Calculation method - Cooling connections

Suction line

The following table lists recommendations for each suction line based on the minimum and maximum cooling capacity.

Evap. temp. °C	Diameter line	GAS LINE EVAPORATOR SUCTION COMPRESSOR R-449A / R-452A / R-404A							GAS LINE EVAPORATOR SUCTION COMPRESSOR R-134a							
		Minimum Cooling capacity (kW)	Cooling capacity max. (kW) for a temperature drop of saturation 1 K, as equivalent to length of line						Minimum Cooling capacity (kW)	Cooling capacity max. (kW) for a temperature drop of saturation 1 K, as equivalent to length of line						
			10 m	15 m	20 m	25 m	30 m	40 m	50 m	10 m	15 m	20 m	25 m	30 m	40 m	50 m
High temperature Evaporation temperature: 0 °C	3/8"	0.2	1.3	1.0	0.9	0.8	0.7	0.6	0.5	0.2	0.8	0.7	0.6	0.5	0.4	0.4	0.3
	1/2"	0.5	3.2	2.6	2.2	1.9	1.7	1.5	1.3	0.5	2.0	1.6	1.4	1.2	1.1	0.9	0.8
	5/8"	0.9	6.1	4.9	4.2	3.7	3.3	2.8	2.5	0.9	3.8	3.1	2.6	2.3	2.1	1.8	1.6
	3/4"	1.4	10.1	8.1	6.9	6.1	5.5	4.7	4.2	1.5	6.4	5.1	4.4	3.9	3.5	3.0	2.6
	7/8"	2.0	15.8	13	11	9.6	8.7	7.4	6.5	2.2	10	8.0	6.9	6.1	5.5	4.7	4.1
	1"	3.0	22	19	16	14	13	11	9.6	3.2	15	12	10.0	8.9	8.0	6.9	6.1
	1 1/8 "	4.0	28	25	22	19	17	15	13	3.7	17	16	14	12	11	9.4	8.3
	1 3/8 "	7	41	41	36	32	29	25	22	6	24	24	23	21	19	16	14
	1 5/8 "	10	58	58	58	52	47	40	35	9	35	35	35	33	30	25	23
	2 1/8 "	21	103	103	103	103	99	84	75	19	61	61	61	61	63	54	48
	2 5/8 "	35	155	155	155	155	155	145	129	32	95	95	95	95	95	93	82
	3 1/8 "	55	225	225	225	225	225	225	209	50	135	135	135	135	135	135	133
	3 5/8 "	80	300	300	300	300	300	300	300	75	180	180	180	180	180	180	180
	4 1/8 "	115	400	400	400	400	400	400	400	100	230	230	230	230	230	230	230
Positive temperature Evaporation temperature: -10 °C	3/8"	0.2	0.9	0.7	0.6	0.5	0.5	0.4	0.4	0.2	0.55	0.44	0.37	0.33	0.30	0.25	0.22
	1/2"	0.4	2.2	1.8	1.5	1.3	1.2	1.0	0.9	0.4	1.3	1.1	0.9	0.8	0.7	0.6	0.5
	5/8"	0.8	4.2	3.4	2.9	2.5	2.3	2.0	1.7	0.7	2.6	2.1	1.8	1.5	1.4	1.2	1.1
	3/4"	1.2	7.0	5.6	4.8	4.3	3.9	3.3	2.9	1.2	4.3	3.4	2.9	2.6	2.3	2.0	1.8
	7/8"	1.7	11	8.8	7.5	6.7	6.0	5.1	4.5	1.8	6.7	5.4	4.6	4.1	3.7	3.1	2.8
	1"	2.5	15	13	11	9.7	8.8	7.5	6.7	2.6	9.9	7.9	6.7	6.0	5.4	4.6	4.1
	1 1/8 "	3.5	19	18	15	13	12	10	9.1	3.0	11	10.8	9.2	8.1	7.4	6.3	5.5
	1 3/8 "	5.5	28	28	25	22	20	17	15	5.0	16	17	16	14	12	11	9.4
	1 5/8 "	9.0	40	40	40	36	33	28	25	7.5	23	24	25	22	20	17	15
	2 1/8 "	18	70	70	70	70	69	59	52	15	41	42	43	44	42	36	32
	2 5/8 "	30	105	105	105	105	105	101	90	25	62	63	64	65	66	62	55
	3 1/8 "	50	155	155	155	155	155	155	146	40	90	91	92	93	94	95	89.7
	3 5/8 "	65	200	200	200	200	200	200	200	60	120	121	122	123	124	125	126
	4 1/8 "	90	265	265	265	265	265	265	265	75	150	151	152	153	154	155	156
Negative temperature Evaporation temperature: -30 °C	3/8"	0.2	0.4	0.3	0.3	0.2	0.2	0.2	0.2								
	1/2"	0.3	1.0	0.8	0.7	0.6	0.5	0.4	0.4								
	5/8"	0.5	1.8	1.5	1.3	1.1	1.0	0.9	0.8								
	3/4"	0.9	3.1	2.5	2.1	1.9	1.7	1.4	1.3								
	7/8"	1.2	4.8	3.9	3.3	2.9	2.6	2.2	2.0								
	1"	1.5	6.2	5.6	4.8	4.3	3.9	3.3	2.9								
	1 1/8 "	2.0	8.1	7.7	6.6	5.8	5.3	4.5	4.0								
	1 3/8 "	3.5	12	12	11	9.9	8.9	7.6	6.7								
	1 5/8 "	5.5	17	17	17	16	14	12	11								
	2 1/8 "	11	30	30	30	30	30	26	23								
	2 5/8 "	18	46	46	46	46	46	45	39								
	3 1/8 "	30	66	66	66	66	66	66	64								
	3 5/8 "	45	90	90	90	90	90	90	90								
	4 1/8 "	60	115	115	115	115	115	115	115								
Negative temperature - Vapour injection Evaporation temperature: -30 °C	3/8"	0.2	0.7	0.5	0.4	0.4	0.4	0.3	0.3								
	1/2"	0.5	1.6	1.3	1.1	1.0	0.9	0.7	0.7								
	5/8"	0.8	3.1	2.5	2.1	1.9	1.7	1.4	1.3								
	3/4"	1.3	5.1	4.1	3.5	3.1	2.8	2.4	2.1								
	7/8"	1.8	8.0	6.4	5.5	4.9	4.4	3.7	3.3								
	1"	2.5	11	9.4	8.0	7.1	6.4	5.5	4.9								
	1 1/8 "	4.0	14	13	11	9.7	8.8	7.5	6.6								
	1 3/8 "	6.0	20	20	19	16	15	13	11								
	1 5/8 "	10	30	30	30	26	24	20	18								
	2 1/8 "	18	50	50	50	50	50	43	38								
	2 5/8 "	30.0	75	75	75	75	75	75	66								
	3 1/8 "	50.0	110	110	110	110	110	110	110								
	3 5/8 "	70.0	150	150	150	150	150	150	150								
	4 1/8 "	100.0	200	200	200	200	200	200	200								

Suction pipe selection

Given a cooling capacity at a determined evaporating temperature, it is necessary to select the pipe that includes this capacity value between the minimum recommended value for the pipe and the maximum recommended value depending on the equivalent length of the pipe. To ensure the correct oil return in vertical uprights, it is recommended to select a pipe diameter where the cooling capacity is 50 % higher than the minimum recommended value.

It is recommended to avoid the selection of pipes with red data, which are associated with a cooling performance loss of more than 15 %.

It is recommended not to exceed the values indicated in blue, associated with a maximum gas velocity of 15 m/s.

Pipe insulation

In suction pipes, the following minimum insulation thickness is recommended in elastomeric foam in order to avoid surface condensation at an ambient temperature of 25 °C and 50 % RH:

- High and positive temperature: 10 mm
- Negative temperature (Evap. temp.: -30 °C): 20 mm

Calculation basis

This calculation method developed by INTARCON is provided for guidance only and it is the responsibility of the designer to carry out the appropriate checks. The calculation is only valid for the pre-dimensioning of refrigerant lines in copper piping for refrigeration use.

The maximum cooling capacities indicated for each case correspond to a pressure drop of 1 K at saturation temperature, with a gas velocity limit of 15 m/s (data in blue).

The minimum recommended cooling capacities for the suction lines correspond to a minimum velocity of 4 m/s at medium and high temperature, 5 m/s at low temperature.

All data ratings have been calculated based on a condensing temperature of 45 °C, evaporator superheat of 10 K and expansion valve subcooling of 0 K or 40 K for liquid subcooled at low temperature.

Fluid line

The following table indicates the recommended average cooling capacity for fluid piping and refrigerant charge according to the diameter.

Diameter copper line	Cooling capacity recommended in fluid line				Refrigerant load (gr/m)	
	Without subcooling		With subcooling 0°C			
	R-404A / R-452A	R-134a / R-449A	R-404A	R-134a / R-449A	R-449A / R-452A	R-134a / R-449A
1/4"	2	3	4	5	20	25
3/8"	5	7	12	15	50	65
1/2"	10	14	24	30	100	120
5/8"	15	23	40	50	160	200
3/4"	23	35	55	80	240	300
7/8"	32	50	80	120	340	400
1"	43	63	105	150	450	500
1 1/8"	55	80	135	200	550	700
1 3/8"	80	120	200	300	850	1 000
1 5/8"	115	170	280	400	1 200	1 500
2 1/8"	200	300	500	700	2 100	2 500

Equivalent length

The equivalent length of a cooling line is usually between 1.2 and 5 times the actual length depending on the number of elbows and reductions. A rough estimate can be made using the values indicated in the following table:

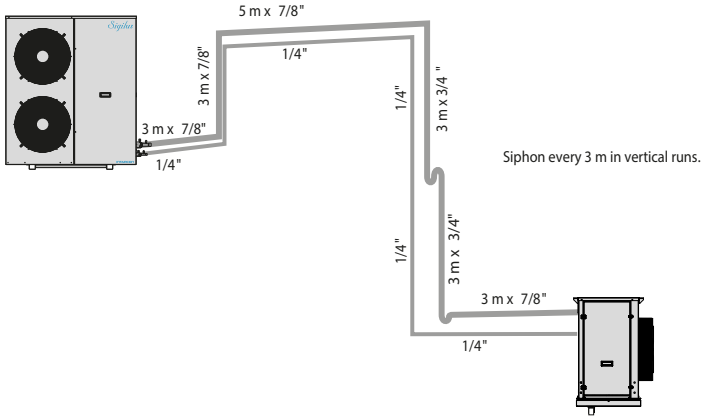
Diameter cooper line	Longitud equivalente (m)						
	Elbow to 90°	T-branch		Reduction	Siphon	Service angular valve	Gate service valve
		Straight flow	Derived flow				
3/8"	0.7	0.3	0.8	0.3	1.1	1.8	0.2
1/2"	0.8	0.3	0.9	0.4	1.2	2.0	0.2
5/8"	0.9	0.4	1.0	0.5	1.4	2.2	0.3
3/4"	1.0	0.4	1.2	0.6	1.6	2.5	0.3
7/8"	1.1	0.5	1.4	0.6	1.8	3.0	0.3
1"	1.2	0.5	1.5	0.7	2.0	3.5	0.3
1 1/8"	1.4	0.6	1.8	0.8	2.3	4.0	0.4
1 3/8"	1.7	0.7	2.2	1.0	2.7	5.0	0.5
1 5/8"	2.0	0.9	2.7	1.2	3.5	6.0	0.6
2 1/8"	2.5	1.1	3.3	1.5	4.3	8.0	0.7

Recommendations

In designing the layout of the refrigerant lines the following practices are recommended:

- Design the layout as straight as possible, with the minimum number of elbows, diversions and valves.
- Install a trap in vertical runs of suction line every 3 meters.
- Install the horizontal sections of the suction line in a downward slope towards the compressor.
- Evaporators refrigeration connections to the intake manifold must always be conducted through the top of the units.

Example - Refrigeration line calculation



Liquid piping selection

Given a given cooling capacity at a given evaporating temperature, the liquid pipe diameter must be selected according to the recommended cooling capacity with a range of ± 50 %.

It is recommended that liquid piping should not be insulated unless it is exposed to direct sunlight or in two-stage compression or vapour injection systems, where the piping should be insulated with a minimum 10 mm thick element to preserve liquid subcooling and prevent surface condensation.

The recommended cooling capacities for liquid lines correspond to flow rates of 1 m/s.

Calculation example

Dimensioning of refrigerant lines according to service to a 1500 W evaporator for low temperature cold rooms at -20 °C with a DT1 of 7 K.

The liquid line is dimensioned based on the recommended cooling capacity, 1/4" piping being admissible.

Initially we take an equivalent length of 1.5 times the actual length. This is: Leq = 1.5 x 20 m = 30 m.

Admitting in the suction line a pressure drop equivalent to 1K saturation temperature, if we go to the column for 30 m of low temperature pipe (-30 °C evaporation), finding that:

Pipe 3/4" pipe has a recommended maximum power of 1.7 kW, but with a loss of efficiency greater than 15 % (figures in red).

Pipe 7/8" has a minimum power of 1.5 kW, impeding the return of gas in vertical uprights.

7/8" diameter it is recommended for horizontal and descending sections, and 3/4" diameter only in vertical uprights.

We can see that the estimate of the equivalent length is correct:

Leq = 20 m + 3x 1.1 m (elbow) + 2x 1.6 m (oil trap) +2.5 m (check valve) = 29 m