PRODUCTS FOR REFRIGERATING SYSTEMS
GENERAL DATA

FROM QUALITY OUR NATURAL DEVELOPMENT.

Achieved the goal of fifty years working in the industry of Refrigeration and Air Conditioning, Castel Quality Range of Products is well known and highly appreciated all over the world. Quality is the main issue of our Company and it has a special priority, in every step, all along the production cycle. UNI EN ISO 9001:2008, issued by ICIM, certifies the Quality System of the Factory. Moreover Castel Products count a number of certifications in conformity with EEC Directives and with European and American Quality Approval.
We produce on high tech machinery and updated automatic production lines, operating in conformity with the safety and environment standards currently enforced.
Castel offers to the Refrigeration and Air Conditioning Market and to the Manufacturers fully tested products suitable with HCFC and HFC Refrigerants currently used in the Refrigeration & Air Conditioning Industry.

September 2011

INDICE

EXTERNAL LEAKAGE

All the products illustrated in this Handbook are submitted, one by one, to tightness tests besides to functional tests. Allowable external leakage, measurable during the test, agrees to the definition given in Par. 9.4 of EN 12284 : 2003 Standard:

"During the test, no bubbles shall form over a period of at least one minute when the specimen is immersed in water with low surface tension, ...".

PRESSURE CONTAINMENT

All the products illustrated in this Handbook, if submitted to hydrostatic test, guarantee a pressure strength at least equal to 1,43 x PS in compliance with the Directive 97/23/EC.
All the products illustrated in this Handbook, if submitted to burst test, guarantee a pressure strength at least equal to 3 x PS according to EN 378-2 : 2008 Standard. A great number of products illustrated in this Handbook can guarantee an higher pressure strength, equal to 5 x PS according the UL Standard 207: 2009.

WEIGHTS

The weights of the items listed in this Handbook include packaging.

GUARANTEE

All Castel products are covered by a 12 – months warranty. This warranty covers all products or parts thereof that turn out to be defective within the warranty period. In this case, at his own expenses, the customer shall return the defective item with a detailed description of the claimed defects. The warranty doesn't apply if the defect of Castel products are due to mistakes either by customer or by third parties such wrong installations, use contrary to Castel indications, tampering. In case of defects of its own products, Castel will only replace the defective goods and will not refund damages of any kind.
The technical data shown on this catalogue are indicative. Castel reserves the right to modify the same at any time without any previous notice.

Application of Directive 97/23/EC of the European Parliament and of the Council, of 29 May 1997, concerning pressure equipment towards Castel refrigeration products

The Directive 97/23/EC (PED) applies to the design, manufacture and conformity assessment of pressure equipment and assemblies with a maximum allowable pressure "PS" greater than 0,5 bar with the exception of the possibilities listed in Article 1, Section 3 of the same Directive.
Since 30 May 2002 the Directive has become mandatory and, in the Member States of European Community, it has been possible to place on the market only pressure equipments CE marked according to PED.

For the purposes of the Directive see the following definitions, used in this Handbook too:
- **Pressure equipment** : vessels, piping, safety accessories, and pressure accessories
- **Vessel** : a housing designed and built to contain fluids under pressure.
- **Piping** : piping components intended for the transport of fluids, when connected together for integration into a pressure system.
- **Safety accessories** : devices designed to protect pressure equipment against the allowable limits being exceeded.
- **Pressure accessories** : devices with an operational function and having pressure-bearing housing. For example: solenoid valves, valves, indicators.
- **Assemblies** : several pieces of pressure equipment assembled by a manufacturer to constitute an integrated and functional whole.
- **Maximum allowable pressure (PS)**: the maximum pressure for which the equipment is designed, as specified by the manufacturer.
- **Maximum/minimum** allowable temperature (TS): the maximum/minimum temperatures for which the equipment is designed, as specified by the manufacturer
- **Volume (V)** : the internal volume of a chamber, including the volume of nozzles to the first connection or weld and excluding the volume of permanent internal parts.
- **Nominal size (DN)** : numerical designation of size, which is common to all components in a piping system.
- **Fluids** : gases, liquids and vapours in pure phase as well as mixture thereof.

Pressure equipments referred to in Article 3 are classified by categories in accordance with Annex II, according to ascending level of hazard, on the basis of:
- State of the fluid
- Danger classification of the fluid
- Type of equipment
- Dimensions and energetic potential; V, DN, PS, PS x V, PS x DN

and must satisfy the Essential Safety Requirement set out in Annex I of PED.
Pressure equipments below or equal to the limits in Article 3, sections 1.1 , 1.2 and 1.3 and section 2, must not satisfy the Essential Safety Requirement set out in Annex I . They must be designed and manufactured in accordance with the sound engineering practice of a Member State in order to ensure safe use (Article 3, Section 3).
In the tables of general characteristics, collected in this Handbook, it's showed the risk category in which every product is classified.

In Article 9 of PED the fluids are classified, according to their hazard, into two groups:
- **Group 1** comprises dangerous fluids. A dangerous fluid is a substance or preparation covered by the definitions in Article 2 of Council Directive 67/548/EEC of 27 June 1967 and following amendments, relating to the classification, packaging and labeling of dangerous substance. Group I comprises fluids defined as : explosive, extremely flammable, highly flammable, flammable, very toxic, toxic, oxidizing.
- **Group 2** comprises all the others fluids not referred to in group I.

Castel products are suitable for using with refrigerant fluids proper to the Group 2 .
These refrigerant fluids are listed and classified A1 in Annex E of standard EN 378-1:2008.
Among the fluids listed in this standard, there are the well known R12 ; R22 ; R134a ; R404A ; R407C ; R410A ; R502 ; R507.

Application of Directive 2002/95/EC of the European Parliament and of the Council, of 27 January 2003, on the restriction of the use of certain hazardous substances in electrical and electronic equipment towards Castel refrigeration products

The purpose of Directive 2002/95/EC (RoHS Directive) is to prevent or restrict the use of hazardous substances in electrical and electronic equipment and to contribute to the environmentally sound recovery and disposal of waste electrical and electronic equipment.
RoHS Directive shall apply to electrical and electronic equipment falling under the categories 1, 2, 3, 4, 5, 6, 7 and 10 set out in Annex 1A to Directive 2002/96/EC (WEEE – Waste electrical and electronic equipment) and to electric light bulbs and luminaries in households.
The equipment proper to the first category, **"Large household appliances" ,** and to the 10th category**, "Automatic dispensers"** , of Annex 1A in WEEE Directive, are specified in Annex 1B in the same Directive; this list of products shows:

- Large cooling appliance
- Refrigerators
- Freezers
- Other large appliances used for refrigeration, conservation and storage of food
- Air conditioner appliances
- Other fanning, exhaust ventilation and conditioning equipment
- Automatic dispenser for hot or cold bottles and cans

Article10 of WEEE Directive establishes that, from 13 August 2005, new electrical and electronic equipment put on the market are appropriately identified as waste subject to separate collection, by means of the proper symbol shown in Annex IV of the same Directive.

Article 4 of RoHS Directive establishes that, from 1 July 2006, new electrical and electronic equipment put on the market does not contain the following substances:

- Lead
- Mercury
- Cadmium
- Hexavalent chromium
- Polybrominated biphenyls (PBB)
- Polybrominated diphenyl ethers (PBDE)

Article 5 establishes maximum concentration values up to which the presence of the substances referred to in Article 4 shall be tolerated. Maximum tolerated concentrations, listed in Annex of the same Directive; are 0,1% by weight for lead, mercury, hexavalent chromium, PBB, PBDE, and 0,01 % by weight for cadmium. The restriction of use of these hazardous substances shall not apply to the applications listed in the same Annex; among these applications the following exceptions are particularly interesting in air conditioning / refrigerating systems:

- Lead as an alloying element in steel containing up to 0,35% lead by weight, aluminium containing up to 0,4% lead by weight and as a copper alloy containing up to 4% lead by weight
- Hexavalent chromium as an anti-corrosion of the carbon steel cooling system in absorption refrigerators

The Member States of European Community had to adopt the two Directives 2002/95/EC and 2002/96/EC , with the next updating 2003/108/EC, before 13 August 2004, unless delays granted by the European Parliament.
For a long time Castel Company has started a careful inquiry, together with its suppliers, to identify the presence or not of the above-mentioned hazardous substances, either in its own products or in its own production processes, and to remove them progressively.
At the end of this wide examination Castel Company may declare that its products:

1. Do not contain mercury, cadmium, polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE)
2. Do not contain hexavalent chromium, used for the surface treatments (yellow zinc plating) of steel parts. Castel Company has removed the yellow zinc plating treatments from all its products, before the end of 2005, and has chosen:

– other surface treatments containing trivalent chromium instead of hexavalent chromium.
– where possible, other materials which don't need surface treatments.

3. Contain lead as an alloying element in steel, aluminium and copper alloys within the accepted limits according to the Annex of RoHS Directive.

Application of Regulation 1907/2006/EC of the European Parliament and of the Council, of 18 December 2006, on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) towards Castel refrigeration products

The European Regulation 1907/2006/EC concerning the **R**egistration, **E**valuation, **A**uthorization and **R**estrictions of **C**hemicals, the so called REACH Regulation, was published on GUCE L136 dated 29 May 2007 and came into force in the European Union on the 1st June 2007. This Regulation requires to pre-register and register chemical substances produced or imported into Europe at the **E**uropean **A**gency for **C**hemicals (ECHA).
Castel investigates for a long time about the contents and the aims of this new law. The purpose of our company is to define its rules in the supply chain and the possible obligations we have to fulfil to, according to the REACH Regulation.

Castel is not a "manufacturer" or an "importer" of substances and so the company has not the obligation to pre-register and/or register.

Castel is not a "manufacturer" or an "importer" of preparations and so the company has not to give to its customers either information about registrations of the contained substances or information about safety.

Castel is not a "manufacturer" or an "importer" of articles that have substances intended to be realised during normal and reasonable foreseeable conditions of use (Art. 7.1 of REACH) and so the company has not the obligation to pre-register and/or register these substances.

For its suppliers, Castel is a "downstream users" of substances, preparations and articles, used in its own manufacturing processes and in its own products. For a long time our Company has started, together with its suppliers of substances/preparations and articles, a careful inquiry to verify that:
- They well know the contents and the aims of REACH Regulation
- They are working to fulfil the obligations pertaining to them , foreseen by the Regulation
- They guarantee us smooth continuity of their supplies also in the future

For its customers, Castel is a "manufacturer" of articles and in this rule our company is constantly engaged to verify that in its products:
- The restricted substances listed in Annex XVII are not used in a manner not conform to restrictions, in compliance with to Art. 67 of REACH
- The SVHC, **S**ubstances of **V**ery **H**igh **C**oncern, listed in the Candidate List of Annex XIV; are not present in the articles we supply you in more than 0,1% mass/mass. (the 0,1% threshold relates to the total weight of the articles) and simultaneously satisfied all the conditions listed in Art. 7.2 of REACH. If this case happens our company binds itself to communicate it in time to its own customers, ensuring sufficient information to safety use, according to Art. 33 of REACH.

CONNECTIONS OF CASTEL PRODUCTS

Castel products can be supplied with different connections.
In particular Castel products are produced either with threaded connections or solder connections.
Table 1 shows the equivalence between Castel codes and dimensions in inches. These codes are commonly used in the international market.

Table 2 shows the equivalence between Castel codes and dimensions in millimeters.

Description of connections that are currently used for Castel products.

1) Threaded connections
They can be of three different types:

FLARE
Straight threaded connection (according to SAE J513-92; ASME B1.1-89) for junction to a copper pipe with a suitable flared end, using a right nut (see Table 3).

NPT
Taper threaded connection (according to ASME B1.20.1-92) to joint fittings, valves, safety valves to vessel or steel pipes.

FPT
Straight threaded connection (according to UNI ISO 228/1) used in the hydraulic system to joint fittings or valves to vessel or steel pipes...
F.e.: Water regulating valves

2) Solder connections
They can be of four different types and can fit pipes with diameter both in inches and in millimeters:

ODS (or ODF)
Female solder connection for copper tubes. The indicated size corresponds to the outer diameter of the copper tube which to joint.
F.e.: 1/2" ODS solder connection suitable to receive inside a copper pipe with a 1/2" outer diameter

ODM
Male solder connection for copper tubes. The indicated size corresponds to the outer diameter of the copper tube which to joint.
F.e.: 16 ODM solder connection suitable to joint a copper pipe with a 16 mm outer diameter, by means of an M16 female/female copper sleeve (in this case the type Castel 7700/M16)

IDS
Male solder connection for copper tube. The indicated size corresponds to the inner diameter of the copper tube which to joint.
F.e.: 10 IDS solder connection suitable to receive outside a copper pipe with a 10 mm inner diameter)

W
Solder connection for steel pipes. The indicated size corresponds to the external diameter of the steel pipe which to joint.
F.e.: 76,1 W solder connection suitable to connect a steel pipe with a 76,1 mm external diameter, by means of butt welding.

TABLE 1 - Equivalence between Castel code and dimensions in inches	
Castel code	Dimension [in]
. .../1	1/8”
. .../2	1/4”
..../2.5	5/16”
. .../3	3/8”
. .../4	1/2”
. .../5	5/8”
. .../6	3/4”
. .../7	7/8”
. .../8	1”
. .../9	1” 1/8
. .../11	1” 3/8
. .../13	1” 5/8
. .../17	2” 1/8
. .../21	2” 5/8
. .../24	3”
. .../25	3” 1/8
. .../28	3” 1/2
. .../29	3” 5/8
. .../33	4” 1/8
. .../34	4” 1/4

F.e. : 1098/7 - solenoid valve with solder connection with Ø = 7/8”.

TABLE 2 - Equivalence between Castel code and dimensions in millimeters	
Castel code	Dimension [mm]
. .../M6	6
. .../M10	10
. .../M12	12
. .../M15	15
. .../M18	18
. .../M22	22
. .../M28	28
. .../M42	42
. .../M64	64
. .../M80	80

F.e. : 4411/M42A - filter drier with replaceable anti-acid solid core with solder connection with Ø = 42 mm

TABLE 3 - Flare Connections		
FLARE	Suitable for copper tube	Thread
5/16”	Ø 5/16”	1/2” - 20 UNF
3/8”	Ø 3/8”	5/8” - 18 UNF
1/2”	Ø 1/2”	3/4” - 16 UNF
5/8”	Ø 5/8”	7/8” - 14 UNF
3/4”	Ø 3/4”	1.1/16” - 14 UNS
7/8”	Ø 7/8”	1.1/4” - 12 UNF
1”	Ø 1”	1.3/8” - 12 UNF

TABLE 4 - FPT Connection	
Castel Code	Thread
…./02	G 1/4”
…./03	G 3/8”
…./04	G 1/2”
…./06	G 3/4”
…./08	G 1”
…./010	G 1.1/4”
…./012	G 1.1/2”
…./016	G 2”
…./020	G 2.1/2”
…./024	G 3”

The correct sizing of tubes and components of a refrigerating system is of the utmost importance for all kinds of plants; over-sizing and under-sizing are both to be avoided since they are equally hazardous for the correct operation of the system.
The correct selection of a component is based on the knowledge of the relationship between capacity and pressure drop through that component. For this purpose, EN 60534-1, EN 60534-2-1 and EN 60534-2-3 standards require manufacturers to specify the Kv coefficient for every product.

The Kv factor is defined as the cold water flow (volumic mass ρ = 1000 kg/m^3) in m^3 /h resulting in a 1 bar pressure drop with a completely open valve.

This definition applies to all products described in this handbook. The merely physical meaning, this coefficient precisely defines the fluid-dynamic and construction characteristics of the product, so that, with the addition of other parameters more closely related to the nature and conditions of the fluid under consideration, the capacity/pressure drop ratio may be precisely determined.
Castel provides appropriate tables for the most commonly used refrigerants in typical plant working conditions in order to help engineers in the correct selection of products.«Table 1» shows refrigeration capacity values with unit Kv related to the standard rating conditions according to AHRI Standard 760-2007.
Appropriate corrective coefficients may be calculated taking the values shown from Table 2 to Table 7 as a basis; this will make it possible to predict actual working conditions.

As a result:

- Liquid line:

$Q = Kv \times Q_1 \times L_1 \times L_2$

- Suction line

$Q = Kv \times Q_1 \times S_1 \times S_2$

- Hot gas line

$Q = Kv \times Q_1 \times H_1 \times H_2$

since:

Q = required refrigeration capacity [kW];
Kv = characteristic valve coefficient [m^3 /h];
Q_1 = reference refrigeration capacity [kW] (see table 1).
L_1 ; S_1 ; H_1 = are correction factors of the refrigeration capacity in the presence of operating temperatures different from reference conditions.
L_2 ; S_2 ; H_2 = are correction factors of the refrigeration capacity for pressure drops different from reference conditions.

TABLE 1 - Refrigeration capacities [KW]

Kv Factor [m^3/h]	Liquid line						Suction line						Hot gas line					
	Pressure drop 0,15 bar						Pressure drop 0,15 bar						Pressure drop 1 bar					
	R134a	R22	R404A	R407C	R410A	R507	R134a	R22	R404A	R407C	R410A	R507	R134a	R22	R404A	R407C	R410A	R507
1	17.00	18.30	11.90	17.23	17.17	11.50	1.89	2.55	2.23	2.27	3.00	2.23	8.50	10.80	9.60	11.62	13.60	9.54

Standard rating conditions according to AHRI Standard 760-2007

Condensing temperature	**110°F**	**(43,3°C)**
Liquid temperature	**100°F**	**(37,8°C)**
Subcooling	**10°R**	**(5,5°K)**
Evaporating temperature	**40°F**	**(4,4°C)**
Suction temperature	**65°F**	**(18,3°C)**
Superheating	**25°R**	**(13,9°K)**
Discharge temperature	**160°F**	**(71,1°C)**

1) Calculation example for liquid line:
Evaluation of pressure drop across the valve under the following operating conditions:

Castel 1078/5 valve: Kv = 2,61 [m^3/h]
Refrigerant: R407C
Set refrigeration capacity: 35 [kW]
Condensation: + 50 [ºC]
Evaporation: 0 [ºC]

$Q = Kv \times Q_1 \times L_1 \times L_2$ [kW] $\Rightarrow$ 35 = 2,61 x 17,23 x 0,84 x L_2 [kW] $\Rightarrow$

L_2 = 35 / 37,8 = 0,92

with:
Q_1 = 17,23 [kW] refrigeration capacity of R407C on liquid line (table 1)
L_1 = 0,84 correction factor of R407C for T_{Liquid} = 50 ºC and
$T_{evaporation}$ = 0ºC (table 2)

Using table 3b a pressure drop of 0,13 bar corresponds to a correction factor L_2 = 0,92. Such a pressure drop is compatible with the minimum differential pressure required by the valve.

LIQUID LINE

TABLE 2- Correction factors - L_1 of the refrigeration capacity for temperatures different from standard values.

Liquid temperature [°C]	Refrigerant	Evaporating temperature [°C]										
		+ 10	+ 5	0	- 5	- 10	- 15	- 20	- 25	- 30	-35	- 40
0	R134a							1.34	1.32	1.30	1.28	1.25
	R22							1.31	1.30	1.28	1.27	1.25
	R404A							1.50	1.48	1.45	1.42	1.39
	R407C							1.38	1.36	1.34	1.32	1.30
	R410A							1.45	1.44	1.42	1.41	1.39
	R507							1.52	1.50	1.47	1.44	1.41
10	R134a							1.23	1.21	1.18	1.16	1.14
	R22							1.22	1.20	1.19	1.17	1.16
	R404A							1.34	1.32	1.29	1.26	1.23
	R407C							1.26	1.24	1.23	1.21	1.19
	R410A							1.32	1.31	1.29	1.28	1.26
	R507							1.36	1.33	1.30	1.27	1.24
20	R134a	1.24	1.22	1.20	1.18	1.16	1.14	1.11	1.09	1.07	1.05	1.03
	R22	1.19	1.18	1.17	1.16	1.15	1.13	1.12	1.11	1.09	1.08	1.06
	R404A	1.33	1.30	1.28	1.26	1.23	1.21	1.18	1.16	1.13	1.10	1.07
	R407C	1.24	1.23	1.21	1.20	1.18	1.16	1.14	1.12	1.11	1.09	1.07
	R410A	1.26	1.25	1.24	1.23	1.22	1.21	1.19	1.18	1.16	1.15	1.13
	R507	1.34	1.32	1.29	1.27	1.24	1.22	1.19	1.16	1.14	1.11	1.08
30	R134a	1.12	1.10	1.08	1.06	1.04	1.02	1.00	0.98	0.96	0.93	0.91
	R22	1.09	1.08	1.07	1.06	1.05	1.03	1.02	1.01	0.99	0.98	0.96
	R404A	1.16	1.14	1.11	1.09	1.07	1.04	1.02	0.99	0.96	0.94	0.91
	R407C	1.12	1.11	1.09	1.07	1.06	1.04	1.02	1.00	0.98	0.97	0.95
	R410A	1.12	1.11	1.10	1.09	1.08	1.07	1.06	1.04	1.03	1.02	1.00
	R507	1.17	1.14	1.12	1.10	1.07	1.05	1.02	0.99	0.97	0.94	0.91
40	R134a	1.00	0.98	0.96	0.94	0.92	0.90	0.88	0.86	0.84	0.82	0.80
	R22	0.99	0.98	0.97	0.96	0.95	0.93	0.92	0.91	0.89	0.88	0.87
	R404A	0.99	0.97	0.94	0.92	0.90	0.87	0.85	0.82	0.80	0.77	0.74
	R407C	0.99	0.98	0.96	0.95	0.93	0.91	0.90	0.88	0.86	0.84	0.82
	R410A	0.98	0.97	0.97	0.96	0.94	0.93	0.92	0.91	0.89	0.88	0.86
	R507	0.99	0.97	0.94	0.92	0.90	0.87	0.85	0.82	0.79	0.77	0.74
50	R134a	0.88	0.86	0.85	0.83	0.81	0.79	0.76	0.74	0.72	0.70	0.68
	R22	0.89	0.88	0.87	0.86	0.85	0.83	0.82	0.81	0.79	0.78	0.77
	R404A	0.81	0.79	0.77	0.74	0.72	0.70	0.67	0.65	0.63	0.60	0.57
	R407C	0.86	0.85	0.84	0.82	0.80	0.79	0.77	0.75	0.74	0.72	0.70
	R410A	0.84	0.83	0.82	0.81	0.80	0.79	0.78	0.76	0.75	0.74	0.72
	R507	0.80	0.78	0.76	0.74	0.72	0.69	0.67	0.64	0.62	0.59	0.56
60	R134a	0.76	0.74	0.72	0.70	0.69	0.67	0.65	0.63	0.60	0.58	0.56
	R22	0.79	0.77	0.76	0.75	0.74	0.73	0.72	0.70	0.69	0.68	0.66
	R404A	0.62	0.60	0.58	0.56	0.54	0.52	0.50	0.47	0.45	0.42	0.40
	R407C	0.73	0.72	0.70	0.69	0.67	0.66	0.64	0.62	0.61	0.59	0.57
	R410A	0.68	0.67	0.67	0.66	0.65	0.64	0.62	0.61	0.60	0.59	0.57
	R507	0.61	0.59	0.57	0.55	0.53	0.51	0.48	0.46	0.43	0.41	0.38

TABLE 3a Correction factors L_2 of the refrigeration capacity for pressure drops ≠ 0,15 bar"	
Pressure drops [bar]	L_2 Factor
0.01	0.26
0.03	0.45
0.05	0.58
0.07	0.68
0.09	0.77
0.11	0.86
0.13	0.93
0.15	1.00
0.17	1.06
0.19	1.13
0.21	1.18
0.23	1.24
0.25	1.29
0.27	1.34
0.29	1.39
0.31	1.44
0.33	1.48
0.35	1.53
0.37	1.57
0.39	1.61
0.41	1.65
0.43	1.69
0.45	1.73
0.47	1.77
0.49	1.81
0.51	1.84
0.53	1.88
0.55	1.91
0.57	1.95
0.59	1.98
0.61	2.02
0.63	2.05
0.65	2.08
0.67	2.11
0.69	2.14
0.71	2.18
0.73	2.21
0.75	2.24

TABLE 3b Pressure drops for correction factors L_2 ≠ 1	
L_2 Factor	Pressure drops [bar]
0.20	0.01
0.25	0.01
0.30	0.01
0.35	0.02
0.40	0.02
0.45	0.03
0.50	0.04
0.55	0.05
0.60	0.05
0.65	0.06
0.70	0.07
0.75	0.08
0.80	0.10
0.85	0.11
0.90	0.12
0.95	0.14
1.00	0.15
1.05	0.17
1.10	0.18
1.15	0.20
1.20	0.22
1.25	0.23
1.30	0.25
1.35	0.27
1.40	0.29
1.45	0.32
1.50	0.34
1.55	0.36
1.60	0.38
1.65	0.41
1.70	0.43
1.75	0.46
1.80	0.49
1.85	0.51
1.90	0.54
1.95	0.57
2.00	0.60
2.05	0.63

2) Calculation example for suction line:
Valve selection under the following conditions:

Refrigerant: R404AC
Set refrigeration capacity: 15 [kW]
Condensation: + 40 [ºC]
Evaporation: – 10 [ºC]
Set pressure drop: 0,11 [bar]

$Q = Kv \times Q_1 \times S_1 \times S_2$ [kW] $\Rightarrow$ 15 = Kv x 2,23 x 0,72 x 0,86 [kW] $\Rightarrow$
Kv = 15 / 1,38 = 10,8 [m^3/h]

with:
Q_1 = 2,23 [kW] refrigeration capacity of R404A on suction line (table 1)
S_1 = 0,72 correction factor of R404A for $T_{condensation}$ = 40 ºC and $T_{evaporation}$ = -10 ºC (table 4)
S_2 = 0,86 correction factor for pressure drop of 0,11 bar (table 5a)

The result involves the selection of a 1078/9 valve with Kv = 10 [m^3/h]

SUCTION LINE

TABLE 4- Correction factors - S_1 of the refrigeration capacity for temperatures different from standard values.

Condensing temperature [°C]	Refrigerant	Evaporating temperature [°C]										
		+ 10	+ 5	0	- 5	- 10	- 15	- 20	- 25	- 30	-35	- 40
30	R134a	1.26	1.11	0.97	0.84	0.72	0.62	0.52	0.43	0.36	0.29	0.23
	R22	1.24	1.12	1.00	0.89	0.79	0.70	0.61	0.53	0.45	0.38	0.32
	R404A	1.34	1.20	1.06	0.94	0.82	0.72	0.62	0.54	0.46	0.38	0.32
	R407C	1.35	1.20	1.07	0.94	0.82	0.71	0.61	0.52	0.43	0.36	0.29
	R410A	1.41	1.27	1.14	1.02	0.91	0.80	0.71	0.62	0.54	0.46	0.39
	R507	1.35	1.20	1.07	0.95	0.83	0.73	0.63	0.54	0.46	0.39	0.32
35	R134a	1.20	1.06	0.93	0.80	0.69	0.59	0.50	0.41	0.34	0.27	0.22
	R22	1.19	1.08	0.96	0.86	0.76	0.67	0.59	0.51	0.43	0.37	0.31
	R404A	1.27	1.13	1.00	0.88	0.77	0.67	0.58	0.50	0.42	0.36	0.29
	R407C	1.29	1.15	1.02	0.90	0.78	0.68	0.58	0.49	0.41	0.34	0.28
	R410A	1.34	1.21	1.09	0.97	0.87	0.77	0.67	0.59	0.51	0.44	0.37
	R507	1.27	1.13	1.01	0.89	0.78	0.68	0.59	0.51	0.43	0.36	0.30
40	R134a	1.15	1.01	0.88	0.77	0.66	0.56	0.47	0.39	0.32		
	R22	1.15	1.04	0.93	0.83	0.73	0.65	0.56	0.49	0.42		
	R404A	1.19	1.06	0.94	0.82	0.72	0.63	0.54	0.46	0.39		
	R407C	1.23	1.10	0.97	0.85	0.74	0.64	0.55	0.47	0.39		
	R410A	1.28	1.15	1.03	0.92	0.82	0.73	0.64	0.56	0.48		
	R507	1.19	1.06	0.94	0.83	0.73	0.63	0.55	0.47	0.40		
45	R134a	1.09	0.96	0.84	0.73	0.63	0.53	0.45				
	R22	1.11	0.99	0.89	0.79	0.70	0.62	0.54				
	R404A	1.11	0.98	0.87	0.76	0.67	0.58	0.50				
	R407C	1.17	1.04	0.92	0.81	0.70	0.61	0.52				
	R410A	1.21	1.09	0.98	0.87	0.78	0.69	0.60				
	R507	1.11	0.99	0.87	0.77	0.67	0.58	0.50				
50	R134a	1.04	0.91	0.80	0.69	0.59	0.50	0.42				
	R22	1.06	0.95	0.85	0.76	0.67	0.59	0.51				
	R404A	1.03	0.91	0.80	0.70	0.61	0.53	0.46				
	R407C	1.11	0.99	0.87	0.76	0.67	0.57	0.49				
	R410A	1.14	1.03	0.92	0.82	0.73	0.64	0.57				
	R507	1.02	0.91	0.80	0.70	0.61	0.53	0.46				
55	R134a	0.98	0.86	0.75	0.65	0.56						
	R22	1.01	0.91	0.81	0.72	0.64						
	R404A	0.94	0.83	0.73	0.64	0.56						
	R407C	1.05	0.93	0.82	0.72	0.62						
	R410A	1.07	0.96	0.86	0.77	0.68						
	R507	0.94	0.83	0.73	0.64	0.55						
60	R134a	0.93	0.81	0.71	0.61	0.52						
	R22	0.96	0.87	0.77	0.69	0.61						
	R404A	0.85	0.75	0.66	0.57	0.50						
	R407C	0.98	0.87	0.77	0.67	0.58						
	R410A	0.99	0.89	0.80	0.71	0.63						
	R507	0.84	0.74	0.65	0.57	0.49						

TABLE 5a
Correction factors S_2 of the refrigeration capacity for pressure drops ≠ 0,15 bar

Pressure drops [bar]	S_2 Factor
0.01	0.26
0.03	0.45
0.05	0.58
0.07	0.68
0.09	0.77
0.11	0.86
0.13	0.93
0.15	1.00
0.17	1.06
0.19	1.13
0.21	1.18
0.23	1.24
0.25	1.29
0.27	1.34
0.29	1.39
0.31	1.44
0.33	1.48
0.35	1.53
0.37	1.57
0.39	1.61
0.41	1.65
0.43	1.69
0.45	1.73
0.47	1.77
0.49	1.81
0.51	1.84
0.53	1.88
0.55	1.91
0.57	1.95
0.59	1.98
0.61	2.02
0.63	2.05
0.65	2.08
0.67	2.11
0.69	2.14
0.71	2.18
0.73	2.21
0.75	2.24

TABLE 5b
Pressure drops for correction factors S_2 ≠ 1

S_2 Factor	Pressure drops [bar]
0.20	0.01
0.25	0.01
0.30	0.01
0.35	0.02
0.40	0.02
0.45	0.03
0.50	0.04
0.55	0.05
0.60	0.05
0.65	0.06
0.70	0.07
0.75	0.08
0.80	0.10
0.85	0.11
0.90	0.12
0.95	0.14
1.00	0.15
1.05	0.17
1.10	0.18
1.15	0.20
1.20	0.22
1.25	0.23
1.30	0.25
1.35	0.27
1.40	0.29
1.45	0.32
1.50	0.34
1.55	0.36
1.60	0.38
1.65	0.41
1.70	0.43
1.75	0.46
1.80	0.49
1.85	0.51
1.90	0.54
1.95	0.57
2.00	0.60
2.05	0.63

3) Calculation example for hot gas line:
Valve selection under the following conditions:

Refrigerant: R410A
Set refrigeration capacity: 20 [kW]
Condensation: + 40 [ºC]
Evaporation: 0 [ºC]
Set pressure drop: 0,5 [bar]

$Q = Kv \times Q_1 \times H_1 \times H_2$ [kW] $\Rightarrow$ 20 = Kv x 13,60 x 1,01 x 0,71 [kW]
$\Rightarrow$ Kv = 20 / 9,75 = 2,05 [m^3/h]

with:
Q_1 = 13,6 [kW] refrigeration capacity of R410A on hot gas line (table 1)
S_1 = 1,01 correction factor of R410A for $T_{condensation}$ = 40 ºC and $T_{evaporation}$ = 0 ºC (table 6)
S_2 = 0,71 correction factor for pressure drop of 0,5 bar (table 7a)

The result involves the selection of a 1078/5 valve with Kv = 2,61 [m^3/h]

HOT GAS LINE

TABLE 6- Correction factors - H_1 of the refrigeration capacity for temperatures different from standard values.

Condensing temperature [°C]	Refrigerant	Evaporating temperature [°C]										
		+ 10	+ 5	0	- 5	- 10	- 15	- 20	- 25	- 30	-35	- 40
30	R134a	0.91	0.90	0.88	0.87	0.85	0.83	0.82	0.80	0.78	0.77	0.75
	R22	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.86	0.85	0.84
	R404A	0.98	0.96	0.94	0.93	0.91	0.89	0.87	0.85	0.83	0.80	0.78
	R407C	0.87	0.86	0.85	0.84	0.83	0.81	0.80	0.79	0.77	0.76	0.74
	R410A	0.96	0.95	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.87	0.86
	R507	0.98	0.96	0.94	0.93	0.91	0.89	0.87	0.84	0.82	0.80	0.78
35	R134a	0.96	0.94	0.92	0.91	0.89	0.87	0.85	0.84	0.82	0.80	0.78
	R22	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.91	0.90	0.89	0.87
	R404A	1.00	0.98	0.97	0.95	0.92	0.90	0.88	0.86	0.84	0.81	0.79
	R407C	0.91	0.89	0.88	0.87	0.85	0.84	0.83	0.81	0.80	0.78	0.77
	R410A	0.99	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.91	0.90	0.89
	R507	1.00	0.98	0.96	0.94	0.92	0.90	0.88	0.86	0.83	0.81	0.78
40	R134a	1.00	0.98	0.96	0.94	0.92	0.90	0.88	0.86	0.84		
	R22	1.09	1.08	1.07	1.05	1.04	1.03	1.01	1.00	0.99		
	R404A	1.02	1.00	0.98	0.96	0.93	0.91	0.89	0.86	0.84		
	R407C	0.94	0.92	0.91	0.90	0.88	0.87	0.85	0.83	0.82		
	R410A	1.02	1.02	1.01	1.00	0.99	0.98	0.96	0.95	0.94		
	R507	1.02	1.00	0.98	0.95	0.93	0.91	0.88	0.86	0.83		
45	R134a	1.04	1.02	1.00	0.98	0.95	0.93	0.91				
	R22	1.07	1.06	1.04	1.03	1.02	1.01	0.99				
	R404A	1.03	1.01	0.99	0.96	0.94	0.91	0.89				
	R407C	0.96	0.95	0.93	0.92	0.90	0.89	0.87				
	R410A	1.05	1.04	1.03	1.02	1.01	1.00	0.98				
	R507	1.02	1.00	0.98	0.96	0.93	0.91	0.88				
50	R134a	1.07	1.05	1.02	1.00	0.98	0.96	0.93				
	R22	1.10	1.09	1.08	1.06	1.05	1.03	1.02				
	R404A	1.03	1.01	0.98	0.96	0.93	0.90	0.88				
	R407C	0.98	0.97	0.95	0.94	0.92	0.90	0.88				
	R410A	1.07	1.06	1.05	1.04	1.03	1.01	1.00				
	R507	1.02	1.00	0.98	0.95	0.92	0.90	0.87				
55	R134a	1.09	1.07	1.05	1.02	1.00						
	R22	1.13	1.12	1.10	1.09	1.08						
	R404A	1.02	1.00	0.97	0.94	0.91						
	R407C	1.00	0.98	0.97	0.95	0.93						
	R410A	1.08	1.07	1.06	1.05	1.03						
	R507	1.01	0.99	0.96	0.93	0.90						
60	R134a	1.11	1.09	1.06	1.04	1.01						
	R22	1.16	1.14	1.13	1.11	1.10						
	R404A	1.00	0.97	0.94	0.91	0.88						
	R407C	1.01	0.99	0.97	0.95	0.93						
	R410A	1.08	1.07	1.06	1.05	1.03						
	R507	0.98	0.96	0.93	0.90	0.87						

TABLE 7a
Correction factors H_2 of the refrigeration capacity for pressure drops ≠ 1 bar

Pressure drops [bar]	H_2 Factor
0.10	0.32
0.20	0.45
0.30	0.55
0.40	0.63
0.50	0.71
0.60	0.77
0.70	0.84
0.80	0.89
0.90	0.95
1.00	1.00
1.10	1.05
1.20	1.10
1.30	1.14
1.40	1.18
1.50	1.22
1.60	1.26
1.70	1.30
1.80	1.34
1.90	1.38
2.00	1.41
2.10	1.45
2.20	1.48
2.30	1.52
2.40	1.55
2.50	1.58
2.60	1.61
2.70	1.64
2.80	1.67
2.90	1.70
3.00	1.73
3.10	1.76
3.20	1.79
3.30	1.82
3.40	1.84
3.50	1.87
3.60	1.90
3.70	1.92
3.80	1.95

TABLE 7b
Pressure drops for correction factors H_2 ≠ 1

H_2 Factor	Pressure drops [bar]
0.20	0.04
0.25	0.06
0.30	0.09
0.35	0.12
0.40	0.16
0.45	0.20
0.50	0.25
0.55	0.30
0.60	0.36
0.65	0.42
0.70	0.49
0.75	0.56
0.80	0.64
0.85	0.72
0.90	0.81
0.95	0.90
1.00	1.00
1.05	1.10
1.10	1.21
1.15	1.32
1.20	1.44
1.25	1.56
1.30	1.69
1.35	1.82
1.40	1.96
1.45	2.10
1.50	2.25
1.55	2.40
1.60	2.56
1.65	2.72
1.70	2.89
1.75	3.06
1.80	3.24
1.85	3.42
1.90	3.61
1.95	3.80
2.00	4.00
2.05	4.20