Technical leaflet

Condensing pressure regulators (water valves)

type WVFM, WVFX and WVS

Introduction

Pressure controlled water valves types WVFM, WVFX and WVS are used for regulating the flow of water in refrigeration plant with water-cooled condensers.

The water valves give modulating regulation of the condensing pressure and so maintain it constant (practically speaking) during operation. When the refrigeration plant is stopped, the cooling water flow is shut off automatically.

WVFX 15, 20 and 25 can be supplied in stainless steel housing which can be used in connection with sea water cooling of condensers and compressors.

Technical data

Type	Condenser side				Liquid side			k_v value 1)
	Refrigerant	Control press. adjustable closing press. bar	Max. working pressure PB bar	Max. test pressure p′ bar	Media	Max. working pressure PB bar	Max. test pressure p′ bar	m^3/h
WVFM 10		3.5 → 10.0	15.0	16.5		10	10	2.4
WVFM 16		3.5 → 10.0	15.0	16.5		10	10	2.4
WVFX 10		3.5 → 16.0	26.4	29.0		16	24	1.4
WVFX 10 2)		4.0 → 23.0	26.4	29.0		16	24	1.4
WVFX 10		15.0 → 29.0	45.2	60.0		16	24	1.4
WVFX 15		3.5 → 16.0	26.4	29.0		16	24	1.9
WVFX 15 2)		4.0 → 23.0	26.4	29.0		16	24	1.9
WVFX 15	CFC, HCFC, HFC	15.0 → 29.0	45.2	60.0	Fresh water, neutral brine, sea water 3)	16	24	1.9
WVFX 20		3.5 → 16.0	26.4	29.0		16	24	3.4
WVFX 20 2)		4.0 → 23.0	26.4	29.0		16	24	3.4
WVFX 20		15.0 → 29.0	45.2	60.0		16	24	3.4
WVFX 25		3.5 → 16.0	26.4	29.0		16	24	5.5
WVFX 25 2)		4.0 → 23.0	26.4	29.0		16	24	5.5
WVFX 25		15.0 → 29.0	45.2	60.0		16	24	5.5
WVFX 32		4.0 → 17.0	24.1	26.5		10	10	11.0
WVFX 40		4.0 → 17.0	24.1	26.5		10	10	11.0
WVS 32		2.2 → 19.0	26.4	29.0		10	16	12.5
WVS 40		2.2 → 19.0	26.4	29.0		10	16	21.0
WVS 50	CFC, HCFC, HFC R717 (NH_3)	2.2 → 19.0	26.4	29.0	Fresh water, neutral brine	10	16	32.0
WVS 65		2.2 → 19.0	26.4	29.0		10	16	45.0
WVS 80		2.2 → 19.0	26.4	29.0		10	16	80.0
WVS 100		2.2 → 19.0	26.4	29.0		10	16	125.0

1) The k_v value is the flow of water in m^3/h at a pressure drop across valve of 1 bar, ρ = 1000 kg/m^3.
2) Fully open valve requires 33% higher pressure than a WVFX, range 3.5 → 16 bar.
3) WVFX 15, 20 and 25 with stainless steel housing only.

WVFM 10 → 16 and WVFX 10 → 40 are direct actuated valves. WVS 32 → 100 are servo-operated valves.

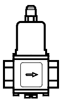
Media temperature range
WVFM: –25 → +90°C
WVFX 10 → 25: –25 → +130°C
WVFX 32 → 40: –25 → +90°C
WVS: –25 → +90°C
If a WVS is required with an opening differential pressure of 1 → 10 bar, the valve servo spring must be replaced. See “Ordering”.

Opening differential pressure
WVFM 10 → 16, WVFX 10 → 25: max. 10 bar
WVFX 32 → 40: max. 10 bar
WVS 32 → 40: min. 0.5 bar; max. 4 bar
WVS 50 → 100: min. 0.3 bar; max. 4 bar

Below 20% of max. capacity the WVS will act as an on-off regulator.

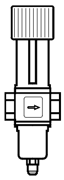
Ordering

WVFM and WVFX, complete valves



Type	Connection		Range	Code no.
	Water side ISO 228/1	Condenser side	bar	
WVFM 10	G 3/8	1/4 in. / 6 mm flare	3.5 → 10	**003D0001**
WVFM 16	G 1/2	1/4 in. / 6 mm flare	3.5 → 10	**003D0002**
WVFX 10	G 3/8	1/4 in. / 6 mm flare	3.5 → 16	**003N1100**
WVFX 10	G 3/8	1/4 in. / 6 mm flare	4.0 → 23	**003N1105**
WVFX 15	G 1/2	1/4 in. / 6 mm flare	3.5 → 16	**003N2100**
WVFX 15	G 1/2	1/4 in. / 6 mm flare	4.0 → 23	**003N2105**
WVFX 20	G 3/4	1/4 in. / 6 mm flare	3.5 →16	**003N3100**
WVFX 20	G 3/4	1/4 in. / 6 mm flare	4.0 → 23	**003N3105**
WVFX 25	G 1	1/4 in. / 6 mm flare	3.5 →16	**003N4100**
WVFX 25	G 1	1/4 in. / 6 mm flare	4.0 → 23	**003N4105**
WVFX 32	G 1 1/4	1/4 in. / 6 mm flare	4.0 →17	**003F1232**
WVFX 40	G 1 1/2	1/4 in. / 6 mm flare	4.0 →17	**003F1240**

WVFX with stainless steel housing

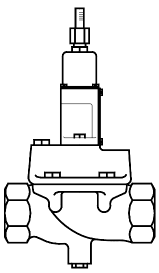


WVFX 15	G 1/2	1/4 in. / 6 mm flare	3.5 → 16	**003N2101**
WVFX 15	G 1/2	1/4 in. / 6 mm flare	4.0 → 23	**003N2104**
WVFX 20	G 3/4	1/4 in. / 6 mm flare	3.5 → 16	**003N3101**
WVFX 20	G 3/4	1/4 in. / 6 mm flare	4.0 → 23	**003N3104**
WVFX 25	G 1	1/4 in. / 6 mm flare	3.5 → 16	**003N4101**
WVFX 25	G 1	1/4 in. / 6 mm flare	4.0 → 23	**003N4104**

WVFX for high pressure refrigerants (Max. Working Pressure 45.2 bar)

WVFX 10	G 3/8	1/4 in. / 6 mm flare	15.0 → 29.0	**003N1410**
WVFX 15	G 1/2	1/4 in. / 6 mm flare		**003N2410**
WVFX 20	G 3/4	1/4 in. / 6 mm flare		**003N3410**
WVFX 25	G 1	1/4 in. / 6 mm flare		**003N4410**

WVS, parts programme



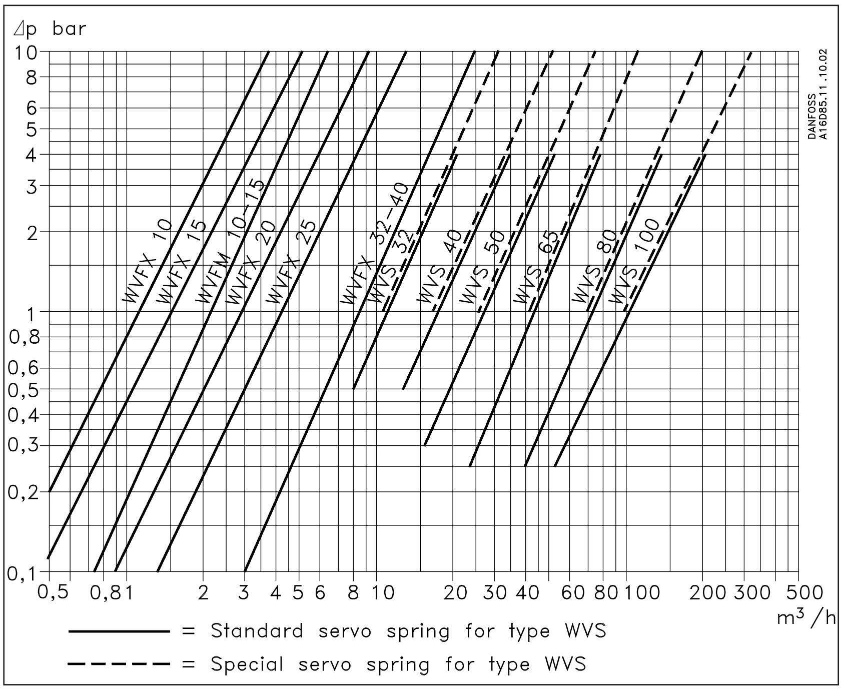
Type	Connection	**Code no.**			
		Valve body	Pilot unit [3]	Flange set [4]	Servo spring for differential pressure range of 1 → 10 bar
WVS 32	G 1 1/4 [1]	**016D5032**	**016D1017**		**016D1327**
WVS 40	G 1 1/2 [1]	**016D5040**	**016D1017**		**016D0575**
WVS 50	2 in. weld flange	**016D5050** [2]	**016D1017**	**027N3050**	**016D0576**
WVS 65	2½ in weld flange	**016D5065** [2]	**016D1017**	**027N3065**	**016D0577**
WVS 80	3 in. weld flange	**016D5080** [2]	**016D1017**	**027N3080**	**016D0578**
WVS 100	4 in. weld flange	**016D5100** [2]	**016D1017**	**027N3100**	**016D0579**

1) ISO 228/1
2) Code numbers cover valve body, flange gaskets, flange bolts and screws for pilot valve.
3) Code numbers cover control element and spring housing.
4) Code numbers cover an inlet and an outlet flange.

Accessories

Description	**Code no.**
1 m capillary tube 1/4 in. (6 mm) flare coupling nuts at each end	**060-0071**
Bracket for WVFX 10 → 25	**003N0388**

Capacity



The capacity curves show the capacities of individual valves (water quantity in m^3/h) depending on the pressure drop across valves.

The capacities given apply at 85% valve opening and are obtained with the following offset (rise in condensing pressure).

Type	bar Δp
WVFM 10 → 16	2.5
WVFX 10	2.0
WVFX 15	2.5
WVFX 20	3.0
WVFX 25	3.5
WVFX 32 → 40	3.0
WVS 32	0.6
WVS 40	0.7
WVS 50 → 80	0.8
WVS 100	0.9

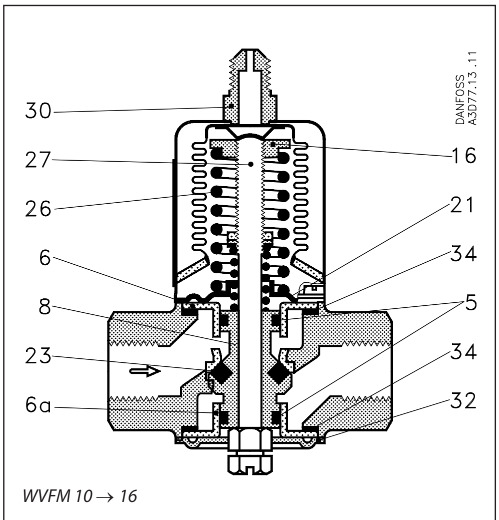
Design
Function

Condensing pressure impulses are transmitted via the bellows element to the valve cone so that the valve - even at very small pressure variations - is able to adapt the quantity of water required by the condenser.
If fluorinated refrigerants are to be used a capillary tube connection is required, 1 m capillary tube with 1/4 in. / 6 mm flared union nuts at either end can be supplied.

The valves are pressure-relieved in such a way that a variation in the water pressure will not affect their setting.

To protect the refrigeration plant against high head pressures in the event that the water supply to the condenser should fail. A safety switch type KP or RT should be fitted on the high pressure side.

5. O-ring
6. Upper guide bush
6a. Lower guide bush
8. Valve cone
16. Spring retainer
21. Top plate
23. T-ring
26. Regulating spring
27. Regulating spindle
30. Pressure connection (¼ in./6 mm flare)
32. Bottom plate
34. Gasket



WVFM 10 → 16

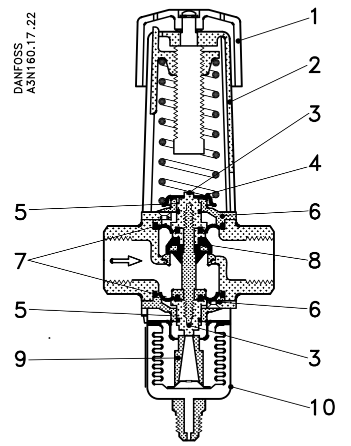
Water side connections are internal BSP and the compressor discharge side connection is ¼ in. / 6 mm flare.
The valve body is made of hot-stamped brass which together with the other valve parts is surface-treated to resist corrosion from condensate etc.
The valve cone (8) is made of brass with a T-ring (23) of artificial rubber forming a flexible seal against the valve seat. The O-rings (5) of artificial rubber are external seals for the cooling water.
The valve cone guide bushes (6) and (6a) are specially treated to counteract lime deposits from the cooling water inside the cylinder, and also to reduce the friction in the valve to a minimum.
The valve seat is of stainless steel and is swaged to the valve body.
Clockwise rotation of the regulating spindle (27) opens the valve at a higher condensing pressure, and vice versa.

Design
Function
(continued)

Water side connections are internal BSP and the compressor discharge side connection is ¼ in. / 6 mm flare.

The valve body WVFX 10 → 25 is made of hot-stamped brass and for WVFX 32 → 40 of cast iron. WVFX 15, 20 and 25 can also be supplied in stainless steel housing.
All external valve parts are surface-treated to resist corrosion from condensate, etc.

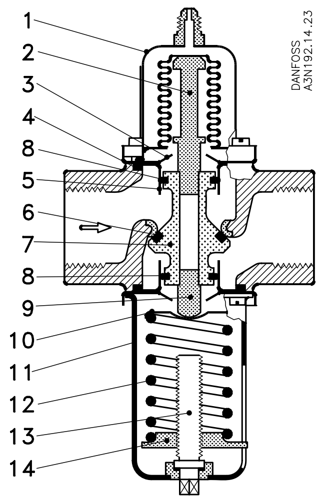
1. Handwheel
2. Spring housing
3. Spindle guide
4. Spring retainer
5. O-ring
6. Guide bush
7. Diaphragm
8. Valve plate
9. Thrust pad
10. Bellows element



WVFX 10 → 25

The valve plate (8) is a brass plate with a vulcanized layer of special rubber to form an elastic seal against the valve seat. The valve is externally sealed by the diaphragms (7).
The top and bottom of the valve plate holder are extended by a guide that is fitted with O-rings (5) to ensure the internal operating parts move correctly. These O-rings, fitted in conjunction with the diaphragms, also provide extra protection against external leakage.
The valve seat is made of stainless steel and is swaged to the valve body.
The spring housing (2) is of aluminium and has a guide slot for the spring holder that is extended in the form of an indicating pointer.
An associated indicator label is riveted to the housing and is graduated from 1 to 15.

1. Bellows element
2. Upper pressure spindle
3. Top plate
4. Guide bush gland
5. Guide bush
6. T-ring
7. Valve cone
8. O-ring
9. Lower pressure spindle
10. Spring retainer
11. Spring housing
12. Regulating spring
13. Regulating spindle
14. Spring holder

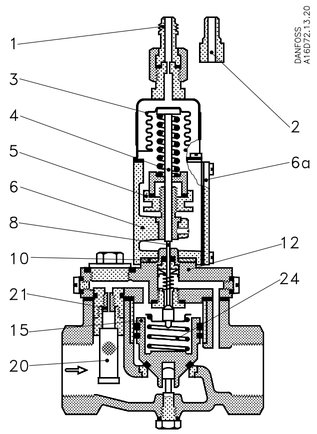


WVFX 32 → 40

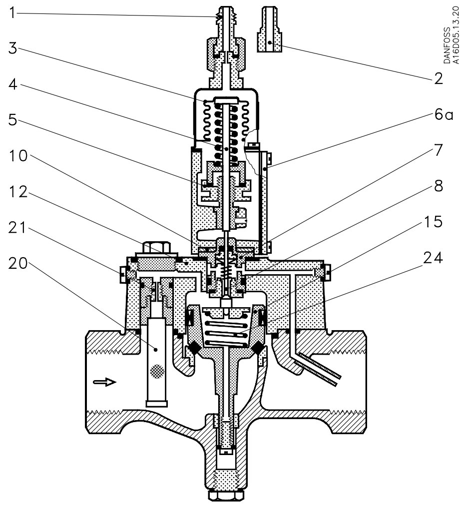
The valve cone (7) is made of brass with a
T-ring (6) of artificial rubber forming a flexible seal against the valve seat.
The O-rings (8) are external seals for the cooling water.
The valve cone guide bushes (5) are specially treated to counteract lime deposits from the cooling water inside the cylinder, and also to reduce friction in the valve to a minimum.
The valve seat is made of stainless steel and is swaged to the valve body.
The regulating spindle (13) is mounted in a guide in the spring housing which has a notch for the spring holder (14). The spring holder also acts as an indicator.

Design

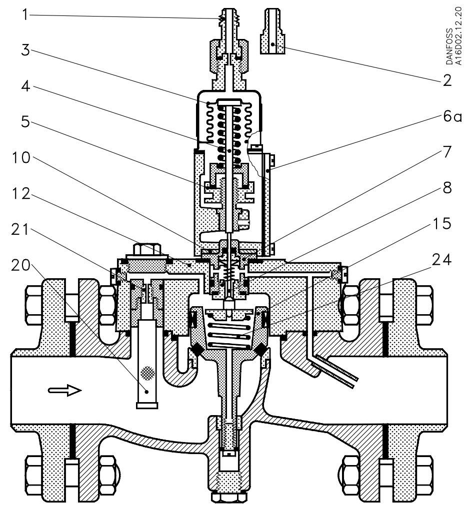
Function (continued)



WVS 32



WVS 40



WVS 50 → 100

1. Pressure connection (flare nipple)
2. Pressure connection (weld nipple)
3. Bellows element
4. Push rod
5. Regulating nut
6. Spring housing
6a. Cover
7. Pilot assembly
8. Spindle for pilot cone
10. Insulating gasket
12. Valve cover
15. Servo piston
20. Self-cleaning strainer assembly
21. Pilot orifice
24. Servo spring

WVS 32 → 40 valves have internal BSP connections, while WVS 50 → 100 can be supplied with either BSP connections or weld flanges.
Connection to the plant condenser can be made by copper tube or steel tube, the valves being supplied with both a flare nipple for 1/4 in. (6 mm) copper tube and a weld nipple for ∅ 6 mm / ∅ 10 mm steel tube.

The valve consists of three main components:

1. *Main valve with servo piston*
   The main valve body is made of cast iron with a pressed-in bronze seat. The servo piston is of gun metal and has a sleeve and a profiled rubber seal ring.
2. *Pilot valve*
   The pilot valve is made of gun metal, the pilot cone and seat of stainless steel and the pilot orifice of brass. These materials are particularly resistant to water corrosion. However, the valve is not resistant to sea water.

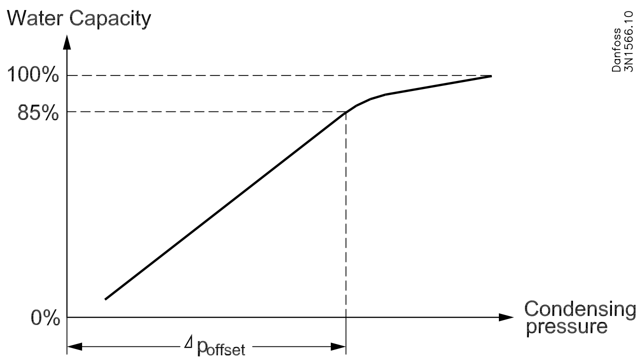
The strainer ahead of the pilot orifice is made of nickel gauze.
The degree of opening of the pilot valve (which corresponds to the increase in condensing pressure above the set opening pressure) determines the degree of opening of the main valve and thereby amount of the water flow.

3. *Bellows unit with connection to condenser*
   The bellows unit is made of aluminium and corrosion-proofed steel.

Sizing

When sizing and selecting water valves it is most important to ensure that the valve at any time is able to give the necessary quantity of cooling water.
To select a suitable size of valve it is necessary to know the precise amount of cooling required.
On the other hand, to avoid the risk of unstable regulation (hunting) the valve should not be oversized.

In general, the aim should be to select the smallest valve capable of giving the required flow .
To obtain a precise control it can be recommended to only use 85% of the capacity. Below 85% the ratio between flow and condensing difference pressure is linear. Above 85% the ratio is no longer linear .
To reach a 100% capacity the water valve needs significant increase of condensing pressure. See fig. below.



Type	bar Δpoffset
WVFM 10 → 16	2.5
WVFX 10	2.0
WVFX 15	2.5
WVFX 20	3.0
WVFX 25	3.5
WVFX 32 → 40	3.0
WVS 32	0.6
WVS 40	0.7
WVS 50 → 80	0.8
WVS 100	0.9

Valve size

The following data is used when selecting the size of the water valve:

- Cooling capacity of condenser
- Temperature rise in cooling media
- Differential pressure across valve
- Condensing temperature
- Specific heat capacity of cooling media
- Refrigerant

Sizing Examples

Example 1:

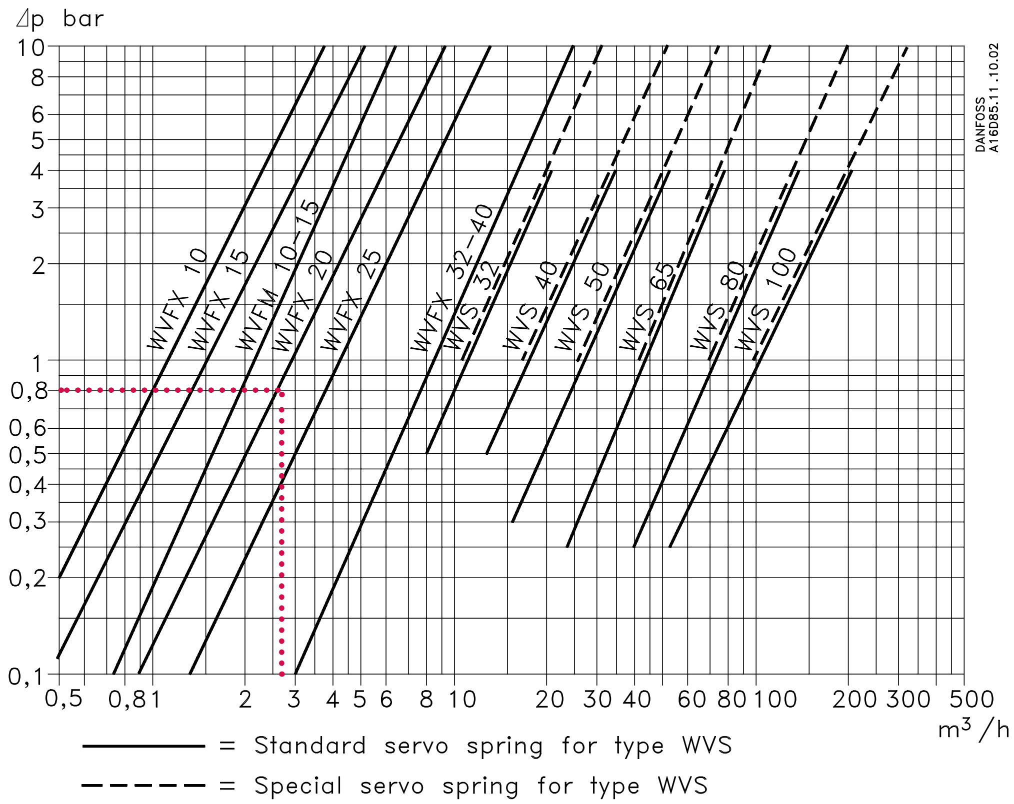
Condenser capacity Q_0: 30 kW
Condensing temperature t_0: 35°C
Refrigerant: R404A
Cooling media: water

Specific heat capacity of water C_p: 4.19 kj/(kg*K)
Water inlet temperature t_1: 15°C
Water outlet temperature t_2: 25°C
Pressure drop across valve Δ_p: max. 1.0 bar

Necessary mass flow: $$\dot{m} = \frac{Q_c}{C_p \cdot (t_2 - t_1)} \cdot 3600 = \frac{30}{4.19 \cdot (25 - 15)} \cdot 3600 = 2577 \text{ kg/h}$$

Volume flow: $$\dot{V} = \frac{\dot{m}}{\rho} = \frac{2577}{1000} \approx 2.6 \text{ m}^3/\text{h}$$

Selecting size



Selecting WVFX 20

Code number
The saturated pressure for R404A
$T_c = 35°C \Rightarrow P_c = 15.5$ barg

Choose a WVFX 20 with 4 -23 barg range

Example 2:

Condenser capacity Q_c: 20 kW
Condensing temperature t_c: 35°C
Refrigerant : R134a
Cooling media: Brine
Density of brine ρ: 1015 kg/m³

Specific heat capacity of brine C_p: 4.35 kj (kg*K)
Brine inlet temperature t_1: 20°C
Brine outlet temperature t_2: 25°C
Pressure drop across valve Δp: max. 2.0 bar

Necessary mass flow:

$$\dot{m} = \frac{Q_c}{C_p \cdot (t_2 - t_1)} \cdot 3600 = \frac{20}{4.35 \cdot (25 - 20)} \cdot 3600 = 3310 \text{ kg/h}$$

Volume flow:

$$\dot{V} = \frac{\dot{m}}{\rho} = \frac{3310}{1015} \approx 3.26 \text{ m}^3\text{/h}$$

k_v value

$$k_v \geq \frac{\dot{V}}{\sqrt{\frac{1000 \cdot \Delta p}{\rho}}} = \frac{3.26}{\sqrt{\frac{1000 \cdot 2.0}{1015}}} = 2{,}32 \text{ m}^3\text{/h}$$

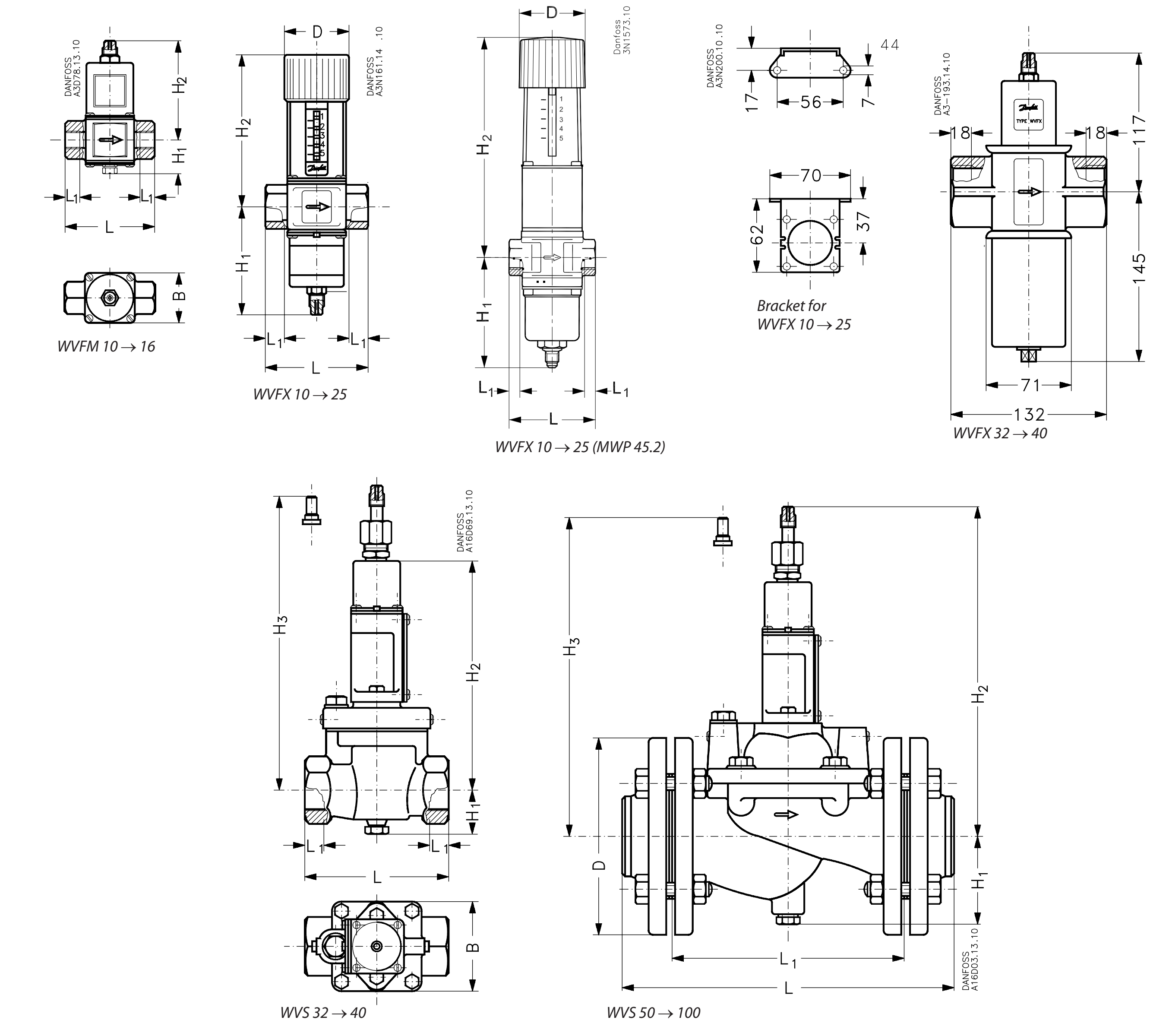
Selecting size of WVFX 20

$k_v \geq 2.32$ m³/h ⇒ **WVFX 20**
WVFX 20 has $k_v = 3.4$ m³/h and the necessary capacity is below 85% of full capacity

Code number
The saturated pressure for 134a
T_c = 35°C P_c = 7.9 barg

Choose a WVFX 20 with 3,5-16 barg range

Dimensions and weights



Type	H1 mm	H2 mm	H3 mm	L mm	L1 mm	B mm	Ø mm	Weight kg
WVFM 10 → 16	28	87		76	13	42		0.6
WVFX 10	91	133		72	11		55	1.0
WVFX 10 (MWP 45.2)	91	189		72	11		55	1.0
WVFX 15	91	133		72	14		55	1.0
WVFX 15 (MWP 45.2)	91	189		72	14		55	1.0
WVFX 20	91	133		90	16		55	2.0
WVFX 20 (MWP 45.2)	91	189		90	16		55	2.0
WVFX 25	96	138		95	19		55	2.0
WVFX 25 (MWP 45.2)	96	194		95	19		55	2.0
WVS 32	42	243	234	138	20	85		4.0
WVS 40	72	271	262	198	30	100		7.0
WVS 50	78	277	268	315	218		165	19.0
WVS 65	82	293	284	320	224		185	24.0
WVS 80	90	325	316	370	265		200	34.0
WVS 100	100	345	336	430	315		220	44.0