

Klea® 134a Engineers Tables – SI Units

1. Introduction

The following tables provide practical information to help you design or set up refrigeration systems using Klea® 134a. We've tried to make the layout as easy as possible to use; where possible we've followed the existing conventions used in standard reference works. These tables are supplementary to the Physical Property Datasheet for Klea®134a and the booklets of Thermodynamic Property Data for Klea® 134a.

2. Temperature-Pressure Tables for Klea® 134a

The following simple guidelines explain which tables to use to obtain the relationships between the saturated liquid and vapour pressures and temperatures. We have tabulated the following data for you:

Table 1: Saturation pressure from temperature

Table 2: Saturation temperature from pressure

Table 3-5: Maximum recommended suction line capacities for varying suction gas conditions

Table 6: Discharge line capacities

Table 7: Liquid line capacities

Table 8: Recommended minimum capacities for oil entrainment in suction lines

Table 9: Correction factors for use with the capacity tables at other conditions

Refrigerant Flowrate: A graphical correlation of refrigerant flowrate per unit capacity.

3. Refrigerant Line Capacity Tables

3.1 Methods used to generate the tables

The tables presented here have been developed using the methodology described in the ASHRAE Handbook: Refrigeration Systems and Applications (1994). The physical property data used to generate these tables are correlated in the Mexichem datasheets, thermodynamic tables. Pressure drop has been estimated using the Colebrook equation to obtain friction factors and the Darcy-Weisbach equation for pressure drop.

Gas Compressibility Effects In calculating the maximum capacity (flowrate) it has been assumed that the gas is incompressible. This is in line with the tables published in the ASHRAE Handbook and for most systems this is perfectly adequate.

The assumption of incompressibility may however over-predict capacity if the total pressure drop is appreciable compared to the static pressure. The likely over-prediction will be in the region of 5-10% depending on the evaporator pressure and total line loss (including fittings loss).

Mexichem recommends that the pressure drop obtained for a line using these tables should be compared to the total pressure available; if it is greater than 5% of the static pressure then the compressibility may have some effect, and sizing should be made on that basis.

3.2 Suction Line Capacity Tables

These tables give capacities for cycles operating under the following conditions:

Condenser temperature 40 °C

Zero subcooling

Vapour leaving evaporator (i) saturated or (ii) superheated (superheat quoted in the table).

The capacity for other liquid temperatures may be found using the tabulated correction factors given in Table 9. Note that the tables are referenced to a condenser of 40 °C; the liquid temperature corresponding to this condition is quoted in the tables.

The tables quote capacity for pressure drops in the evaporating pressure equivalent to a drop in saturation temperature of 0.01, 0.02 and 0.04 Kelvin for every metre of suction line. Data are presented for copper tubing, Type L, and Schedule 40 steel pipe with dimensions as given in the ASHRAE Handbook HVAC Systems and Equipment (1992).

The mass flowrate of refrigerant is also presented graphically as the flow in kg/hr required for a duty of 1 kW refrigeration over a range of evaporating temperatures and liquid temperatures.

3.3 Discharge Line Capacity Tables

These have been calculated on the following basis:

Condenser temperature of 40 °C

Zero subcooling

Vapour leaves evaporator at zero useful superheat Superheat at compressor discharge is (i) 45 or (ii) 60 °C.

3.4 Liquid Line Capacity Tables

These are quoted for conditions of (i) 0.5 m/s maximum velocity or (ii) 0.02 K/m drop in saturation temperature. Use the velocity criterion for sizing self-venting lines.

3.5 Correcting for other Temperature Drops or Line Lengths

The suction capacity tables reference according to saturation temperature losses of 0.01, 0.02 and 0.04 K in one metre length. In order to correct the capacities for different values of temperature drop or line length, use the following equation:

$$\text{Capacity} = \text{Table Capacity} \times \frac{(\text{Required } \Delta T_e \times \text{Table } L_e)^{0.54}}{\text{Table } \Delta T_e \text{ Required } L_e}$$

where:

ΔT_e is the change in evaporating temperature

ΔL_e is the length of suction line

To evaluate the change in saturation temperature for differing capacities or line lengths, use the equation :

$$\text{Actual } \Delta T_e = \text{Table } \Delta T_e \times \frac{(\text{Actual } L_e) \times (\text{Actual Capacity})^{1.8}}{\text{Table } L_e \times \text{Table Capacity}}$$

4. What's New In This Edition

This is version 1.1 of the Tables. The updates from version 1.0 are as follows:

Tables 5-9: A revision of the physical property routines and calculation methods has occurred so that all physical properties used in the calculation are now obtained from the most recent physical property datasheets for each refrigerant.

Tables 5-9: The nomenclature in the tables has been changed slightly to make it more readable.

Tables 5-11: The number of significant figures in the tables is revised to three to better reflect the accuracy limits of the calculations.

Table 11: The changes in physical property calculations have resulted in some changes to the correction factors displayed in this table.

Table 1: Saturation Pressure from Temperature – Klea® 134a

Temperature °F	Pressure psia	Temperature °F	Pressure psia	Temperature °F	Pressure psia
-40	0.51	-5	2.43	30	7.67
-39	0.54	-4	2.52	31	7.89
-38	0.57	-3	2.62	32	8.12
-37	0.60	-2	2.72	33	8.35
-36	0.63	-1	2.82	34	8.59
-35	0.66	0	2.92	35	8.83
-34	0.70	1	3.03	36	9.08
-33	0.73	2	3.14	37	9.33
-32	0.77	3	3.25	38	9.59
-31	0.80	4	3.37	39	9.85
-30	0.84	5	3.49	40	10.12
-29	0.89	6	3.61	41	10.39
-28	0.93	7	3.74	42	10.67
-27	0.97	8	3.87	43	10.96
-26	1.02	9	4.00	44	11.25
-25	1.06	10	4.14	45	11.54
-24	1.11	11	4.28	46	11.85
-23	1.16	12	4.42	47	12.15
-22	1.22	13	4.56	48	12.47
-21	1.27	14	4.72	49	12.79
-20	1.33	15	4.87	50	13.12
-19	1.39	16	5.03	51	13.45
-18	1.45	17	5.19	52	13.79
-17	1.51	18	5.35	53	14.13
-16	1.57	19	5.52	54	14.49
-15	1.64	20	5.70	55	14.85
-14	1.71	21	5.87	56	15.21
-13	1.78	22	6.06	57	15.58
-12	1.85	23	6.24	58	15.96
-11	1.93	24	6.43	59	16.35
-10	2.01	25	6.63	60	16.74
-9	2.09	26	6.83		
-8	2.17	27	7.03		
-7	2.25	28	7.24		
-6	2.34	29	7.45		

Table 2: Saturation Temperature from Pressure – Klea® 134a

Temperature °F	Pressure psia	Temperature °F	Pressure psia	Temperature °F	Pressure psia	Temperature °F	Pressure psia
1	-26.34	8.8	34.93	14.2	53.23	25	77.70
1.2	-22.31	9	35.74	14.4	53.80	25.5	78.61
1.4	-18.78	9.2	36.54	14.6	54.36	26	79.52
1.6	-15.61	9.4	37.33	14.8	54.92	26.5	80.40
1.8	-12.74	9.6	38.10	15	55.47	27	81.28
2	-10.10	9.8	38.87	15.2	56.01	27.5	82.14
2.2	-7.66	10	39.62	15.4	56.55	28	82.99
2.4	-5.38	10.2	40.36	15.6	57.08	28.5	83.83
2.6	-3.25	10.4	41.08	15.8	57.61	29	84.66
2.8	-1.23	10.6	41.80	16	58.13	29.5	85.48
3	0.68	10.8	42.51	16.2	58.65	30	86.29
3.2	2.49	11	43.21	16.4	59.16		
3.4	4.22	11.2	43.89	16.6	59.67		
3.6	5.87	11.4	44.57	16.8	60.17		
3.8	7.46	11.6	45.24	17	60.67		
4	8.98	11.8	45.90	17.2	61.17		
4.2	10.45	12	46.56	17.4	61.66		
4.4	11.86	12.2	47.20	17.6	62.14		
4.6	13.23	12.4	47.84	17.8	62.62		
4.8	14.55	12.6	48.46	18	63.10		
5	15.83	12.8	49.08	18.2	63.57		
5.2	17.08	13	49.70	18.4	64.04		
5.4	18.28	13.2	50.30	18.6	64.51		
5.6	19.46	13.4	50.90	18.8	64.97		
5.8	20.60	13.6	51.50	19	65.43		
6	21.71	13.8	52.08	19.2	65.88		
6.2	22.79	14	52.66	19.4	66.33		
6.4	23.85	14.2	53.23	19.6	66.78		
6.6	24.89	14.4	53.80	19.8	67.22		
6.8	25.90	14.6	54.36	20	67.66		
7	26.88	14.8	54.92	20.5	68.75		
7.2	27.85	12.6	48.46	21	69.81		
7.4	28.80	12.8	49.08	21.5	70.86		
7.6	29.72	13	49.70	22	71.89		
7.8	30.63	13.2	50.30	22.5	72.89		
8	31.52	13.4	50.90	23	73.89		
8.2	32.40	13.6	51.50	23.5	74.86		
8.4	33.26	13.8	52.08	24	75.82		
8.6	34.10	14	52.66	24.5	76.77		

Table 3a: Suction line capacities in kW for Klea® 134a Saturated vapour leaving evaporator

Nominal line size mm	Saturation temperature change 1.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T $\Delta P/\Delta L$	79	92	106	121	138
Type L Copper					
10	0.143	0.177	0.216	0.261	0.314
12	0.333	0.410	0.500	0.605	0.725
15	0.632	0.777	0.946	1.14	1.37
19	1.08	1.33	1.62	1.96	2.35
22	1.69	2.07	2.52	3.04	3.64
28	3.44	4.22	5.13	6.19	7.40
35	6.03	7.39	8.98	10.8	12.9
42	9.58	11.7	14.2	17.2	20.5
54	20.0	24.5	29.7	35.7	42.6
67	35.5	43.4	52.6	63.3	75.5
79	56.8	69.4	84.1	101	121
92	84.7	103	125	151	180
105	120	146	177	213	254
Schedule 40 steel					
10	0.420	0.511	0.616	0.737	0.875
15	0.783	0.951	1.15	1.37	1.63
20	1.66	2.01	2.42	2.89	3.43
25	3.15	3.82	4.59	5.48	6.50
32	6.51	7.90	9.50	11.3	13.4
40	9.79	11.9	14.3	17.0	20.2
50	18.9	22.9	27.6	32.9	38.9
65	30.2	36.6	44.0	52.4	62.1
80	53.6	64.8	77.9	92.8	110
100	109	132	159	189	224

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 3b: Suction line capacities in kW for Klea® 134a Saturated vapour leaving evaporator

Nominal line size mm	Saturation temperature change 2.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
ΔP/ΔL	158	183	211	242	275
Type L Copper					
10	0.213	0.262	0.319	0.386	0.463
12	0.493	0.605	0.737	0.890	1.07
15	0.932	1.14	1.39	1.68	2.01
19	1.60	1.96	2.38	2.87	3.44
22	2.48	3.04	3.69	4.45	5.32
28	5.05	6.19	7.51	9.04	10.8
35	8.83	10.8	13.1	15.8	18.9
42	14.0	17.1	20.8	25.0	29.9
54	29.2	35.7	43.2	52.0	62.0
67	51.7	63.2	76.5	91.9	110
79	82.7	101	122	147	175
92	123	150	182	218	260
105	174	212	257	308	367
Schedule 40 steel					
10					
15	1.12	1.36	1.64	1.96	2.32
20	2.37	2.88	3.46	4.13	4.89
25	4.50	5.46	6.56	7.82	9.26
32	9.30	11.3	13.5	16.1	19.1
40	14.0	16.9	20.3	24.2	28.7
50	27.0	32.7	39.2	46.7	55.3
65	43.1	52.1	62.6	74.5	88.2
80	76.2	92.2	111	132	156
100	155	188	225	268	318

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 3c: Suction line capacities in kW for Klea® 134a Saturated vapour leaving evaporator

Nominal line size mm	Saturation temperature change 4.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
ΔP/ΔL	316	367	422	484	551
Type L Copper					
10	0.314	0.386	0.470	0.568	0.681
12	0.726	0.891	1.08	1.31	1.56
15	1.37	1.68	2.04	2.46	2.94
19	2.34	2.87	3.49	4.20	5.02
22	3.63	4.45	5.40	6.50	7.77
28	7.39	9.04	11.0	13.2	15.7
35	12.9	15.8	19.1	23.0	27.4
42	20.4	25.0	30.3	36.4	43.4
54	42.5	51.9	62.8	75.4	89.9
67	75.2	91.8	111	133	159
79	120	147	177	213	253
92	179	218	263	316	376
105	252	307	371	445	530
Schedule 40 steel					
10					
15	1.61	1.95	2.34	2.79	3.31
20	3.39	4.11	4.93	5.88	6.96
25	6.42	7.78	9.34	11.1	13.2
32	13.3	16.0	19.3	22.9	27.1
40	19.9	24.1	28.9	34.4	40.7
50	38.4	46.5	55.7	66.4	78.5
65	61.3	74.1	88.9	106	125
80	108	131	157	187	221
100	221	267	320	381	450

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 4: Suction line capacities in kW for Klea® 134a Suction line vapour with 5°C of superheat

Nominal line size mm	Saturation temperature change 1.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
ΔP/ΔL	79	92	106	121	138
Type L Copper					
10	0.145	0.179	0.219	0.265	0.318
12	0.338	0.416	0.507	0.613	0.736
15	0.641	0.788	0.960	1.16	1.39
19	1.10	1.35	1.65	1.99	2.38
22	1.71	2.10	2.55	3.08	3.69
28	3.50	4.29	5.21	6.28	7.51
35	6.13	7.51	9.12	11.0	13.1
42	9.73	11.9	14.5	17.4	20.8
54	20.3	24.8	30.1	36.3	43.3
67	36.0	44.1	53.4	64.3	76.7
79	57.7	70.5	85.5	103	123
92	86.0	105	127	153	183
105	122	149	180	216	258
Schedule 40 Steel					
10	0.427	0.519	0.626	0.749	0.890
15	0.796	0.968	1.17	1.39	1.65
20	1.69	2.05	2.46	2.94	3.49
25	3.20	3.89	4.68	5.58	6.62
32	6.63	8.04	9.66	11.5	13.7
40	9.96	12.1	14.5	17.3	20.5
50	19.3	23.3	28.1	33.5	39.6
65	30.8	37.3	44.8	53.4	63.2
80	54.5	66.0	79.2	94.4	112
100	111	135	162	193	228

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 4a: Suction line capacities in kW for Klea 134a Suction line vapour with 5°C of superheat

Nominal line size mm	Saturation temperature change 2.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
ΔP/ΔL	158	183	211	242	275
Type L Copper					
10	0.216	0.265	0.324	0.391	0.470
12	0.500	0.614	0.748	0.903	1.08
15	0.946	1.16	1.41	1.70	2.04
19	1.62	1.99	2.42	2.92	3.49
22	2.52	3.08	3.75	4.52	5.40
28	5.13	6.28	7.63	9.18	11.0
35	8.97	11.0	13.3	16.0	19.2
42	14.2	17.4	21.1	25.4	30.3
54	29.6	36.2	43.9	52.8	63.0
67	52.5	64.2	77.8	93.4	111
79	84.0	103	124	149	178
92	125	153	185	222	265
105	177	216	261	313	373
Schedule 40 Steel					
10	0.614	0.746	0.898	1.07	1.27
15	1.14	1.39	1.67	1.99	2.36
20	2.42	2.93	3.52	4.20	4.98
25	4.58	5.55	6.67	7.96	9.43
32	9.47	11.5	13.8	16.4	19.4
40	14.2	17.2	20.7	24.7	29.2
50	27.5	33.3	39.9	47.6	56.3
65	43.9	53.1	63.7	75.9	89.8
80	77.6	93.9	113	134	159
100	158	191	230	273	323

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 4b: Suction line capacities in kW for Klea® 134a Suction line vapour with 5°C of superheat

Nominal line size mm	Saturation temperature change 2.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
$\Delta P/\Delta L$	158	183	211	242	275
Type L Copper					
10	0.216	0.265	0.324	0.391	0.470
12	0.500	0.614	0.748	0.903	1.08
15	0.946	1.16	1.41	1.70	2.04
19	1.62	1.99	2.42	2.92	3.49
22	2.52	3.08	3.75	4.52	5.40
28	5.13	6.28	7.63	9.18	11.0
35	8.97	11.0	13.3	16.0	19.2
42	14.2	17.4	21.1	25.4	30.3
54	29.6	36.2	43.9	52.8	63.0
67	52.5	64.2	77.8	93.4	111
79	84.0	103	124	149	178
92	125	153	185	222	265
105	177	216	261	313	373
Schedule 40 Steel					
10					
15	1.14	1.39	1.67	1.99	2.36
20	2.42	2.93	3.52	4.20	4.98
25	4.58	5.55	6.67	7.96	9.43
32	9.47	11.5	13.8	16.4	19.4
40	14.2	17.2	20.7	24.7	29.2
50	27.5	33.3	39.9	47.6	56.3
65	43.9	53.1	63.7	75.9	89.8
80	77.6	93.9	113	134	159
100	158	191	230	273	323

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 4c: Suction line capacities in kW for Klea® 134a Suction line vapour with 5°C of superheat

Nominal line size mm	Saturation temperature change 4.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
$\Delta P/\Delta L$	316	367	422	484	551
Type L Copper					
10	0.319	0.392	0.477	0.576	0.691
12	0.737	0.904	1.10	1.33	1.59
15	1.39	1.71	2.07	2.50	2.99
19	2.38	2.92	3.54	4.27	5.10
22	3.69	4.52	5.48	6.60	7.89
28	7.50	9.18	11.1	13.4	16.0
35	13.1	16.0	19.4	23.4	27.9
42	20.8	25.4	30.8	37.0	44.1
54	43.2	52.7	63.8	76.6	91.4
67	76.4	93.3	113	135	161
79	122	149	180	216	257
92	182	221	268	321	382
105	256	312	378	453	539
Schedule 40 Steel					
10					
15	1.64	1.98	2.38	2.84	3.37
20	3.45	4.18	5.02	5.99	7.09
25	6.54	7.92	9.50	11.3	13.4
32	13.5	16.3	19.6	23.4	27.6
40	20.3	24.5	29.4	35.0	41.4
50	39.1	47.3	56.7	67.6	79.9
65	62.4	75.4	90.5	108	127
80	110	133	160	190	225
100	225	272	326	388	458

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 5a: Suction line capacities in kW for Klea® 134a Suction line vapour at 20°C

Nominal line size mm	Saturation temperature change 1.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
$\Delta P/\Delta L$	79	92	106	121	138
Type L Copper					
10	0.131	0.163	0.202	0.249	0.303
12	0.304	0.380	0.469	0.576	0.701
15	0.578	0.720	0.889	1.09	1.32
19	0.993	1.24	1.52	1.87	2.27
22	1.54	1.92	2.37	2.90	3.52
28	3.16	3.92	4.83	5.90	7.17
35	5.54	6.87	8.46	10.3	12.5
42	8.80	10.9	13.4	16.4	19.9
54	18.4	22.8	28.0	34.1	41.3
67	32.6	40.4	49.6	60.5	73.2
79	52.3	64.7	79.4	96.7	117
92	78.0	96.4	118	144	174
105	110	136	167	203	246
Schedule 40 Steel					
10	0.388	0.478	0.584	0.707	0.850
15	0.725	0.892	1.09	1.32	1.58
20	1.54	1.89	2.30	2.78	3.34
25	2.92	3.59	4.36	5.27	6.32
32	6.05	7.42	9.02	10.9	13.1
40	9.10	11.2	13.6	16.4	19.6
50	17.6	21.6	26.2	31.6	37.9
65	28.2	34.5	41.8	50.4	60.4
80	49.9	61.0	74.1	89.2	107
100	102	125	151	182	218

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 5b: Suction line capacities in kW for Klea® 134a Suction line vapour at 20°C

Nominal line size mm	Saturation temperature change 2.0 K in 100 m Mean evaporating temperature °C at corresponding pressure drop, pa/m				
	-10	-5	0	5	10
T					
ΔP/ΔL	158	183	211	242	275
Type L Copper					
10	0.194	0.242	0.300	0.367	0.447
12	0.451	0.561	0.693	0.849	1.03
15	0.853	1.06	1.31	1.60	1.95
19	1.46	1.82	2.24	2.74	3.33
22	2.27	2.82	3.47	4.25	5.15
28	4.64	5.75	7.08	8.64	10.5
35	8.12	10.1	12.4	15.1	18.3
42	12.9	16.0	19.6	23.9	28.9
54	26.9	33.2	40.8	49.7	60.1
67	47.6	58.9	72.3	87.9	106
79	76.2	94.2	115	140	170
92	114	140	172	209	252
105	160	198	243	295	356
Schedule 40 Steel					
10	0.560	0.688	0.838	1.01	1.22
15	1.04	1.28	1.56	1.88	2.26
20	2.21	2.71	3.29	3.97	4.76
25	4.19	5.13	6.23	7.52	9.01
32	8.66	10.6	12.9	15.5	18.6
40	13.0	15.9	19.3	23.3	27.9
50	25.1	30.8	37.3	45.0	53.8
65	40.2	49.1	59.5	71.7	85.9
80	71.1	86.9	105	127	152
100	145	177	215	258	309

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 5c: Suction line capacities in kW for Klea® 134a Suction line vapour at 20°C

Nominal line size mm	Saturation temperature change 4.0 K in 100 m				
	Mean evaporating temperature °C at corresponding pressure drop, pa/m				
T	-10	-5	0	5	10
$\Delta P/\Delta L$	316	367	422	484	551
Type L Copper					
10	0.287	0.358	0.442	0.541	0.659
12	0.665	0.827	1.02	1.25	1.51
15	1.26	1.56	1.92	2.35	2.85
19	2.15	2.67	3.29	4.01	4.86
22	3.34	4.14	5.09	6.21	7.52
28	6.79	8.41	10.3	12.6	15.3
35	11.9	14.7	18.0	22.0	26.6
42	18.8	23.3	28.6	34.8	42.1
54	39.2	48.4	59.3	72.2	87.2
67	69.3	85.7	105	128	154
79	111	137	168	204	246
92	165	204	249	303	365
105	233	287	351	427	515
Schedule 40 steel					
10	0.804	0.986	1.20	1.45	1.73
15	1.50	1.83	2.23	2.68	3.22
20	3.16	3.86	4.69	5.66	6.78
25	5.98	7.32	8.88	10.7	12.8
32	12.4	15.1	18.3	22.1	26.4
40	18.5	22.7	27.5	33.1	39.6
50	35.8	43.8	53.0	63.9	76.4
65	57.1	69.8	84.6	102	122
80	101	123	150	180	215
100	206	251	305	367	438

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 6a: Discharge line capacities in kW for Klea® 134a Saturated vapour leaving evaporator

Nominal line size mm	Condenser saturation temperature change 2.0 K in 100 m Pressure gradient of 542 pa/m Mean evaporating temperature °C Discharge line superheat of 45°C				
	-10	-5	0	5	10
Type L Copper					
10	0.862	0.880	0.899	0.917	0.935
12	1.98	2.02	2.07	2.11	2.15
15	3.73	3.81	3.89	3.97	4.04
19	6.36	6.50	6.64	6.77	6.90
22	9.84	10.1	10.3	10.5	10.7
28	20.0	20.4	20.8	21.2	21.7
35	34.8	35.5	36.3	37.0	37.7
42	55.0	56.2	57.4	58.5	59.7
54	114	116	119	121	124
67	201	206	210	214	219
79	321	328	335	342	348
92	477	488	498	508	518
105	673	687	702	716	730
Schedule 40 steel					
10	2.27	2.32	2.36	2.41	2.46
15	4.20	4.29	4.39	4.47	4.56
20	8.85	9.04	9.23	9.42	9.60
25	16.7	17.1	17.5	17.8	18.2
32	34.5	35.3	36.0	36.7	37.4
40	51.8	52.9	54.0	55.1	56.2
50	99.8	102	104	106	108
65	159	163	166	169	173
80	281	287	293	299	305
100	572	585	597	609	621

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 6b: Discharge line capacities in kW for Klea® 134a Saturated vapour leaving evaporator

Nominal line size mm	Condenser saturation temperature change 2.0 K in 100 m		Pressure gradient of 542 pa/m		
	Mean evaporating temperature °C		Discharge line superheat of 60°C		
T	-10	-5	0	5	10
Type L Copper					
0	0.824	0.842	0.860	0.877	0.894
12	1.90	1.94	1.98	2.02	2.06
15	3.57	3.65	3.73	3.80	3.88
19	6.10	6.23	6.36	6.49	6.62
22	9.44	9.64	9.85	10.0	10.2
28	19.2	19.6	20.0	20.4	20.8
35	33.4	34.1	34.8	35.5	36.2
42	52.9	54.0	55.1	56.3	57.3
54	110	112	114	117	119
67	194	198	202	206	210
79	309	316	322	329	335
92	459	469	479	489	498
105	648	662	676	689	703
Schedule 40 steel					
10	2.19	2.24	2.29	2.33	2.38
15	4.07	4.16	4.24	4.33	4.41
20	8.57	8.76	8.94	9.12	9.30
25	16.2	16.6	16.9	17.3	17.6
32	33.4	34.2	34.9	35.6	36.3
40	50.1	51.2	52.3	53.4	54.4
50	96.7	98.8	101	103	105
65	154	158	161	164	167
80	273	278	284	290	296
100	555	567	579	591	602

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 7a: Liquid line capacities in kW for Klea® 134a Saturated vapour leaving evaporator

Nominal line size mm	Liquid line velocity 0.5 m/s Mean evaporating temperature °C					
	T	-10	-5	0	5	10
Type L Copper						
10		3.92	4.01	4.09	4.17	4.25
12		7.30	7.46	7.62	7.77	7.93
15		11.7	12.0	12.2	12.5	12.7
19		17.5	17.9	18.3	18.7	19.0
22		24.4	24.9	25.4	25.9	26.4
28		41.5	42.4	43.3	44.2	45.1
35		63.2	64.6	66.0	67.3	68.6
42		89.5	91.5	93.4	95.3	97.1
54		156	159	162	166	169
67		240	245	250	256	261
79		343	350	358	365	372
92		464	474	484	493	503
105		603	616	629	641	654
Schedule 40 Steel						
10		9.60	9.81	10.0	10.2	10.4
15		15.3	15.6	16.0	16.3	16.6
20		26.8	27.4	28.0	28.6	29.1
25		43.5	44.4	45.4	46.3	47.2
32		75.2	76.9	78.5	80.1	81.7
40		102	105	107	109	111
50		169	173	176	180	183
65		241	246	251	256	261
80		372	380	388	396	404
100		641	654	668	682	695

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 7b: Liquid line capacities in kW for Klea® 134a Saturated vapour leaving evaporator

Nominal line size mm	Condenser saturation temperature change 2.0 K in 100 m Pressure gradient of 542 Pa/m Mean evaporating temperature °C				
	-10	-5	0	5	10
T					
Type L Copper					
10	4.43	4.52	4.62	4.71	4.81
12	10.2	10.4	10.7	10.9	11.1
15	19.3	19.7	20.1	20.5	20.9
19	33.0	33.7	34.4	35.1	35.8
22	51.1	52.2	53.3	54.4	55.4
28	104	106	108	111	113
35	181	185	189	193	197
42	287	294	300	306	312
54	597	610	623	636	648
67	1057	1080	1103	1125	1147
79	1688	1725	1761	1797	1832
92	2511	2566	2619	2673	2724
105	3543	3620	3696	3771	3844
Schedule 40 Steel					
10	12.1	12.4	12.7	12.9	13.2
15	22.5	23.0	23.5	24.0	24.5
20	47.5	48.6	49.6	50.6	51.6
25	90.0	92.0	93.9	95.8	97.7
32	186	190	194	198	202
40	279	285	291	297	303
50	538	550	561	573	584
65	858	877	895	914	931
80	1518	1551	1583	1615	1647
100	3092	3159	3225	3291	3355

Note:

- (i) Capacity based on saturated vapour (no useful superheat)
- (ii) Mean condenser temperature 40 °C (no subcooling)

Table 8a: Minimum refrigeration capacity in kW for oil entrainment A mixture of Klea® 134a and 32 cSt Polyolester lubricant - Type L Copper Tubing

Saturated Temp °C	Suction Temp °C	Nominal bore mm												
		10	12	15	19	22	28	35	42	54	67	79	92	105
10	15	0.220	0.480	0.867	1.43	2.16	4.21	7.12	11.0	22.0	37.8	58.9	85.9	119
	20	0.221	0.481	0.869	1.44	2.17	4.22	7.14	11.0	22.0	37.8	59.0	86.1	120
	25	0.221	0.481	0.870	1.44	2.17	4.23	7.15	11.0	22.0	37.9	59.1	86.2	120
5	10	0.200	0.436	0.788	1.30	1.96	3.83	6.47	10.0	20.0	34.3	53.5	78.1	108
	15	0.201	0.437	0.791	1.31	1.97	3.84	6.49	10.0	20.0	34.4	53.7	78.3	109
	20	0.201	0.438	0.793	1.31	1.98	3.85	6.51	10.1	20.1	34.5	53.8	78.5	109
0	5	0.181	0.394	0.713	1.18	1.78	3.46	5.85	9.04	18.1	31.0	48.4	70.6	98.0
	10	0.182	0.396	0.716	1.18	1.78	3.48	5.88	9.08	18.1	31.2	48.6	70.9	98.5
	15	0.183	0.398	0.719	1.19	1.79	3.49	5.90	9.12	18.2	31.3	48.8	71.2	98.9
-5	0	0.163	0.355	0.642	1.06	1.60	3.12	5.27	8.14	16.3	28.0	43.6	63.6	88.3
	5	0.164	0.357	0.646	1.07	1.61	3.14	5.30	8.19	16.4	28.1	43.9	64.0	88.8
	10	0.165	0.359	0.649	1.07	1.62	3.15	5.33	8.23	16.4	28.3	44.1	64.3	89.3
-10	-5	0.146	0.318	0.576	0.952	1.43	2.80	4.73	7.30	14.6	25.1	39.1	57.1	79.2
	0	0.147	0.321	0.580	0.958	1.44	2.82	4.76	7.35	14.7	25.2	39.4	57.4	79.7
	5	0.148	0.323	0.584	0.964	1.45	2.83	4.79	7.40	14.8	25.4	39.6	57.8	80.2

Note: Content of refrigerant in lubricant estimated from solubility at suction gas temperature and pressure

Table 8b: Minimum refrigeration capacity in kW for oil entrainment - A mixture of Klea® 134a and 68 cSt Polyolester lubricant - Type L Copper Tubing

Saturated Temp °C	Suction Temp °C	Nominal bore mm												
		10	12	15	19	22	28	35	42	54	67	79	92	105
10	15	0.214	0.465	0.841	1.390	2.096	4.085	6.908	10.668	21.310	36.617	57.125	83.343	115.675
	20	0.214	0.466	0.843	1.393	2.100	4.093	6.922	10.689	21.352	36.690	57.239	83.509	115.906
	25	0.214	0.467	0.844	1.395	2.103	4.099	6.932	10.705	21.384	36.745	57.325	83.634	116.080
5	10	0.194	0.423	0.764	1.263	1.904	3.711	6.276	9.693	19.361	33.269	51.902	75.723	105.099
	15	0.195	0.424	0.767	1.267	1.911	3.724	6.297	9.725	19.425	33.379	52.073	75.973	105.446
	20	0.195	0.425	0.769	1.271	1.916	3.734	6.315	9.752	19.480	33.472	52.219	76.186	105.742
0	5	0.176	0.382	0.692	1.143	1.723	3.359	5.680	8.771	17.521	30.106	46.968	68.525	95.108
	10	0.176	0.384	0.695	1.148	1.731	3.374	5.705	8.810	17.599	30.241	47.178	68.831	95.534
	15	0.177	0.386	0.698	1.153	1.738	3.387	5.728	8.846	17.670	30.362	47.367	69.107	95.917
-5	0	0.158	0.345	0.623	1.030	1.553	3.026	5.118	7.904	15.788	27.128	42.322	61.747	85.701
	5	0.159	0.347	0.627	1.036	1.562	3.043	5.147	7.948	15.877	27.281	42.560	62.094	86.183
	10	0.160	0.348	0.630	1.041	1.570	3.059	5.173	7.989	15.958	27.420	42.777	62.410	86.622
-10	-5	0.142	0.309	0.559	0.924	1.393	2.715	4.591	7.090	14.162	24.335	37.964	55.388	76.875
	0	0.143	0.311	0.563	0.930	1.402	2.733	4.622	7.137	14.257	24.498	38.218	55.759	77.391
	5	0.144	0.313	0.566	0.936	1.411	2.750	4.650	7.181	14.345	24.649	38.455	56.104	77.869

Note: Content of refrigerant in lubricant estimated from solubility at suction gas temperature and pressure

Table 8c: Minimum refrigeration capacity in kW for oil entrainment - A mixture of Klea® 134a and 32 cSt Polyolester lubricant - Schedule 40 steel

Saturated Temp °C	Suction Temp °C	Nominal bore mm									
		10	15	20	25	32	40	50	65	80	100
10	15	0.675	1.21	2.44	4.46	8.85	13.0	24.3	37.9	65.3	129
	20	0.676	1.21	2.44	4.47	8.87	13.0	24.4	38.0	65.4	129
	25	0.678	1.21	2.45	4.47	8.88	13.1	24.4	38.0	65.5	129
5	10	0.613	1.10	2.22	4.05	8.04	11.8	22.1	34.4	59.3	117
	15	0.615	1.10	2.22	4.06	8.07	11.9	22.2	34.5	59.5	117
	20	0.617	1.10	2.23	4.08	8.09	11.9	22.2	34.6	59.6	118
0	5	0.555	0.99	2.00	3.66	7.28	10.7	20.0	31.2	53.6	106
	10	0.557	1.00	2.01	3.68	7.31	10.7	20.1	31.3	53.9	106
	15	0.560	1.00	2.02	3.70	7.34	10.8	20.2	31.4	54.1	107
-5	0	0.500	0.894	1.81	3.30	6.55	9.63	18.0	28.1	48.3	95.3
	5	0.503	0.899	1.82	3.32	6.59	9.69	18.1	28.2	48.6	95.8
	10	0.505	0.904	1.83	3.34	6.63	9.74	18.2	28.4	48.8	96.3
-10	-5	0.448	0.802	1.62	2.96	5.88	8.64	16.1	25.2	43.3	85.5
	0	0.451	0.807	1.63	2.98	5.92	8.70	16.3	25.3	43.6	86.0
	5	0.454	0.813	1.64	3.00	5.96	8.76	16.4	25.5	43.9	86.6

Table 8d: Minimum refrigeration capacity in kW for oil entrainment - A mixture of Klea® 134a and 68 cSt Polyolester lubricant - Schedule 40 steel

Saturated Temp °C	Suction Temp °C	Nominal bore mm									
		10	15	20	25	32	40	50	65	80	100
10	15	0.655	1.171	2.366	4.324	8.586	12.622	23.576	36.763	63.289	124.834
	20	0.656	1.174	2.371	4.333	8.603	12.647	23.623	36.837	63.416	125.084
	25	0.657	1.176	2.374	4.339	8.616	12.666	23.658	36.892	63.511	125.271
5	10	0.595	1.064	2.150	3.929	7.801	11.468	21.420	33.402	57.503	113.421
	15	0.597	1.068	2.157	3.942	7.827	11.505	21.491	33.512	57.693	113.796
	20	0.599	1.071	2.163	3.953	7.849	11.538	21.551	33.606	57.855	114.115
0	5	0.538	0.963	1.945	3.555	7.059	10.377	19.384	30.227	52.037	102.639
	10	0.541	0.967	1.954	3.571	7.091	10.424	19.471	30.362	52.270	103.099
	15	0.543	0.971	1.962	3.586	7.119	10.466	19.549	30.484	52.479	103.512
-5	0	0.485	0.868	1.753	3.204	6.361	9.351	17.467	27.237	46.890	92.487
	5	0.488	0.873	1.763	3.222	6.397	9.404	17.565	27.390	47.153	93.007
	10	0.490	0.877	1.772	3.238	6.430	9.451	17.655	27.530	47.394	93.481
-10	-5	0.435	0.779	1.572	2.874	5.706	8.388	15.668	24.432	42.061	82.962
	0	0.438	0.784	1.583	2.893	5.744	8.444	15.773	24.596	42.343	83.518
	5	0.441	0.789	1.593	2.911	5.780	8.496	15.871	24.748	42.605	84.035

Note: Content of refrigerant in lubricant estimated from solubility at suction gas temperature and pressure

Table 9a: Suction line capacity correction factors for Klea® 134a

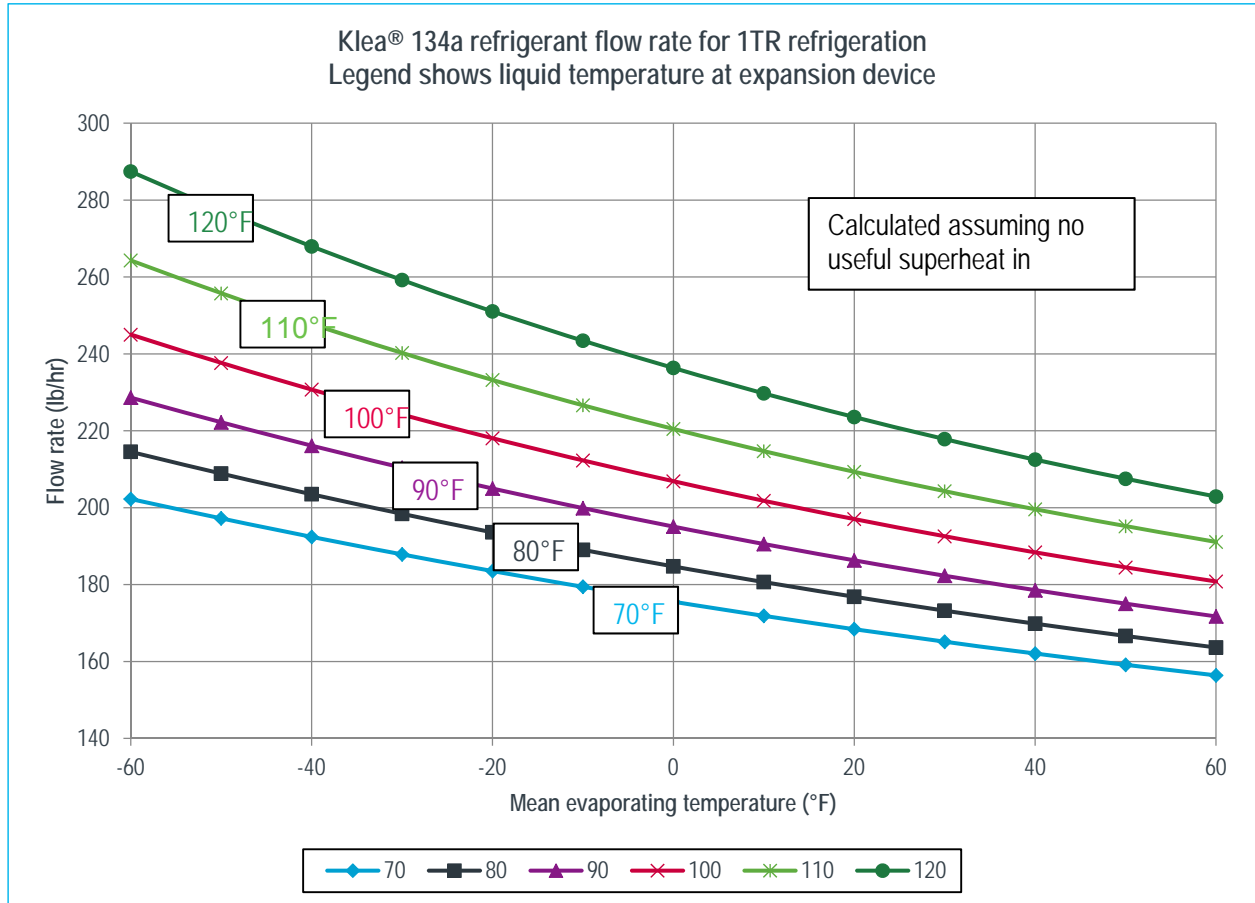
To convert from tabulated values at a mean condenser temperature of 40°C to the desired value, multiply by the appropriate factor.

Evap. Temp. °C	Temperature liquid °C						
	20	25	30	35	40	45	50
5	1.199	1.150	1.101	1.051	1.000	0.949	0.896
0	1.203	1.153	1.103	1.052	1.000	0.948	0.894
-5	1.207	1.156	1.105	1.053	1.000	0.947	0.892
-10	1.212	1.160	1.107	1.054	1.000	0.945	0.890

Table 9b: Discharge line capacity correction factors for Klea® 134a

To convert from tabulated values at a condenser temperature of 40 °C to the desired value, multiply by the appropriate factor

Evap. Temp. °C	Condenser Temperature °C		
	30	40	50
10	0.852	1.000	1.140
5	0.854	1.000	1.137
0	0.855	1.000	1.134
-5	0.857	1.000	1.132
-10	0.859	1.000	1.129



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