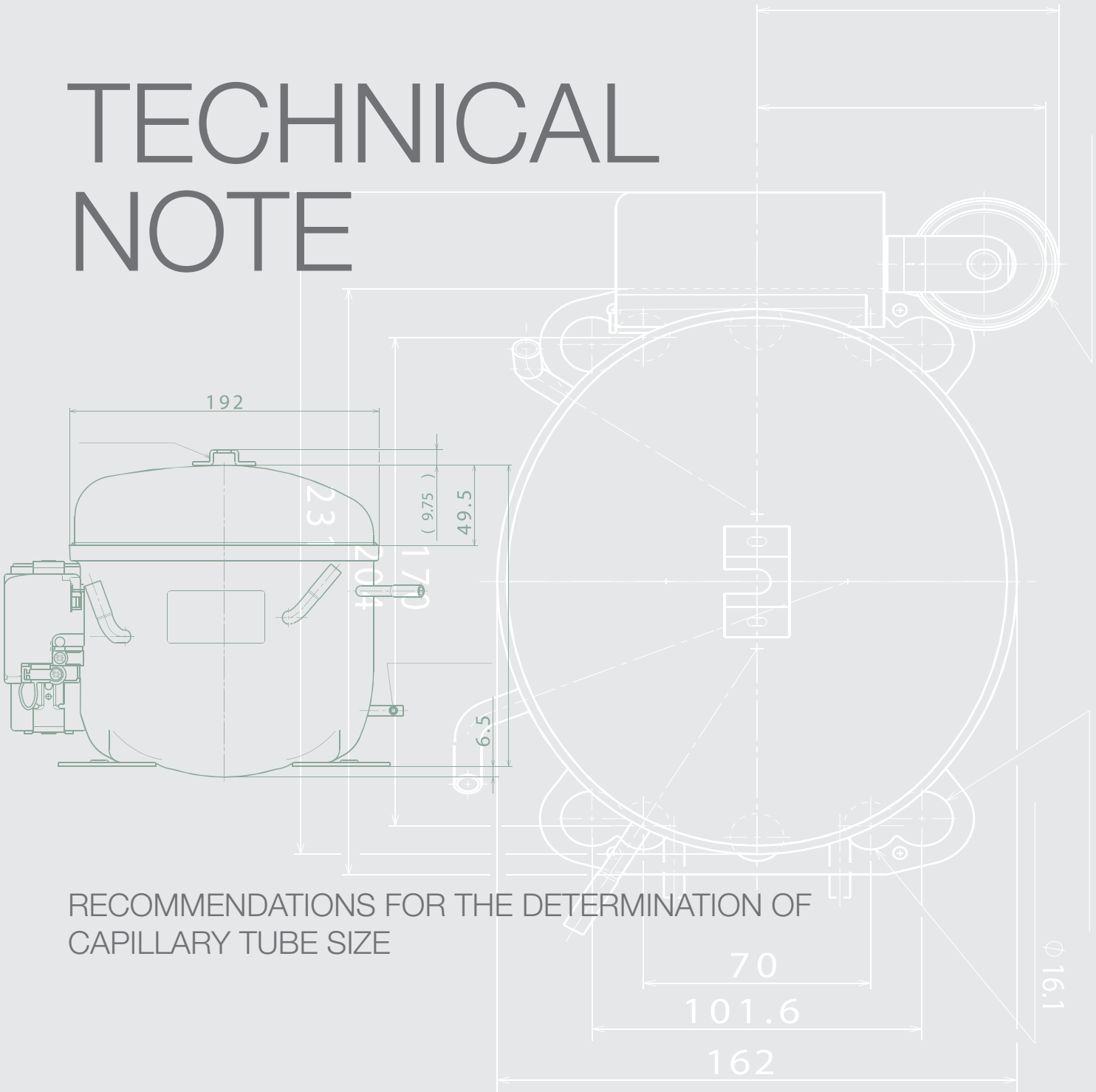
TECHNICAL NOTE



RECOMMENDATIONS FOR THE DETERMINATION OF CAPILLARY TUBE SIZE

cubigel® compressors by HUAYI COMPRESSOR BARCELONA

Recommendations for the determination of capillary tube size

INTRODUCTION

The capillary tube is one of the most commonly used expansion devices in those cooling systems which work in vapour compression cycles. It is used in all domestic appliances and also in many commercial designs. It is easy to mount, economic and free from breakdowns.

The selection is based on the practical method of “trial and error”, i.e. testing the different capillaries to determine which one gives the best performance. Although simplified calculation models are available, the final adjustment for a given application should be made by practical laboratory tests. This is simply because the cooling system does not operate under constant conditions and the capillary behaviour is therefore directly affected.

Tables are presented at the end of this document for the most suitable capillary selection for a given cooling capacity. These are intended to assist the commencement of laboratory tests, with a view to minimize the number of tests. The tables refer to R22, R600a, R134a, R290 and R404A.

CHOICE OF THE CAPILLARY TUBE

Among the conditions which most affect the flow within the capillary are the inlet and outlet pressures which, in general, correspond to the condensing and evaporating pressures. A practical observation would be that a change of 10 K in the condensing temperature can result in an approximate variation of 5 K in the evaporating temperature.

In mass production, the differences of diameter and surface roughness due to production tolerances, will also affect the real gas flow through the capillary.

This above explanation of the variables encountered will highlight the constraints of giving some recommendations of a general nature. The information given refers to a condensing **temperature of ºC** and the **existence of a heat exchanger.**

Using the tables is very simple. In principle, the starting point should be the refrigerant flow but, as a cooling cycle is defined, the flow is proportional to the cooling capacity which is accessed from the compressor catalogue, *by using the corresponding cooling capacity and not the flow data.*

I.e. the necessary data are:

Evaporating temperature (e.g. -30ºC)

Compressor model (e.g. GL80AH)

The cooling capacity of each compressor can be read from the relevant data sheet. E.g. the GL80AH with evaporating/ condensing temperatures of -30/45ºC respectively, generates a cooling capacity of 129 kcal/h in cycle with subcooling to 32ºC (ASHRAE).

Turn to the relevant refrigerant table, in this case R134a, and look for the approximate cooling capacity, 129 kcal/h. In the first column the closest reading is 123 kcal/h and the second and third columns respectively, give the inner diameter and length of the capillary.

CHANGES IN THE DIAMETER

It is possible, with some restriction, to work with different diameters than those indicated in the tables. The following formula will help determine the approximate length of the new capillary when specifying a different diameter than given in the tables.

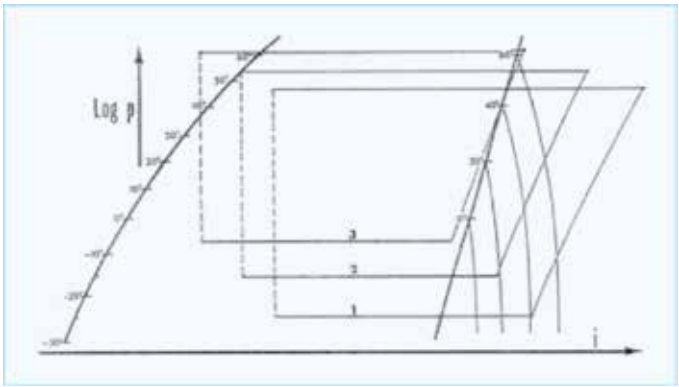
$$Z = \left(\frac{D}{D_0}\right)^{4.7} * Z_0$$

NOTE: The subindex (0) indicates the given values of the enclosed tables

EQUILIBRIUM OF THE COOLING SYSTEM

Each element of the system - compressor, condenser, capillary, evaporator - has its own behavioural characteristics. Once designed and constructed, the equilibrium to some given working conditions - thermal load, ambient temperature - is established by the refrigerant charge. *Whether this is adequate or not will greatly influence the efficiency of the system.*

Too small a charge will result in too low an evaporating temperature, little refrigerant effect and poor use of the evaporator (low flow)



“Figure 2” Diagram

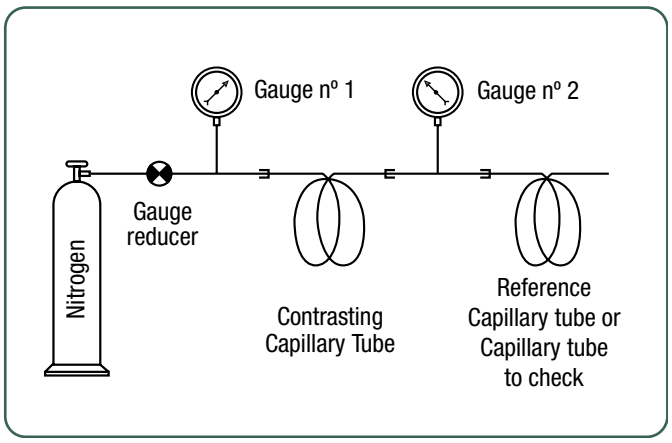
An excess of refrigerant gas will result in high discharge pressures, a decrease in compressor efficiency and an excess of liquid which will appear in the suction line.

The figure shows a schematic outline, over the enthalpy diagram, of the effects of the different refrigerant charges. Curve 1 corresponds to a low refrigerant gas charge. The low suction pressure results in a low flow from the compressor which

fails to generate sufficient liquid to fill the capillary. As a consequence, a significant quantity of vapour passes through the capillary.

In curve 2, an increase in the charge raises the pressures and the capillary receives only liquid. In curve 3, if the degree of subcooling is excessive, there is an accumulation of liquid at the outlet of the condenser, which could affect its efficiency with an increase in the discharge pressure. An adequate charge is one which provides a *slight subcooling* at the outlet of the condenser.

With an excessive charge, there is the increased risk of liquid entering the compressor. This can provoke dilution of the lubricating oil, leading to poor lubrication, wear and, in the case of liquid entering the cylinder, breakage of the valve rendering the compressor useless.



"Figure 3" Diagram

SEAL OF LIQUID AT THE INLET OF THE CAPILLARY

The refrigerant should enter the capillary in the direction "from top to bottom", i.e. the filter-desiccant inclined (minimum 15º) with the inlet capillary at the lowest level. In this way the refrigerant liquid will accumulate, due to the weight, at the inlet of the capillary producing a "seal of liquid" which impedes vapour from entering. If the direction of the flow is "bottom to top", the liquid only reaches the capillary through being carried on by the velocity of the gas, whilst its natural tendency is to flow back which encourages vapour to bubble through the liquid and enter the capillary. This increases the discharge pressure and reduces the efficiency of the system.

VERIFICATION OF A CAPILLARY

After determining, with the help of the tables and adjustment testing, the appropriate capillary for a certain system, it is necessary to reproduce its characteristics through large batch production (to obtain, in the equivalent systems, the same pressures employing a similar compressor).

Here, a nitrogen bottle equipped with a pressure regulator adjusted to supply a variable flow at a constant pressure, e.g. 14 bar, is used.

A capillary, of the same dimensions as the one already determined, is used as a constant capillary and is mounted between the precision manometers 1 and 2.

The capillary previously established as the appropriate one for the system, is mounted at the outlet of the manometer 2. This is the reference capillary.

After adjusting the pressure regulator, the readings of the manometers is e.g. the following values

Example Manometer 1: 14 bar

Manometer 2: 7.8 bar

These values are considered the reference values.

Then, if the reference capillary is substituted by the capillary to be verified and the pressure regulator is adjusted to 14 bars, the reading on manometer 2 is 7.8 bars, only if the capillary being verified is behaving as the reference capillary.

If the manometer 2 reading is greater than 7.8 bars, then the capillary being verified is considered to be more restrictive than the reference capillary and it is necessary to reduce its length. Conversely, a lower pressure means the capillary is less restrictive and will not function. It will be impossible to recover it and a longer version has to be introduced.

NOTE: The values of 14 bars and 7.8 bars have been chosen at random for this example. It is always recommended to set the pressure regulator at a value higher than 5 bars, except in the case of high flow rates and manometers of great precision.

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C and heat exchanger in capillary...
Increase length 2% per each K of increase of condensing temperature...

TABLE FOR REFRIGERANT R22 (LBP)															
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)													
		0,6		0,7		0,8		0,9		1		1,2		1,5	
kcal/h	kg/h	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3
100	2,16	2,63	2,76												
120	2,59	1,81	1,90												
130	2,80	1,54	1,62												
140	3,02	1,33	1,39	3,06	3,20										
150	3,23	1,15	1,21	2,66	2,79										
160	3,45	1,01	1,06	2,33	2,45										
170	3,66			2,07	2,17										
180	3,88			1,84	1,93										
190	4,10			1,65	1,73	3,42	3,58								
200	4,31			1,49	1,56	3,08	3,23								
215	4,64			1,29	1,35	2,65	2,78								
230	4,96			1,12	1,18	2,31	2,42								
245	5,28			0,99	1,04	2,03	2,13								
260	5,61					1,80	1,89	3,42	3,59						
275	5,93					1,60	1,68	3,05	3,20						
300	6,47					1,34	1,41	2,55	2,68						
320	6,90					1,17	1,23	2,23	2,35						
340	7,33					1,04	1,09	1,97	2,07	3,53	3,70				
360	7,76							1,75	1,84	3,13	3,29				
380	8,19							1,57	1,65	2,80	2,94				
400	8,62							1,41	1,48	2,52	2,64				
450	9,70							1,11	1,17	1,97	2,07				
500	10,78									1,58	1,66				
550	11,86									1,30	1,36	3,56	3,74		
600	12,94									1,08	1,14	2,96	3,11		
650	14,01									0,92	0,96	2,50	2,63		
700	15,09											2,14	2,25		
750	16,17											1,85	1,95		
800	17,25											1,62	1,70		
850	18,32											1,42	1,50		
900	19,40											1,26	1,33		
950	20,48											1,13	1,18		
1000	21,56											1,01	1,06	3,58	3,68
1100	23,71													2,97	3,01
1200	25,87													2,51	2,50
1300	28,03													2,14	2,11
1400	30,18													1,85	1,80
1500	32,34													1,62	1,56
1600	34,49													1,43	1,36

Q_{ASH} is the cooling capacity under ASHRAE (LBP) condition corresponding to the indicated mass flow rate M (liquid subcooled down to 32°C, return gas superheated up to 32°C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$..
NOTE: *R22 is not recommended for LBP use..*

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C and heat exchanger in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R134a (LBP)															
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)													
		0,6		0,7		0,8		0,9		1		1,2		1,5	
kcal/h	kg/h	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3
75	1,69	2,81	2,96												
80	1,80	2,47	2,60												
85	1,91	2,18	2,31												
90	2,03	1,95	2,06												
95	2,14	1,75	1,85												
100	2,25	1,58	1,67												
105	2,36	1,43	1,52	3,30	3,48										
110	2,48	1,30	1,38	3,00	3,17										
115	2,59	1,19	1,26	2,74	2,90										
120	2,70	1,10	1,16	2,52	2,66										
125	2,82	1,01	1,07	2,32	2,45										
130	2,93			2,14	2,26										
140	3,15			1,85	1,95	3,82	4,04								
150	3,38			1,61	1,70	3,32	3,51								
160	3,60			1,41	1,49	2,91	3,08								
170	3,83			1,25	1,32	2,58	2,72								
180	4,05			1,11	1,17	2,29	2,42								
190	4,28					2,06	2,17	3,90	4,12						
200	4,50					1,85	1,95	3,52	3,71						
210	4,73					1,68	1,77	3,18	3,36						
220	4,95					1,53	1,61	2,90	3,06						
230	5,18					1,39	1,47	2,65	2,79						
240	5,41					1,28	1,35	2,43	2,56	4,29	4,56				
250	5,63						1,24	2,23	2,36	3,94	4,19				
275	6,19							1,84	1,94	3,25	3,45				
300	6,76							1,54	1,63	2,72	2,89				
325	7,32								1,38	2,31	2,45				
350	7,88								1,19	1,98	2,10				
375	8,45								1,03	1,72	1,83				
400	9,01										1,60	4,11	4,34		
425	9,57										1,41	3,63	3,83		
450	10,14										1,26	3,22	3,40		
475	10,70										1,13	2,88	3,04		
500	11,26										1,01	2,59	2,73		
525	11,82											2,34	2,47		
550	12,39											2,13	2,24		
575	12,95											1,94	2,05		
600	13,51											1,78	1,87		
650	14,64												1,59		
700	15,77												1,36	4,38	4,61
750	16,89												1,18	3,79	4,00
800	18,02												1,03	3,30	3,49
850	19,14													2,91	3,07
900	20,27													2,58	2,72
950	21,40													2,30	2,42
1000	22,52													2,06	2,18

Q_{ASH} is the cooling capacity under ASHRAE (LBP) condition corresponding to the indicated mass flow rate M (liquid subcooled down to 32 °C, return gas superheated up to 32 °C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$..

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C and heat exchanger in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R290 (LBP)															
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)													
		0,6		0,7		0,8		0,9		1		1,2		1,5	
kcal/h	kg/h	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3
150	1,76	1,55	1,62	3,59	3,76										
155	1,82	1,45	1,51	3,36	3,52										
165	1,94	1,28	1,33	2,96	3,10										
175	2,05	1,14	1,18	2,63	2,75										
185	2,17	1,02	1,06	2,35	2,46										
200	2,35			2,01	2,10										
210	2,47			1,82	1,91	3,77	3,94								
220	2,58			1,65	1,73	3,43	3,58								
235	2,76			1,45	1,52	3,00	3,13								
250	2,93			1,28	1,34	2,64	2,76								
265	3,11			1,14	1,19	2,34	2,45								
280	3,29			1,02	1,07	2,10	2,19								
295	3,46					1,88	1,97	3,60	3,76						
315	3,70					1,65	1,72	3,14	3,29						
335	3,93					1,45	1,52	2,76	2,90						
355	4,17					1,29	1,35	2,45	2,58						
375	4,40					1,15	1,21	2,19	2,30						
395	4,64					1,04	1,09	1,97	2,07	3,56	3,70				
420	4,93							1,73	1,82	3,13	3,26				
445	5,22							1,54	1,62	2,78	2,89				
470	5,52							1,37	1,45	2,48	2,58				
500	5,87							1,21	1,28	2,18	2,27				
530	6,22							1,07	1,13	1,93	2,01				
560	6,57									1,72	1,80				
595	6,98									1,52	1,58				
630	7,40									1,35	1,41	3,66	3,82		
670	7,87									1,19	1,24	3,21	3,36		
705	8,28									1,07	1,11	2,88	3,02		
750	8,80											2,53	2,65		
795	9,33											2,24	2,34		
840	9,86											1,99	2,08		
890	10,45											1,76	1,84		
945	11,09											1,55	1,63		
1000	11,74											1,38	1,44		
1060	12,44											1,22	1,28		
1120	13,15											1,09	1,14	3,77	3,89
1190	13,97													3,34	3,45
1260	14,79													2,98	3,08
1335	15,67													2,65	2,74
1415	16,61													2,36	2,44
1500	17,61													2,10	2,17

Q_{ASH} is the cooling capacity under ASHRAE (LBP) condition corresponding to the indicated mass flow rate M (liquid subcooled down to 32 °C, return gas superheated up to 32 °C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$..

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C and heat exchanger in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R404A (LBP)															
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)													
		0,6		0,7		0,8		0,9		1		1,2		1,5	
kcal/h	kg/h	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3
130	3,51	1,39	1,47	3,22	3,38										
135	3,64	1,29	1,36	2,99	3,13										
140	3,78	1,20	1,26	2,77	2,91										
145	3,91	1,11	1,18	2,58	2,71										
150	4,05	1,04	1,10	2,41	2,52										
155	4,18		1,03	2,25	2,36										
160	4,32			2,11	2,21										
165	4,45			1,98	2,08										
170	4,59			1,87	1,96										
175	4,72			1,76	1,84	3,68	3,81								
180	4,86			1,66	1,74	3,48	3,60								
190	5,13			1,49	1,56	3,11	3,22								
200	5,40			1,34	1,40	2,80	2,90								
225	6,07			1,05	1,10	2,20	2,28								
250	6,74					1,77	1,83	3,35	3,49						
275	7,42					1,46	1,51	2,75	2,87						
300	8,09					1,22	1,26	2,30	2,40						
325	8,77					1,04	1,07	1,94	2,03	3,55	3,69				
350	9,44							1,67	1,74	3,04	3,17				
375	10,12							1,45	1,51	2,64	2,74				
400	10,79							1,27	1,32	2,30	2,40				
425	11,46							1,12	1,17	2,03	2,11				
450	12,14								1,04	1,80	1,88				
475	12,81									1,61	1,68				
500	13,49									1,45	1,51				
525	14,16									1,31	1,36	3,54	3,78		
550	14,84									1,19	1,24	3,21	3,43		
575	15,51									1,08	1,13	2,92	3,12		
600	16,19										1,03	2,67	2,85		
650	17,53											2,25	2,41		
700	18,88											1,93	2,06		
750	20,23											1,67	1,79		
800	21,58											1,45	1,56		
850	22,93											1,28	1,37		
900	24,28											1,13	1,22		
950	25,63											1,01	1,09	3,54	3,76
1000	26,98													3,18	3,38
1100	29,67													2,61	2,77
1200	32,37													2,18	2,32
1300	35,07													1,84	1,96
1400	37,77													1,58	1,68
1500	40,46													1,37	1,46

Q_{ASH} is the cooling capacity under ASHRAE (LBP) condition corresponding to the indicated mass flow rate M (liquid subcooled down to 32 °C, return gas superheated up to 32 °C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$..

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C and heat exchanger in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R600a (LBP)											
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)									
		0,6		0,7		0,8		0,9		1	
kcal/h	kg/h	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3	-30	-23,3
55	0,69	3,13	3,28								
60	0,75	2,64	2,77								
65	0,81	2,26	2,36								
70	0,87	1,95	2,05								
75	0,93	1,71	1,79								
80	1,00	1,51	1,58								
85	1,06	1,34	1,40	3,03	3,18						
90	1,12	1,20	1,25	2,71	2,84						
95	1,18	1,08	1,13	2,43	2,55						
100	1,25			2,20	2,31						
105	1,31			2,00	2,09						
110	1,37			1,82	1,91						
115	1,43			1,67	1,75						
120	1,49			1,54	1,61	3,14	3,28				
130	1,62			1,31	1,37	2,67	2,80				
140	1,74				1,19	2,31	2,42				
150	1,87					2,01	2,11				
160	1,99					1,77	1,85	3,33	3,49		
170	2,12					1,57	1,64	2,95	3,10		
180	2,24					1,40	1,47	2,64	2,77		
190	2,37					1,26	1,32	2,37	2,49		
200	2,49					1,14	1,19	2,14	2,25		
210	2,62					1,03	1,08	1,95	2,04	3,39	3,56
220	2,74							1,77	1,86	3,09	3,25
230	2,87							1,63	1,71	2,82	2,97
240	2,99							1,49	1,57	2,59	2,73
250	3,11							1,38	1,45	2,39	2,51

Q_{ASH} is the cooling capacity under ASHRAE (LBP) condition corresponding to the indicated mass flow rate M (liquid subcooled down to 32 °C, return gas superheated up to 32 °C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$..

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C. Non adiabatic flow in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R22 (HMBP)													
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)											
		0,7		0,8		0,9		1		1,2		1,5	
kcal/h	kg/h	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2
100	2,23												
120	2,67	4,54	4,68										
130	2,90	3,90	4,02										
140	3,12	3,36	3,47										
150	3,34	2,92	3,03										
160	3,57	2,59	2,68										
170	3,79	2,29	2,37	4,67	4,82								
180	4,01	2,04	2,11	4,16	4,30								
190	4,24	1,83	1,89	3,73	3,88								
200	4,46	1,66	1,72	3,40	3,52								
215	4,79	1,43	1,49	2,94	3,04								
230	5,13	1,25	1,30	2,56	2,65	4,79	4,95						
245	5,46	1,09	1,14	2,26	2,35	4,26	4,41						
260	5,80		1,01	2,01	2,09	3,79	3,92						
275	6,13			1,80	1,87	3,38	3,50						
300	6,69			1,50	1,56	2,83	2,94	5,00					
320	7,13			1,31	1,37	2,50	2,60	4,40	4,55				
340	7,58			1,16	1,22	2,21	2,30	3,89	4,02				
360	8,02			1,04	1,09	1,97	2,05	3,46	3,58				
380	8,47					1,76	1,83	3,12	3,24				
400	8,92					1,58	1,65	2,82	2,93				
450	10,03					1,25	1,31	2,22	2,31				
500	11,15						1,05	1,78	1,86	4,76	4,93		
550	12,26							1,47	1,54	3,96	4,11		
600	13,37							1,23	1,29	3,32	3,45		
650	14,49							1,03	1,09	2,82	2,93		
700	15,60									2,41	2,52		
750	16,72									2,09	2,18		
800	17,83									1,84	1,93		
850	18,95									1,63	1,71		
900	20,06									1,44	1,52	4,87	
950	21,18									1,28	1,35	4,36	4,53
1000	22,29									1,15	1,21	3,92	4,07
1100	24,52											3,21	3,35
1200	26,75											2,71	2,84
1300	28,98											2,30	2,41
1400	31,21											1,96	2,06
1500	33,44											1,69	1,78
1600	35,67											1,46	1,55

Q_{ASH} is the cooling capacity under ASHRAE (HMBP) condition corresponding to the indicated mass flow rate M (liquid subcooled 9K, return gas superheated up to 35 °C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$ ..

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C. Non adiabatic flow in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R134a (HMBP)																	
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)															
		0,7		0,8		0,9		1		1,2		1,5		1,7		2	
kcal/h	kg/h	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2
100	2,32	4,11	3,86														
110	2,56	3,40	3,20														
120	2,79	2,88	2,71														
130	3,02	2,45	2,31														
140	3,25	2,12	2,00	4,30	4,04												
150	3,49	1,84	1,74	3,77	3,55												
160	3,72	1,62	1,53	3,32	3,12												
170	3,95	1,43	1,35	2,93	2,76												
180	4,18	1,27	1,21	2,63	2,48												
190	4,42	1,14	1,08	2,36	2,23	4,43	4,16										
200	4,65			2,13	2,00	3,99	3,76										
220	5,11			1,75	1,65	3,31	3,12										
240	5,58			1,47	1,40	2,78	2,63	4,88	4,59								
260	6,04			1,24	1,18	2,36	2,23	4,15	3,91								
280	6,51			1,06	1,02	2,04	1,93	3,60	3,40								
300	6,97					1,77	1,68	3,13	2,96								
320	7,44					1,55	1,47	2,75	2,60								
340	7,90					1,36	1,30	2,42	2,29								
360	8,37					1,21	1,15	2,17	2,06								
380	8,83					1,08	1,03	1,94	1,84	5,19	4,89						
400	9,30							1,74	1,66	4,67	4,42						
450	10,46							1,36	1,30	3,69	3,48						
500	11,62							1,09	1,05	2,99	2,83						
550	12,78									2,46	2,33						
600	13,95									2,05	1,95						
650	15,11									1,73	1,65	5,83	5,50				
700	16,27									1,47	1,42	5,00	4,73				
750	17,43									1,28	1,23	4,38	4,15				
800	18,60									1,11	1,08	3,84	3,64				
850	19,76											3,39	3,22				
900	20,92											3,00	2,86				
1000	23,25											2,40	2,30	4,80	4,54		
1100	25,57											1,98	1,90	3,94	3,74		
1200	27,89											1,64	1,58	3,28	3,12		
1300	30,22											1,37	1,33	2,79	2,66		
1400	32,54											1,16	1,13	2,38	2,29		
1500	34,87													2,05	1,98	5,01	4,76
1600	37,19													1,78	1,72	4,42	4,21
1700	39,52													1,55	1,51	3,90	3,72
1800	41,84													1,36	1,33	3,45	3,31
1900	44,17													1,20	1,18	3,08	2,95
2000	46,49													1,06	1,05	2,75	2,65
2250	52,30															2,12	2,06
2500	58,11															1,66	1,63
2750	63,92															1,35	1,33
3000	69,74															1,09	1,10

Q_{ASH} is the cooling capacity under ASHRAE (HMBP) condition corresponding to the indicated mass flow rate M (liquid subcooled 9K, return gas superheated up to 35 °C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$ ..

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C. Non adiabatic flow in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R290 (HMBP)															
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)													
		0,7		0,8		0,9		1		1,2		1,5		1,7	
kcal/h	kg/h	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2
130	1,58	5,12	4,39												
140	1,70	4,43	4,06												
150	1,83	3,88	3,55												
160	1,95	0,41	3,12												
170	2,07	3,01	2,77												
180	2,19	2,70	2,48	5,50	5,04										
190	2,31	2,43	2,23	4,95	4,54										
200	2,43	2,19	2,01	4,47	4,10										
220	2,68	1,80	1,66	3,69	3,40										
240	2,92	1,51	1,40	3,12	2,86	5,84	5,35								
260	3,16	1,29	1,19	2,66	2,44	4,97	4,56								
280	3,41	1,11	1,03	2,28	2,10	4,30	3,95								
300	3,65			1,98	1,83	3,76	3,45								
320	3,89			1,75	1,62	3,30	3,04								
340	4,14			1,55	1,43	2,92	2,69	5,11	4,71						
360	4,38			1,38	1,27	2,60	2,39	4,60	4,22						
380	4,62			1,23	1,14	2,33	2,15	4,13	3,79						
400	4,87			1,10	1,02	2,11	1,95	3,72	3,42						
450	5,48					1,66	1,54	2,93	2,69						
500	6,08					1,33	1,24	2,38	2,19						
550	6,69					1,09	1,01	1,96	1,81	5,23	4,80				
600	7,30							1,63	1,51	4,38	4,03				
650	7,91							1,38	1,28	3,72	3,42				
700	8,52							1,18	1,10	3,21	2,96				
750	9,13									2,80	2,59				
800	9,73									2,46	2,27				
850	10,34									2,17	2,00				
900	10,95									1,92	1,78				
950	11,56									1,71	1,59				
1000	12,17									1,54	1,43	5,17	4,76		
1050	12,78									1,38	1,29	4,70	4,34		
1100	13,38									1,25	1,17	4,30	3,96		
1150	13,99									1,14	1,07	3,93	3,63		
1200	14,60											3,60	3,33		
1250	15,21											3,31	3,06		
1300	15,82											3,05	2,83		
1350	16,43											2,82	2,61		
1400	17,03											2,61	2,42	5,18	4,77
1450	17,64											2,43	2,25	4,82	4,45
1500	18,25											2,26	2,10	4,50	4,15
1550	18,86											2,11	1,96	4,20	3,88
1600	19,47											1,97	1,84	3,94	3,64
1650	20,08											1,84	1,72	3,69	3,42
1700	20,68											1,73	1,62	3,47	3,21

Q_{ASH} is the cooling capacity under ASHRAE (HMBP) condition corresponding to the indicated mass flow rate M (liquid subcooled 9K, return gas superheated up to 35 °C)..
The relationship between length and diameter is, approximately: $(L / L_0) = (D / D_0)^{5,4}$..

Recommendations for the determination of capillary tube size

Table considers condensing temperature Tc = 45 °C. Non adiabatic flow in capillary..
Increase length 2% per each K of increase of condensing temperature..

TABLE FOR REFRIGERANT R404A (HMBP)																	
Q_{ASH}	M	Capillary tube length (m) Capillary tube internal diameter (mm) & Evaporating temperature (°C)															
		0,7		0,8		0,9		1		1,2		1,5		1,7		2	
kcal/h	kg/h	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2	5	7,2
110	3,12	4,75	4,30														
120	3,41	4,00	3,61														
130	3,69	3,42	3,10														
140	3,97	2,95	2,67														
150	4,26	2,57	2,33														
160	4,54	2,25	2,05	4,62	4,19												
170	4,83	2,00	1,81	4,10	3,72												
180	5,11	1,77	1,61	3,66	3,32												
190	5,39	1,60	1,45	3,28	2,98												
200	5,68	1,44	1,31	2,96	2,69												
220	6,24	1,19	1,08	2,44	2,22	4,61	4,18										
240	6,81			2,04	1,87	3,86	3,52										
260	7,38			1,75	1,60	3,30	2,99										
280	7,95			1,50	1,37	2,84	2,58										
300	8,52			1,30	1,19	2,46	2,24	4,37	3,96								
320	9,08			1,14	1,05	2,17	1,97	3,83	3,48								
340	9,65					1,92	1,75	3,39	3,08								
360	10,22					1,71	1,56	3,02	2,74								
380	10,79					1,53	1,40	2,70	2,46								
400	11,35					1,38	1,26	2,43	2,22								
450	12,77							1,93	1,76								
500	14,19							1,55	1,42	4,16	3,78						
550	15,61							1,27	1,17	3,43	3,11						
600	17,03									2,86	2,61						
650	18,45									2,44	2,23						
700	19,87									2,10	1,92						
750	21,29									1,82	1,67						
800	22,71									1,59	1,47						
850	24,13									1,40	1,29	4,72	4,29				
900	25,55									1,24	1,15	4,20	3,82				
1000	28,38											3,40	3,11				
1100	31,22											2,80	2,57				
1200	34,06											2,34	2,15	4,63	4,22		
1300	36,90											1,98	1,82	3,93	3,59		
1400	39,74											1,69	1,56	3,38	3,09		
1500	42,58											1,46	1,35	2,93	2,69		
1600	45,42											1,27	1,18	2,56	2,35		
1700	48,25											1,11	1,03	2,25	2,07		
1800	51,09													1,99	1,84	4,87	4,45
1900	53,93													1,77	1,64	4,36	3,99
2000	56,77													1,58	1,47	3,92	3,59
2250	63,87													1,22	1,14	3,06	2,81
2500	70,96															2,44	2,25
2750	78,06															1,99	1,84
3000	85,15															1,64	1,53
3250	92,25															1,37	1,29
3500	99,35															1,16	1,10

Q_{ASH} is the cooling capacity under ASHRAE (HMBP) condition corresponding to the indicated mass flow rate M (liquid subcooled 9K, return gas superheated up to 35 °C)..
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TECHNICAL NOTE RECOMMENDATIONS FOR THE DETERMINATION OF CAPILLARY TUBE SIZE · 07/2013

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