124}{200} = .62 = 62\%$$

6. COIL SIZING AND SELECTION

Knowing the face velocities and the air quantities, the exhaust and supply air coil face areas can be determined as follows:

Exhaust Air Coil Face Area

$$= \frac{\text{15,000 S.C.F.M.}}{\text{400 F.P.M.}} = \text{37.5 Sq. Ft.}$$

Supply Air Coil Face Area

$$= \frac{\text{10,800 S.C.F.M.}}{\text{400 F.P.M.}} = \text{27.0 Sq. Ft.}$$

Knowning the face areas required , consult Table 2 and select coils that will result in face areas as close as possible to those above. (Coil lengths should be approximately double the coil width for the most economic selection).

Exhaust Air Coil: Select a 45” wide x 120” fin length coil Face Area = 37.5 Sq. Ft.

Supply Air Coil: Select a 45” wide x 90” fin length coil Face Area = 28.1 Sq. Ft.

7. DETERMINING INITIAL MINIMUM GLYCOL G.P.M.

$$\text{U.S.G.P.M.} = \frac{\text{Large S.C.F.M. X 1.09 x (M+1)}}{\text{2M x 410}}$$

$$= \frac{15{,}000 \times 1.09 \times (1.38 + 1)}{(2 \times 1.38) \times 410}$$

= 34 U.S.G.P.M.

8. CIRCULATING AND ACTUAL GLYCOL G.P.M. REQUIRED

The approximate number of circuiting feeds required may be determined by using the minimum glycol G.P.M. required (Step 7) and dividing by 3 G.P.M. / feed.

This is as follows: $\frac{34}{3}$ = Approximately 12 feeds

Referring to Table 3, a 45” wide coil KWH circuiting has 15 feeds. The actual G.P.M. / feed would be

$\frac{34}{15}$ = 2.26. This is lower than the allowable minimum of 3 G.P.M. / feed.

In order to operate at the minimum G.P.M. / feed, the total G.P.M. would be 15 x 3 = 45 G.P.M.
This is the final G.P.M. that should be used.

9. DETERMINING GLYCOL TEMPERATURES

(This step may be omitted if not specifically required)

(a) Find the glycol temperature difference (ΔT_g) as follows:

$$\frac{\text{BTU/HR recovered (Step 5a)}}{\text{Final GPM (Step 8) x 410}}$$

$$= \frac{1{,}459{,}728}{45 \text{ x } 410}$$

= 79 °F

(b) Find the approximate hot and cold glycol temperatures as follows:

$$\text{Factor } \Delta_g = \frac{\text{Supply Air } \Delta T\text{s (Step 4a)}}{\text{Glycol } \Delta T_g \text{ (Step 9a)}}$$

$$= \frac{124}{79}$$

= 1.57

(c) Find Factor ITD / ΔT_g from I.T.D. factor Chart Fig 4B Page 6 using factor Δ_g above of 1.57. Factor ITD / ΔT_g = 2.0.

(d) Initial temperature between entering supply air and hot glycol (I.T.D.$_f$) =

ITDf / ΔT_g Factor x ΔT_g (Step 9a)

= 2.0 x 79 °F
= 158 °F

(e) Hot Glycol Temperature = ITD$_f$ + Entering Supply Air Temperature °F
= 158 °F + 0 °F
= 158 °F

(f) Cold Glycol Temperature = Hot Glycol Temperature (Step 9e) minus Glycol ΔT_g (Step 9a)
= 158 °F - 79 °F
= 79 °F

10. DETERMINE FLUID AND AIR SIDE PRESSURE DROP

(a) Fluid Pressure Drop:

Refer to Fig. 2, Page 5 and using 3 GPM / feed, the base fluid pressure drop can be read as 10.5 feet of water. The conversion factor for the exhaust air coil is 2.93 (Table 4) and 2.31 for the supply air coil.

The exhaust air coil glycol pressure drop is
10.75 x 2.93 = 31.5 ft. of water.

The supply air coil glycol pressure drop is
10.75 x 2.31 = 24.8 ft. of water.

(b) Air side Pressure Drop:

Fig. 3, Page 5 indicates the air side pressure drop for an 8 row coil, 12 FPI at 400 F.P.M. face velocity is .49 inches W.G.

CONCLUSION

The following are the final coil selections:

Exhaust Air Coil: 1 - 8 row, 12 FPI, 45” x 120”
Fluid pressure drop -31.5 ft. of water Air side pressure drop .49” W.G.

Supply Air Coil: 1 - 8 row, 12 FPI, 45” x 90”
Fluid pressure drop - 24.8 ft. of water
Air side pressure drop - .49” W.G.

Required Glycol Flow Rate: 45 U.S.G.P.M. of 50% Glycol solution. (By wt.)

TEMPERATURE AND ALTITUDE CONVERSION FACTORS

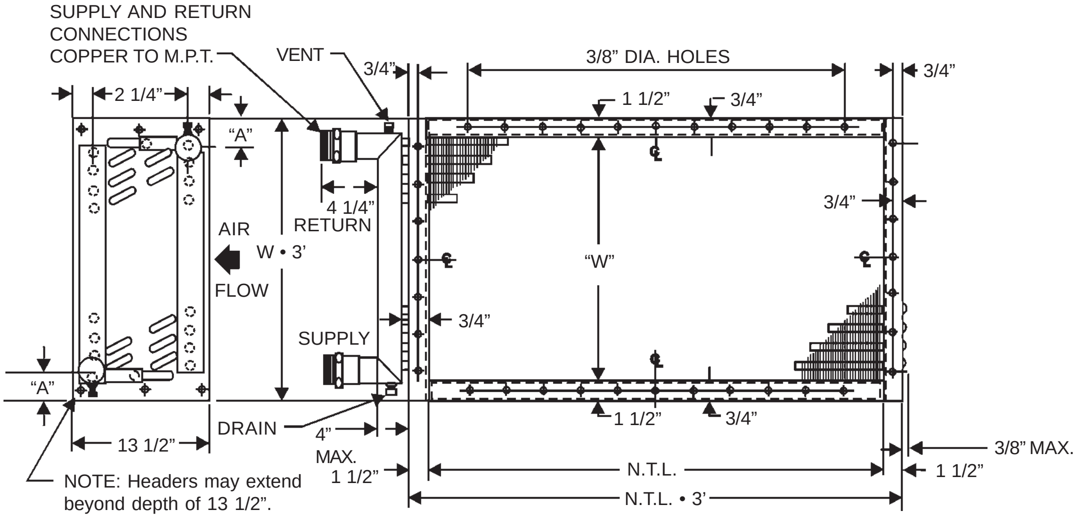
TABLE 1

AIR	ALTITUDE (FEET)								
TEMP °F	0	1000	2000	3000	4000	5000	6000	7000	8000
-20	1.20	1.16	1.12	1.08	1.04	1.00	.97	.93	.89
0	1.15	1.10	1.08	1.02	.99	.95	.92	.88	.85
20	1.11	1.06	1.02	.98	.95	.92	.88	.85	.82
40	1.06	1.02	.98	.94	.91	.88	.84	.81	.78
60	1.02	.98	.94	.91	.88	.85	.81	.79	.76
70	1.00	.96	.93	.89	.86	.83	.80	.77	.74
80	.98	.94	.91	.88	.84	.81	.78	.75	.72
100	.94	.91	.88	.84	.81	.78	.75	.72	.70
120	.92	.88	.85	.81	.78	.76	.72	.70	.67
140	.89	.85	.82	.79	.76	.73	.70	.68	.65
160	.85	.82	.79	.76	.74	.70	.68	.65	.63
200	.80	.77	.75	.72	.69	.67	.64	.62	.60
250	.75	.72	.69	.67	.65	.62	.60	.58	.56

COIL SIZES - NOMINAL FACE AREA SQ. FT.

TABLE 2

"W"	NOMINAL TUBE LENGTH - NTL - (INCHES)																				
INCHES	12	15	18	21	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
12	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
15		1.56	1.87	2.19	2.50	3.12	3.75	4.37	5.0	5.6	6.2	6.9	7.5	8.1	8.7	9.4	10.0	10.6	11.2	11.9	12.5
18			2.25	2.62	3.00	3.75	4.50	5.25	6.0	6.7	7.5	8.2	9.0	9.7	10.5	11.2	12.0	12.7	13.5	14.2	15.0
21				3.06	3.50	4.37	5.25	6.12	7.0	7.9	8.7	9.6	10.5	11.4	12.2	13.1	14.0	14.9	15.7	16.6	17.5
24					4.00	5.00	6.00	7.00	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
27						5.62	6.75	7.87	9.0	10.1	11.2	12.4	13.5	14.6	15.7	16.9	18.0	19.1	20.2	21.4	22.5
30						6.25	7.50	8.75	10.0	11.2	12.5	13.7	15.0	16.2	17.5	18.7	20.0	21.2	22.5	23.7	25.0
33							8.25	9.62	11.0	12.4	13.7	15.1	16.5	17.9	19.2	20.6	22.0	23.4	24.7	26.1	27.5
36							9.00	10.50	12.0	13.5	15.0	16.5	18.0	19.5	21.0	22.5	24.0	25.5	27.0	28.5	30.0
39								11.37	13.0	14.6	16.2	17.9	19.5	20.1	22.7	24.4	26.0	27.6	29.2	30.9	32.5
42								12.25	14.0	15.7	17.5	19.2	21.0	22.7	24.5	26.2	28.0	29.7	31.5	33.2	35.0
45									15.0	16.8	18.7	20.6	22.5	24.3	26.2	28.1	30.0	31.8	33.7	35.6	37.5
48										18.0	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0
54										20.2	22.5	24.7	27.0	29.2	31.5	33.7	36.0	38.2	40.5	42.7	45.0
60											25.0	27.5	30.0	32.5	35.0	31.5	40.0	42.5	45.0	47.5	50.0



COIL CONNECTION SIZES (INCHES)

TOTAL G.P.M.	0-10	11-20	21-30	31-50	51-80	81-125	126-175
HEADER AND CONN. SIZE	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	3 1/2"
DIM. "A"	1 7/8"	1 7/8"	1 7/8"	2 1/16"	2 5/16"	2 9/16"	2 13/16"

COIL CIRCUITING

TABLE 3

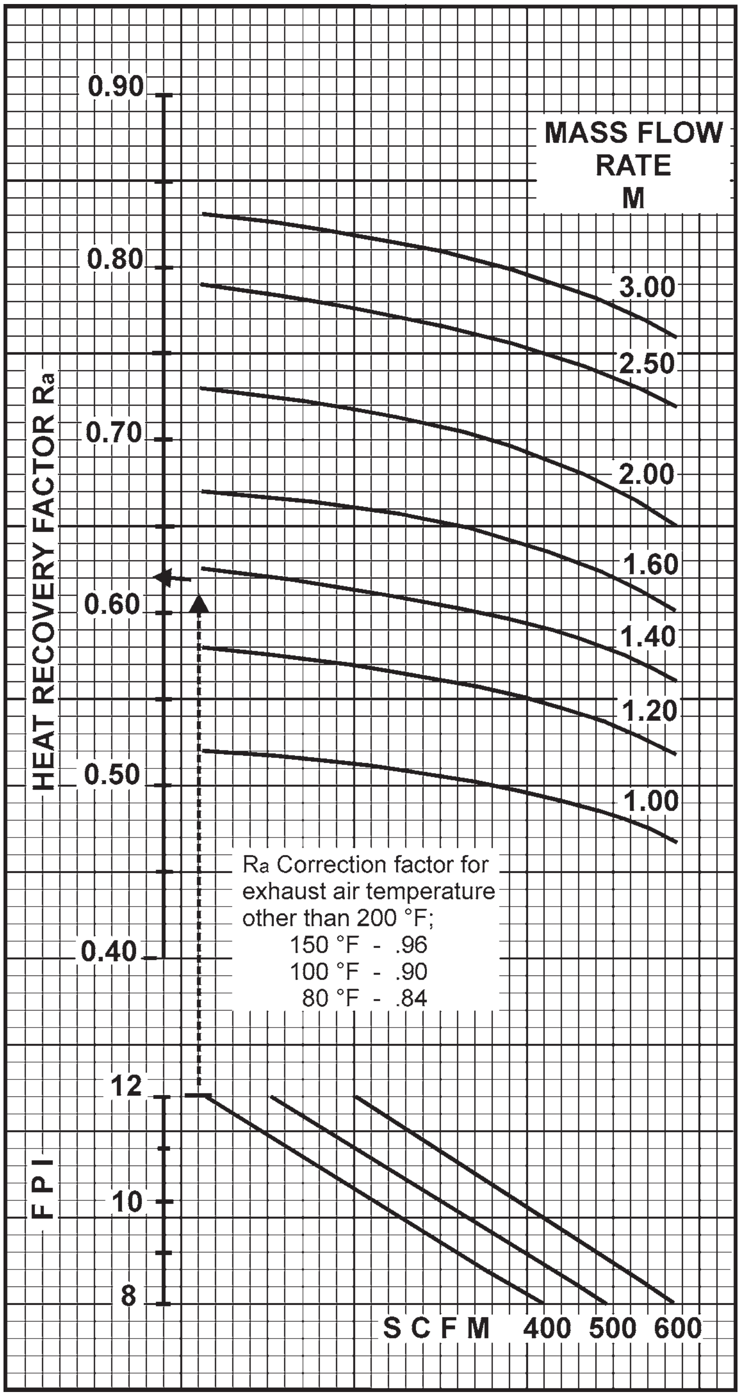
CIRCUIT	COIL FIN WIDTH (INCHES)														
TYPE	12	15	18	21	24	27	30	33	36	39	42	45	48	54	60
KWQ	2	N.A.	3	N.A.	4	N.A.	5	N.A.	6	N.A.	7	N.A.	8	9	10
KWT	N.A.	N.A.	4	N.A.	N.A.	6	8	N.A.	8	N.A.	N.A.	10	N.A.	12	N.A.
KWH*	4	5	6	7	8	9	10	11	12	13	14	15	16	18	20
KWS*	8	10	12	14	16	18	20	22	24	26	28	30	32	36	40

* Select KWH or KWS circuiting for low fluid side pressure drop.
N.A. = Not Available.

RUN AROUND CYCLE HEAT RECOVERY FACTOR
8 ROW COILS

FIG. 1

Based on minimum flow rate of 3 U.S.G.P.M. / feed and 200 °F exhaust air temperature*

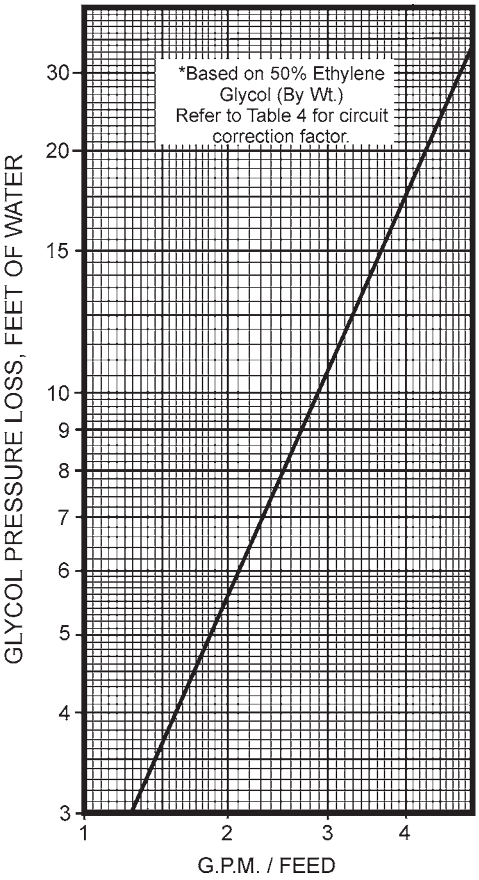


Ra Correction factor for exhaust air temperature other than 200 °F;
150 °F - .96
100 °F - .90
80 °F - .84

COIL	NOMINAL TUBE LENGTH (INCHES)											
TYPE	12	24	36	48	60	72	84	96	108	120	132	144
KWQ	1.27	1.78	2.26	2.74	3.25	3.75	3.91	4.73	5.22	5.73	6.21	6.70
KWT	.99	1.38	1.74	2.10	2.49	2.84	3.20	3.60	3.95	4.34	4.70	5.37
KWH	.70	.95	1.20	1.45	1.69	1.94	2.19	2.44	2.69	2.93	3.18	3.43
KWS	.38	.51	.63	.75	.88	1.00	1.12	1.25	1.37	1.50	1.62	1.74

BASE GLYCOL PRESSURE DROP*

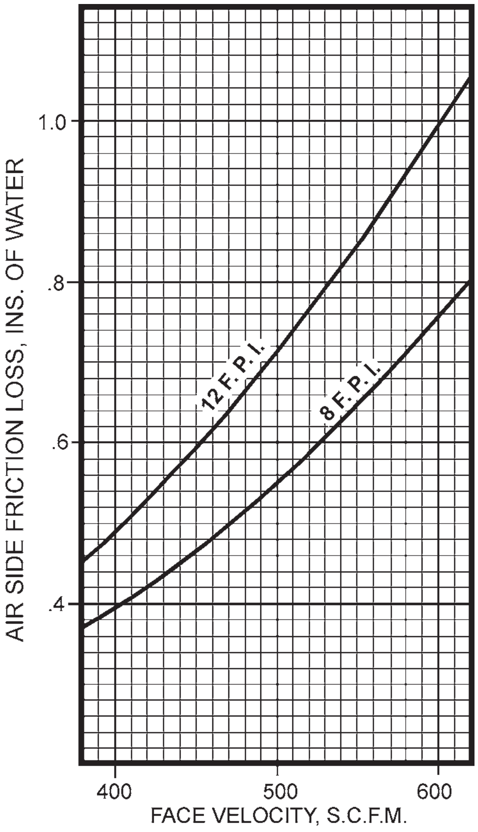
FIG. 2



*Based on 50% Ethylene Glycol (By Wt.)
Refer to Table 4 for circuit correction factor.

AIR SIDE PRESSURE LOSS

FIG. 3



I.T.D. FACTOR CHARTS

FIG. 4

FIG. 4A

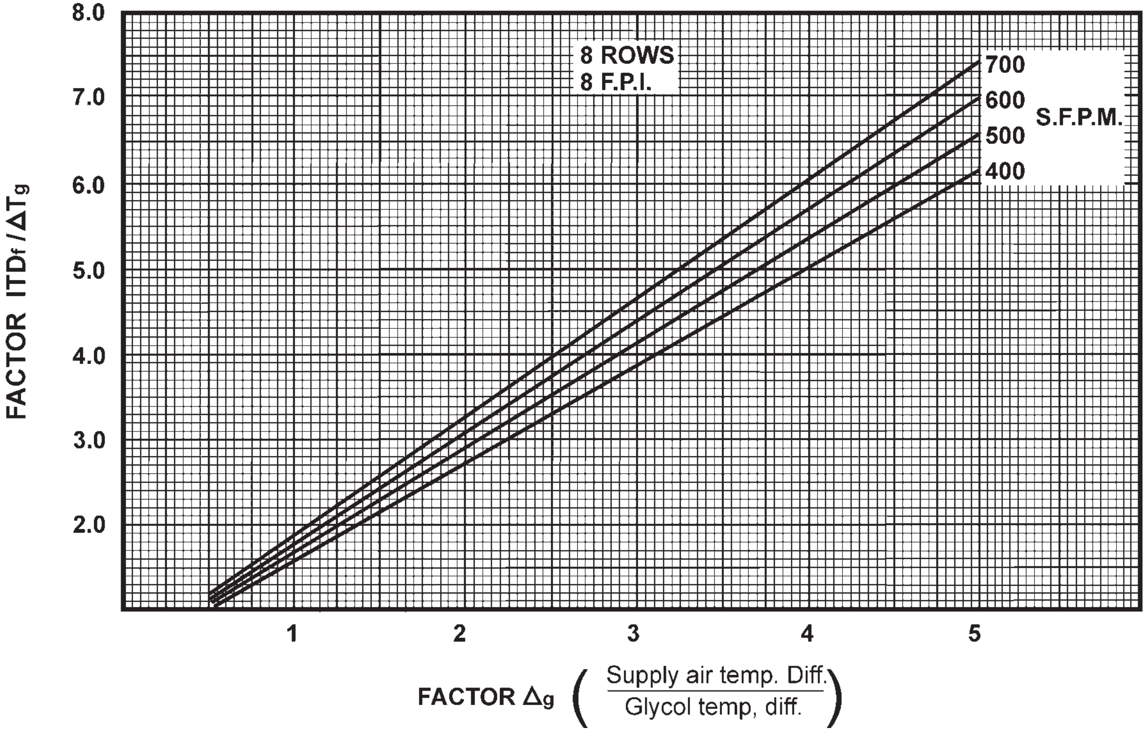
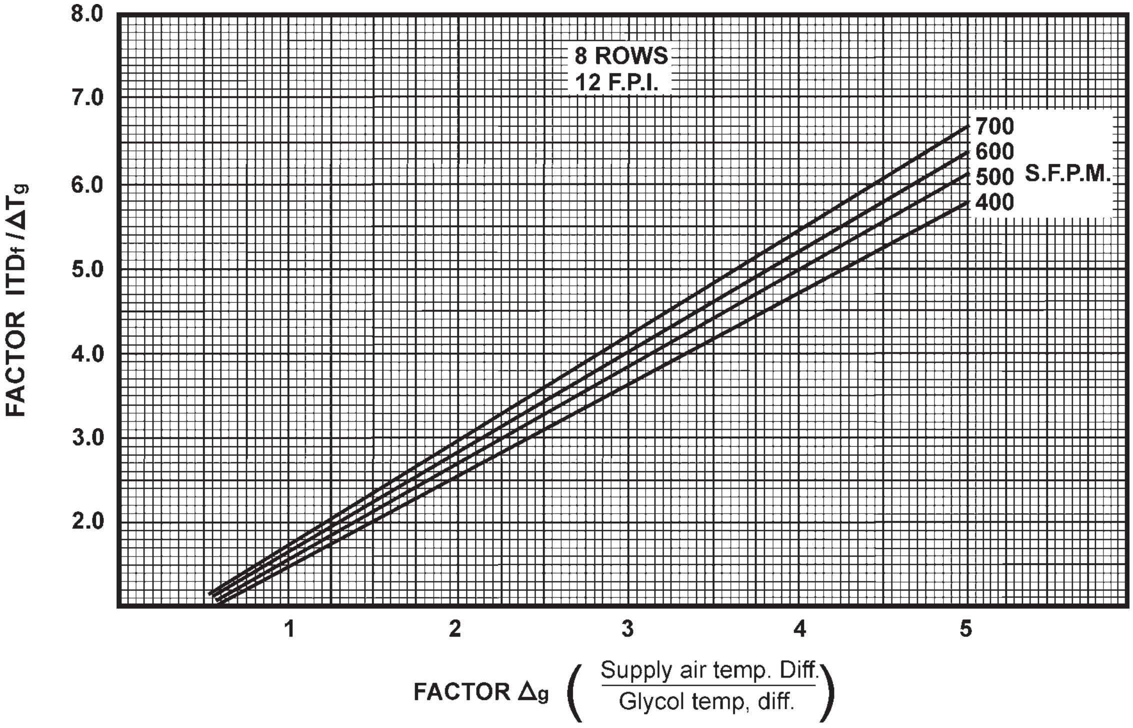


FIG. 4B



NOTES

KeepRite®
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03/17/2007