# Contents

# 1. Refrigerants

## 1.1 F-Gas Regulation

Adopted in April 2014, the Regulation (EU) 517/2014 on fluorinated greenhouse gases (F-Gas Regulation) replaced the first Regulation and strengthened the existing measures while introducing additional new elements. The Regulation's goal is to reduce the emissions of fluorinated gases by two-thirds by
2030 (in $CO_2$ equivalent; $CO_2e$).
The phase-down of hydrofluorocarbons (HFCs) is one of the key pillars of the Regulation as it aims to reduce the amount of HFCs placed on the EU market ($CO_2e$) by 79% by 2030, as compared to average levels in 2009-2012. What the phase-down actually means is that the average GWP of HFCs should fall from today's 2,000 to about 400 by 2030 across all sectors.

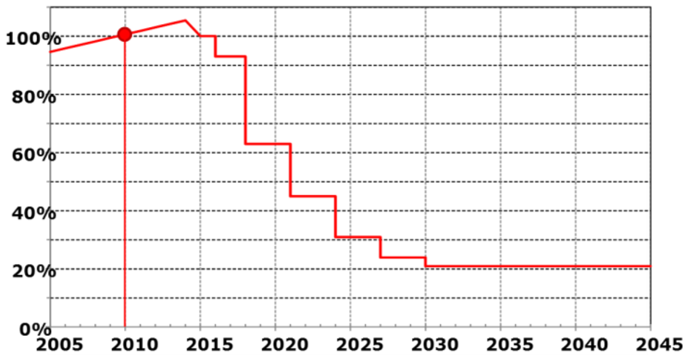


*Figure 1 F-Gas directive: Quota system*

The F-Gas Regulation introduces bans in specific sectors on new equipment using HFCs above a specific global warming potential (GWP) that will take effect by a certain year.

From 2020 all stationary refrigeration (except < -50°C) ban on maximum **GWP 2500** means that well established refrigerants R404A and R507 will be forbidden in new equipment.
Following restrictions especially target the commercial sector, where the EU foresees that as of 2022 new equipment will use refrigerants with a **GWP below 150** in both small plug-in applications (e.g. bottle coolers, vending machines) and in larger centralized systems in supermarkets (with some exceptions).

| SECTOR | GWP | LIMIT YEAR |
|---|---|---|
| Domestic refrigeration | 150 | 2015 |
| Stationary refrigeration (except < -50°C) | 2,500 | 2020 |
| Hermetically sealed commercial refrigeration | 150 | 2022 |
| Centralized commercial refrigeration (>40kW), except in the primary refrigerant circuit of cascade systems where f-gases with a GWP<1,500 may be used | 150 | 2020 |
| Movable room AC | 150 | 2020 |
| Single split AC (< 3kg of f-gases) | 750 | 2025 |

*Table 1 F-Gas directive: thresholds*

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The Regulation intends to abolish the use of very high-GWP gases (GWP above 2,500) not only in new equipment but also in existing installations. As of 2020 it will be prohibited to service existing refrigeration equipment with HFCs that have a GWP of 2,500 or above, unless these refrigerants are **recycled or reclaimed**. Such HFCs could still be used until January 2030 in existing equipment.
Eg. R-404A (GWP 3922) is near azeotropic blend of R125 44% / R143a 52% / R134a 4%.

Commercial systems with capacities <40kW and GWP<2500 will not be banned after 2022. It will be also possible to service systems adding new refrigerant in case of leakages. Quota system will have strong influence on refrigerant prices based on GWP factor but it will not be limited use. New refrigerants which can be classified as short-term or mid-term solution are present on market and will have significant role in smaller systems and maybe even more in retrofitting situations.

Some of them are: R407A, R407F, R448A, R449A and R452A

## 1.2 Refrigerant R407A/F

Refrigerant R407A consists of R32 (20%), R125 (40%) and R134a (40%) and is related to R407C, but pressures are more equal to R22.
Refrigerant R407F is also consists of components as R407A but in different ratios: R32 (30%); R125 (30%) and R134a (40%).
Because of high temperature glide those refrigerants are recommend to is in medium temperature applications.

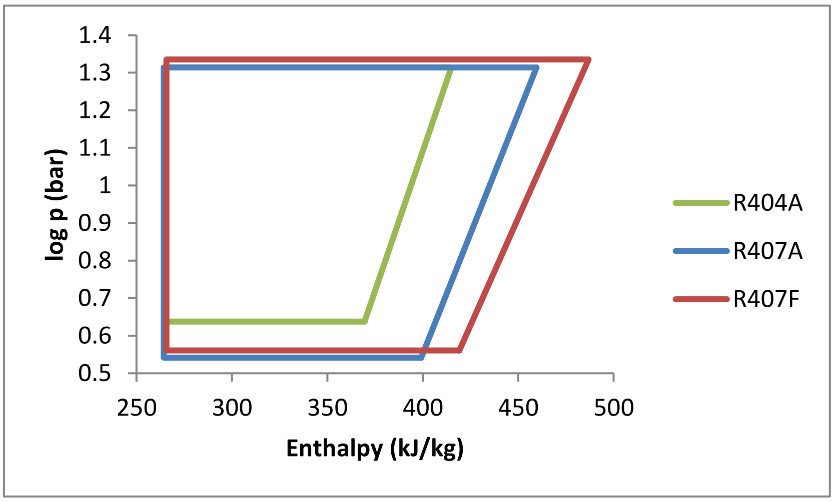
Here are stated characteristics for R404A, R407A and R407F.

| | R404A | R407A | R407F |
|---|---|---|---|
| Class | HFC | HFC | HFC |
| GWP | **3943** | **1923** | **1674** |
| Safety group | A1 | A1 | A1 |
| Oil | POE | POE | POE |
| Temperature glide at -10°C (dew point) | **0,6 K** | **5,9 K** | **5,9 K** |
| Temperature glide at 40°C (bubble point) | **0,4 K** | **4,3 K** | **4,3 K** |

Using Coolselector2 it was compared refrigeration cycle for three refrigerants R404A, R407A and R407F. Refrigeration cycle comparison is shown in figure 2.

- Evaporating temperature: -10°C
- Condensing temperature: +45°C
- Superheating: 10K
- Subcooling: 2K

*Figure 2 Refrigeration cycle comparison for R404A, R407F and R407A*




From above picture, there can be seen that discharge temperature is higher for R407A and R407F than for R404A. The main reason for this is high temperature glide of R407A and R407F. High discharge temperature limits the use of R407A and R407F in low temperature applications.
Values of discharge temperatures for mentioned working conditions:

- R404A: $t_{dis}$=70,1°C;
- R407A: $t_{dis}$=88,1°C;
- R407F: $t_{dis}$=93,8°C

Comparison of compressor performance between refrigerants R404A, R407A and R407F is shown in figure 3.
Comparison is made for 3 phase hermetic reciprocating compressor MTZ040-4 at evaporating temperature of -10°C and condensing temperature of +45°C.

For the same conditions compressor MTZ 040-4 has the best efficiency when it is working with R407F. This is because R407F and R407A has bigger specific refrigeration capacity (enthalpy difference between outlet and inlet of the evaporator) in comparing with R404A.
Vapor density in the suction line is highest for R404A.

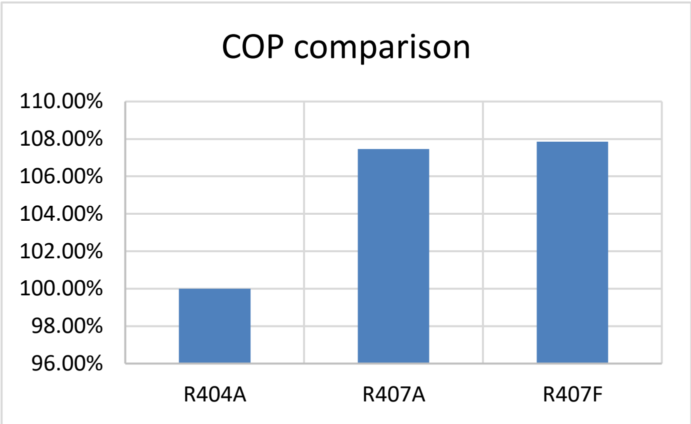



*Figure 3 Comparison of compressor's COP for refrigerants R404A, R407A and R407F*

## 1.3 Refrigerant R448A and R449A

Refrigerant R448A consists of R32 (26%), R125 (26%), R134a (21%), R1234ze (7%) and R1234yf (20%) and is related to R407C, but pressures are more equal to R22.
Refrigerant R449A is consists of R32 (24,3%), R125 (24,7%), R1234yf (25,3%) and R134a (25,7%)
Here is stated characteristics for R404A, R448A and R449A.

| | **R404A** | **R448A** | **R449A** |
|---|---|---|---|
| Class | HFC | HFC/HFO | HFC/HFO |
| GWP | **3943** | **1273** | **1282** |
| Safety group | A1 | A1 | A1 |
| Oil | POE | POE | POE |
| Temperature glide at -10°C (dew point) | **0,6 K** | **5,9 K** | **5,8 K** |
| Temperature glide at 40°C (bubble point) | **0,4 K** | **4,5 K** | **4,5 K** |

As like for R407F and R407A, here was also compared refrigeration cycle for three refrigerants R404A, R448A and R449A. Diagram which is showing stated comparison is shown on figure 3.
Input data for calculation was:

- Evaporating temperature: -10°C;
- Condensing temperature: +45°C
- Superheating: 10K
- Subcooling: 2K

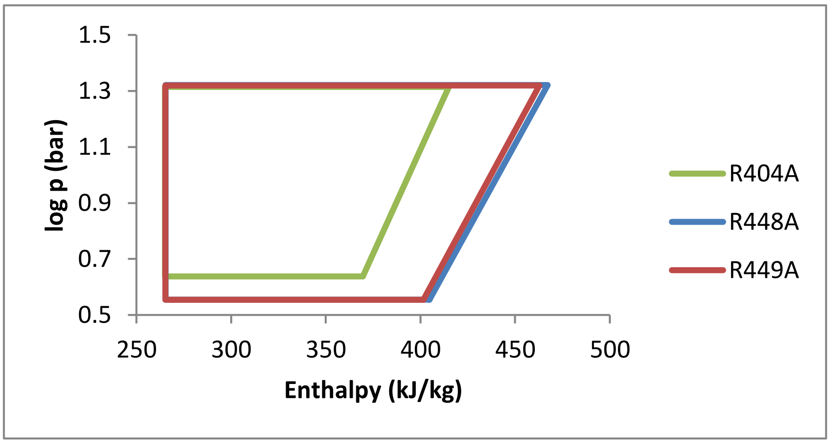



*Figure 4 Refrigeration cycle comparison for R404A, R448A and R449A*

From above picture as like for R407A and R407F, there can be seen that discharge temperature is higher for R448A and R449A than for R404A. The main reason for this is high temperature glide of R448A and R449A. High discharge temperature limits the use of R448A and R449A in low temperature applications.
Values of discharge temperatures for mentioned working conditions:

- R404A: $t_{dis}$=70,1°C;
- R448A: $t_{dis}$=89°C;
- R449A: $t_{dis}$=88,2°C

Comparison of compressor performance between refrigerants R404A, R448A and R449A is shown in figure 5. Comparison is made for 3 phase hermetic scroll compressor MLZ038T4 at evaporating temperature of -10°C and condensing temperature of +45°C.

For the same conditions compressor MLZ038T4 has the best efficiency when it is working with R404A. Even though R448A and R449A has bigger specific refrigeration capacity (enthalpy difference between outlet and inlet of the evaporator), because of high temperature glide and thus high discharge temperature, compressor absorbed power will have a greater influence on COP then compressor cooling capacity.
Vapor density in the suction line is highest for R404A.

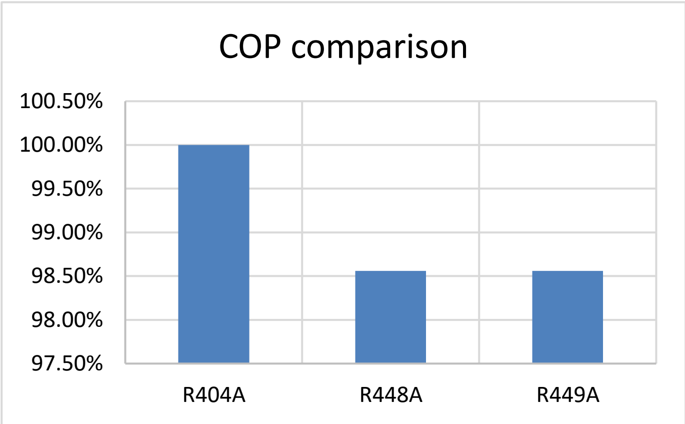



*Figure 5 Comparison of compressor's COP for refrigerants R404A, R448A and R449A*

# 2. Components for alternative refrigerants

## 2.1 Thermostatic expansion valve (exchangeable orifice)

Danfoss can offer thermostatic expansion valves for above mentioned refrigerants with exchangeable orifice like:

- T2 / TE 2;
- TE5 – TE55;

### 2.1.1 Thermostatic expansion valves T2 / TE2

Thermostatic expansion valves regulate the injection of refrigerant liquid into evaporators.
Injection is controlled by the refrigerant superheat.
Therefore the valves are especially suitable for liquid injection in ”dry“ evaporators where the superheat at the evaporator outlet is proportional to the evaporator load.

T2 and TE2 valves are compatible with refrigerants: R22, R407C, R134a, R404A, R507, **R407A**, **R407F**, **R448A** and **R449A**.

When selecting T2 or TE2 valve customer need to order separately these components:

- Thermostatic element;
- Orifice assembly;
- Solder adaptor.

*Thermostatic element:*

| Refrigerant | Type | Range | MOP | Pressure equlization Flare | Connection flare inlet × outlet | | Code no. Multi pack |
|---|---|---|---|---|---|---|---|
| | | | | | [in.] | [mm] | |
| R407F/R407A | T2 | -40 – +10 °C | – | – | 3/8× 1/2 | – | 068Z3716 |
| | TE2 | -40 – +10 °C | – | ¼ in. | 3/8× 1/2 | – | 068Z3713 |
| R448A/R449A | T2 | -40 – +10 °C | – | – | 3/8× 1/2 | – | 068Z3729 |
| | TE2 | -40 – +10 °C | – | ¼ in. | 3/8× 1/2 | – | 068Z3730 |

*Table 2 Thermostatic element T2/TE2 with bulb strap (flare x solder)*

*Orifice capacity for T2 / TE2:*

The rated capacity is based on:

Evaporating temperature $t_e$ = +4.4 °C, condensing temperature $t_c$ = +38 °C and refrigerant temperature ahead of valve $t_l$ = +37 °C

| Orifice no. | Rated capacity in kW | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **R22** | **R407C** | **R134a** | **R404A/R507** | **R407A** | **R407F** | **R448A** | **R449A** |
| 0X | 0,90 | 0,92 | 0,68 | 0,64 | **0,88** | **1,0** | **0,90** | **0,88** |
| 00 | 1,8 | 1,8 | 1,2 | 1,3 | **1,7** | **2,0** | **1,8** | **1,7** |
| 01 | 3,5 | 3,5 | 2,1 | 2,6 | **3,4** | **3,9** | **3,5** | **3,4** |
| 02 | 4,7 | 4,8 | 2,6 | 3,7 | **4,7** | **5,4** | **4,8** | **4,6** |
| 03 | 8,0 | 8,1 | 4,3 | 6,3 | **8,0** | **9,2** | **8,1** | **7,9** |
| 04 | 12,1 | 12,4 | 6,4 | 9,9 | **12,4** | **14,3** | **12,6** | **12,1** |
| 05 | 16,7 | 16,5 | 8,4 | 13,0 | **16,3** | **19,0** | **16,3** | **15,7** |
| 06 | 19,7 | 19,7 | 10,1 | 15,5 | **19,6** | **22,9** | **19,8** | **19,1** |

*Table 3 Orifice capacity for T2 / TE2 thermostatic expansion valve*

*Orifice assembly with filter for solder adaptor*

| Orifice no. | **Code no.** |
|---|---|
| 0X | **068-2089** |
| 00 | **068-2090** |
| 01 | **068-2091** |
| 02 | **068-2092** |
| 03 | **068-2093** |
| 04 | **068-2094** |
| 05 | **068-2095** |
| 06 | **068-2096** |

*Table 4 Orifice assembly with filter for solder adaptor*

*Solder adaptor without orifice assembly and filter*

| Connection ODF solder | **Code no.** |
|---|---|
| 1/4 in. | **068-2062** |
| 6 mm | **068-2063** |
| 3/8 in. | **068-2060** |
| 10 mm | **068-2061** |

*Table 5 Solder adaptor withour orifice assembly and filter*

**<u>Selection example</u>**

Input data:

- Refrigerant: R407F;
- Evaporator capacity: 10 kW;
- Evaporating temperature: -10°C;
- Superheating inside the evaporator: 8K;
- Condensing temperature: +45°C;
- Subcooling inside the condenser: 2K

Results which is given by Coolselector2:

**Selection: T2 - 5**

| Selected | Type | NS | Range | Nominal capacity [kW] | Min. capacity [kW] | Load [%] | DP [bar] | Velocity, in [m/s] | Result |
|---|---|---|---|---|---|---|---|---|---|
| ○ | T2 - 3 | 10 | N | 6,872 | 1,718 | 146 | 18,01 | 1,28 | ⚠ |
| ○ | T2 - 4 | 10 | N | 10,11 | 2,526 | 99 | 18,01 | 1,28 | ✓ |
| ● | T2 - 5 | 10 | N | 13,38 | 3,345 | 75 | 18,01 | 1,28 | ✓ |
| ○ | T2 - 6 | 10 | N | 15,99 | 3,996 | 63 | 18,01 | 1,28 | ✓ |

*Figure 6 T2 selection in Coolselector2*

From above figure it can be seen that adequate T2 thermostatic expansion valve from input data from previous page is T2 or TE2 with orifice 5.
The valve's opening degree should be between 50 and 75% when regulating.
In this way it is ensured that the valve has a sufficiently wide regulation range, so that it can manage changed loads at or near the normal working point.
If there is a liquid distributor at inlet of the evaporator, then it is suggested to use thermostatic expansion valve with external equalization line.

According to the above customer can order below code numbers:

- thermostatic element: **068Z3713** (see table 2);
- orifice assembly: **068-2095** (see table 4);
- solder adaptor: **068-2061** (see table 5)

These code numbers are just an example; customer can order different connections and different thermostatic element with or without MOP charge and with different working range.

## 2.1.2 Thermostatic expansion valves TE5 – TE55

The TE 5 - TE 55 series expansion valve regulate the injection of refrigerant into evaporators. It controls the refrigerant flow based on the superheat. The exchangeable power element is produced with the well-known Danfoss laser welding technology for extended lifetime capability.
The TE 5 - TE 55 series is available with a wide range of orifices which will cover a wide range of applications.

TE5 - TE55 valves are compatible with refrigerants: R22, R407C, R134a, R404A, R507, **R407A**, **R407F**.

When selecting TE5 – TE55 valve customer need to order separately these components:
- Thermostatic element;
- Orifice assembly;
- Valve body with connections.

*Thermostatic element for refrigerants R407A and R407F*

| Valve type | Pressure equalization | | MOP | Range | Capillary tube | Code no. |
|---|---|---|---|---|---|---|
| | Size | Type | [°C] | [°C] | [m] | |
| TE 5 | 1/4 in / 6 mm | Flare | - | -40 – 10 | 3 | **067B3501** |
| | 1/4 in / 6 mm | Flare | 0 | -40 – -5 | 3 | **067B3502** |
| | 1/4 in / 6 mm | Flare | -10 | -40 – -15 | 3 | **067B3503** |
| | 1/4 in | Solder ODF | - | -40 – 10 | 3 | **067B3504** |
| TE 12 | 1/4 in / 6 mm | Flare | - | -40 – 10 | 3 | **067B3532** |
| | 1/4 in / 6 mm | Flare | 0 | -40 – -5 | 3 | **067B3531** |
| | 1/4 in / 6 mm | Flare | -10 | -40 – -15 | 3 | **067B3533** |
| TE 20 | 1/4 in / 6 mm | Flare | - | -40 – 10 | 3 | **067B3561** |
| | 1/4 in / 6 mm | Flare | 0 | -40 – -5 | 3 | **067B3560** |
| | 1/4 in / 6 mm | Flare | -10 | -40 – -15 | 3 | **067B3562** |
| TE 55 | 1/4 in / 6 mm | Flare | - | -40 – 10 | 3 | **067G3500** |

*On systems charged with R407A, SS will different from standard 4K. For range -40 – 10 °C, SS = 2.7K.*
*For range -40 – -5 °C and range -40 – -15 °C, SS = 2.8K.*

*Table 6 Element for expansion valve TE5 - TE55 and for refrigerants R407A/F - including bulb strap*

*Orifice capacity and code numbers for TE5 – TE55:*

| Valve type | Orifice no. | R407F | R407A | R404A/R507 | R22 | R134a | R407C | Code no. |
|---|---|---|---|---|---|---|---|---|
| | | [kW] | | | | | | |
| TE 5 | 0,5 | 11,0 | 10,3 | 8,17 | 10,4 | 6,68 | 10,7 | **067B2788** |
| | 1 | 20,3 | 18,8 | 14,9 | 19,1 | 12,2 | 19,6 | **067B2789** |
| | 2 | 28,1 | 25,9 | 20,5 | 26,3 | 17,0 | 27,2 | **067B2790** |
| | 3 | 35,8 | 33,3 | 26,3 | 33,8 | 21,8 | 34,8 | **067B2791** |
| | 4 | 49,0 | 45,3 | 35,7 | 46,0 | 29,7 | 47,4 | **067B2792** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TE 12 | 5 | 71,0 | 56,0 | 50,7 | 57,2 | 37,7 | 55,8 | **067B2708** |
| | 6 | 95,0 | 75,0 | 64,0 | 76,3 | 50,1 | 73,9 | **067B2709** |
| | 7 | 115 | 96,0 | 81,3 | 97,8 | 65,7 | 94,3 | **067B2710** |
| TE 20 | 8 | 141 | 126 | 87,1 | 128 | 77,8 | 118 | **067B2771** [1]) |
| | 9 | 161 | 148 | 102 | 150 | 92,3 | 136 | **067B2773** [1]) |
| TE 55 | 9B | 124 | 112 | 84,8 | 113 | 77,9 | 112 | **067G2705** [2]) |
| | 10 | 173 | 166 | 128 | 169 | 111 | 161 | **067G2701** |
| | 11 | 188 | 181 | 138 | 184 | 122 | 175 | **067G2704** |
| | 12 | 207 | 199 | 152 | 202 | 134 | 191 | **067G2707** |
| | 13 | 250 | 242 | 182 | 245 | 166 | 232 | **067G2710** |

*Table 7 Orifice for expansion valves TE5 - TE55. Rated capacity and code numbers*

The rated capacity is based on:
Evaporating temperature $t_e$ = 4.4 °C
Condensing temperature $t_c$ = 38 °C
Refrigerant temperature ahead of valve $t_l$ = 37 °C
[1]) Recommend to use orifice no. 9B as alternative for orifice no. 8 and 9 on TE 55 when selecting the valve to work in range -60 – -25°C.
Extend capacity tables for range -60 – -25°C are not provided.
[2]) Alternative for orifice no. 8 and 9 in range -60 – -25°C. Extend capacity tables for range -40 – 10°C are not provided.

*Valve body for expansion valves:*

| Type | Connection Inlet × Outlet | | Connections / Flow direction | Connection type [1]) | Code no. |
|---|---|---|---|---|---|
| | [in] | [mm] | | | |
| TE 5 | 1/2 x 5/8 | 12 × 16 | Flare angleway | - | **067B4013** |
| | 1/2 x 5/8 | - | Solder angleway | ODF × ODF | **067B4009** |
| | 1/2 x 5/8 | - | Solder angleway | ODF × ODF | **067B4010** |
| | 5/8 x 7/8 | - | Solder angleway | ODF × ODF | **067B4011** |
| | 7/8 x 1 1/8 | - | Solder angleway | ODF × ODM | **067B4034** |
| | 1/2 x 5/8 | - | Solder straightway | ODF × ODF | **067B4007** |
| | 1/2 x 7/8 | - | Solder straightway | ODF × ODF | **067B4008** |
| | 5/8 x 7/8 | - | Solder straightway | ODF × ODF | **067B4032** |
| | 7/8 x 1 1/8 | - | Solder straightway | ODF × ODM | **067B4033** |
| | - | 12 × 16 | Solder angleway | ODF × ODF | **067B4004** |
| | - | 12 × 22 | Solder angleway | ODF × ODF | **067B4005** |
| | - | 16 × 22 | Solder angleway | ODF × ODF | **067B4012** |
| | - | 22 × 28 | Solder angleway | ODF × ODM | **067B4037** |
| | - | 12 × 16 | Solder straightway | ODF × ODF | **067B4002** |
| | - | 12 × 22 | Solder straightway | ODF × ODF | **067B4003** |
| | - | 16 × 22 | Solder straightway | ODF × ODF | **067B4035** |
| | - | 22 × 28 | Solder straightway | ODF × ODM | **067B4036** |
| TE 12 | 5/8 x 7/8 | - | Solder angleway | ODF × ODF | **067B4022** |
| | 7/8 x 1 1/8 | - | Solder angleway | ODF × ODM | **067B4023** |

| | | | | | |
|---|---|---|---|---|---|
| | 5/8 x 7/8 | - | Solder straightway | ODF × ODF | **067B4020** |
| | 7/8 x 1 1/8 | - | Solder straightway | ODF × ODM | **067B4021** |
| | - | 22 × 28 | Solder angleway | ODF × ODM | **067B4017** |
| | - | 16 × 22 | Solder straightway | ODF × ODF | **067B4018** |
| | - | 22 × 28 | Solder straightway | ODF × ODM | **067B4016** |
| **TE 12** | 5/8 x 7/8 | - | Solder flanges | ODF × ODF | **067B4025** |
| | 7/8 x 1 | - | Solder flanges | ODF × ODF | **067B4026** |
| | - | 16 × 22 | Solder flanges | ODF × ODF | **067B4027** |
| | - | 22 × 25 | Solder flanges | ODF × ODF | **067B4015** |
| **TE 20** | 7/8 x 1 1/8 | - | Solder angleway | ODF × ODM | **067B4023** |
| | - | 22 × 28 | Solder angleway | ODF × ODM | **067B4017** |
| | 7/8 x 1 1/8 | - | Solder straightway | ODF × ODM | **067B4021** |
| | - | 22 × 28 | Solder straightway | ODF × ODM | **067B4016** |
| **TE 55** | 1 1/8 x 1 3/8 | - | Solder angleway | ODM × ODM | **067G4004** |
| | - | 28 × 35 | Solder angleway | ODM × ODM | **067G4002** |
| | 1 1/8 x 1 3/8 | - | Solder straightway | ODM × ODM | **067G4003** |
| | - | 28 × 35 | Solder straightway | ODM × ODM | **067G4001** |

*[1]) ODF = Internal diameter ODM = External diameter*

*Table 8 Valve body for expansion valves TE5 - TE55*

**Selection example**

Input data:

- Refrigerant: R407A;
- Evaporator capacity: 25 kW;
- Evaporating temperature: -10°C;
- Superheating inside the evaporator: 8K;
- Condensing temperature: +45°C;
- Subcooling inside the condenser: 2K

Results which is given by Coolselector2:

**Selection: TE 5 - 4**

| Selected | Type | NS | Range | Nominal capacity [kW] | Min. capacity [kW] | Load [%] | DP [bar] | Velocity, in [m/s] | Result |
|---|---|---|---|---|---|---|---|---|---|
| ○ | TE 5 - 2 | 16 | N | 20,21 | 5,051 | 124 | 17,13 | 1,16 | ⚠ |
| ○ | TE 5 - 3 | 16 | N | 25,26 | 6,314 | 99 | 17,13 | 1,16 | ✓ |
| ● | TE 5 - 4 | 16 | N | 34,33 | 8,583 | 73 | 17,13 | 1,16 | ✓ |
| ○ | TE 12 - 5 | 22 | N | 36,92 | 9,231 | 68 | 17,13 | 0,57 | ✓ |

*Figure 7 TE5 selection in Coolselector2*

From the above figure it can be seen that adequate TE5 - TE55 thermostatic expansion valve from input data from previous page is TE5 with orifice 4.

According to the above mentioned customer can order code numbers as followed:

- thermostatic element: **067B3501** (see table 6);
- orifice assembly: **067B2792** (see table 3);
- valve body: **067B4005** (see table 4)

These code numbers are just an example, customer can order different connections and different thermostatic element with or without MOP charge and with different working range.

# 3. Retrofitting existing systems with alternative refrigerants

In this section, it will be described how to use Danfoss TXV’s like T2/TE2, TU/TUE and TE5 – TE55 for retrofitting with alternative refrigerants.
All texts, diagrams and recommendations was done by Jepsen Svend Stuhr Product Expert, Small capacity TXV (Danfoss A/S, Nordborg).

## 3.1 Calculation of static SH response to use of R449A drop-in

### 3.1.1 T2/TE2 range N

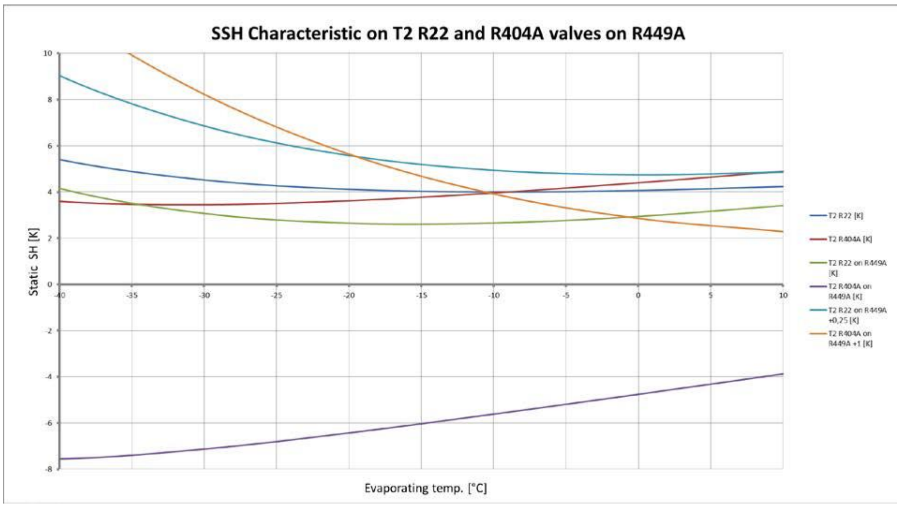



*Figure 8 SSH Characteristic on T2 R22 and R404A valves on R449A*

Recommendation:
When system with R22 is retrofitted to R449A:
    Leave R22 TXV. Increase setting by 0 to 0.25 turn.
When system with R404A is retrofitted to R449A:
    Switch R404A TXV to R22 and increase setting by 0 to 0.25 turn or
    Leave R404A valve and increase setting by 1 turn.

Comment: When using R404A valve on R449A (assuming the valve is on factory setting), the setting MUST be increased by 1 turn, or the valve will have negative SSH. Consequence of this is that the SSH characteristic will increase strongly towards lower Tevap., reaching more than 8K below -30°C.

Capacity of R449A related to original Refrigerant:

| | | | | |
|---|---|---|---|---|
| Tevap.: | -30°C | -10°C | +5°C | (Tcond. = +38°C / Tsub = 1K) |
| R22: | -8% | -4% | 0% | |
| R404A: | +42% | +40% | +41% | |

Example how to use: Capacity: 10 kW (R449A), R22 base refrigerant, Tevap. = -10°C:
Q (R449A) / factor -4% = Q (R22) ~ 10 / 0.96 = 10.4 kW

## 3.1.2 TU/TUE range N

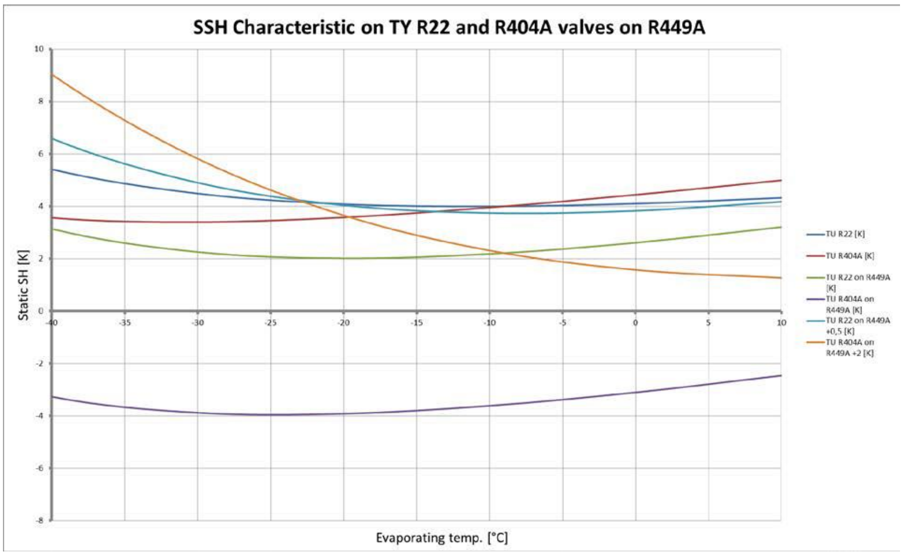



*Figure 9 SSH Characteristic on TU R22 and R404A valves on R449A*

Recommendation:
When system with R22 is retrofitted to R449A:
    Leave R22 TXV. Increase setting by 0 to 0.5 turn.
When system with R404A is retrofitted to R449A:
    Switch R404A TXV to R22 and increase setting by 0 to 0.5 turn or
    Leave R404A valve and increase setting by 2 turn.

Comment: When using R404A valve on R449A (assuming the valve is on factory setting), the setting MUST be increased by 2 turns, or the valve will have negative SSH at high Tevaps. Consequence of this is that the SSH characteristic will increase strongly towards lower Tevap., reaching more than 6K below -30°C

Capacity of R449A related to original Refrigerant:

| | | | | |
|---|---|---|---|---|
| Tevap.: | -30°C | -10°C | +5°C | (Tcond. = +38°C / Tsub = 1K) |
| R22: | -8% | -4% | 0% | |
| R404A: | +42% | +40% | +41% | |

Example how to use: Capacity: 10 kW (R449A), R22 base refrigerant, Tevap. = -10°C:
Q (R449A) / factor -4% = Q (R22) ~ 10 / 0.96 = 10.4 kW

### 3.1.3 TE5 – TE55 range N

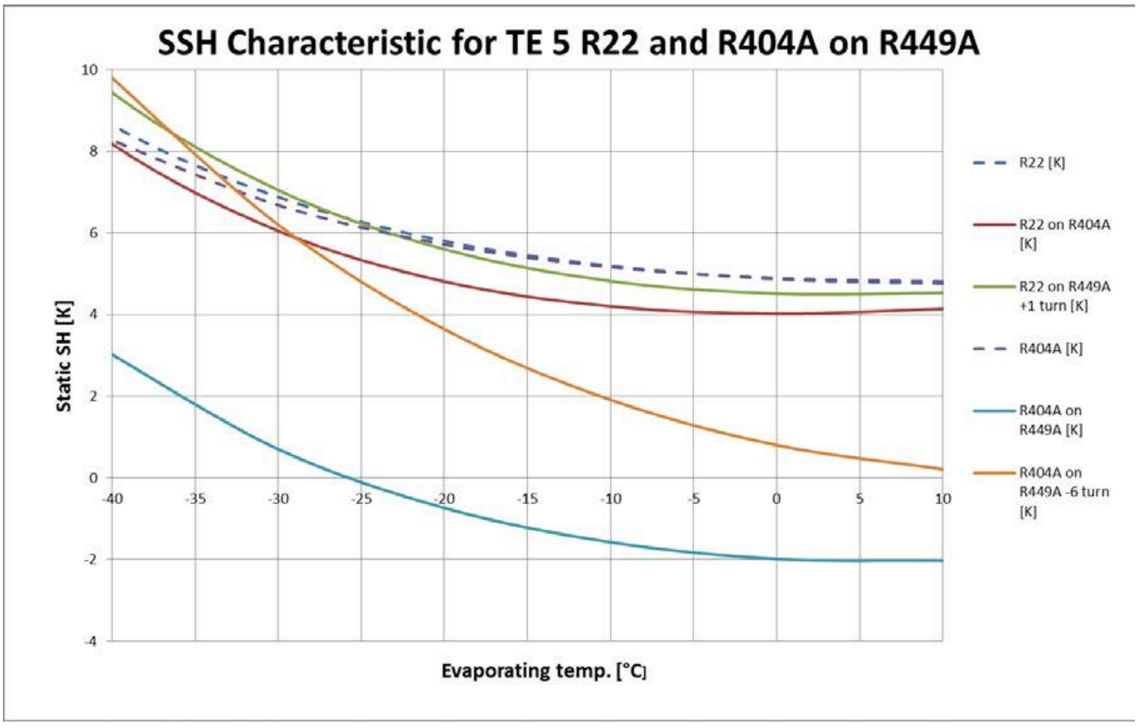



*Figure 10 SSH Characteristic for TE 5 R22 and R404A on R449A*

Recommendation:
When system with R22 is retrofitted to R449A:
Leave R22 TXV. Increase setting by 0 to 0.5 turn.
When system with R404A is retrofitted to R449A:
Switch R404A TXV to R22 and increase setting by 0 to 0.5 turn or
Leave R404A valve and increase setting by 6 turn.

Comment: When using R404A valve on R449A (assuming the valve is on factory setting), the setting MUST be increased by at least 5 turns, or the valve will have negative SSH at high Tevaps. Consequence of this is that the SSH characteristic will increase strongly towards lower Tevap., reaching more than 6K below -30°C

Capacity of R449A related to original Refrigerant:

| Tevap.: | -30°C | -10°C | +5°C | (Tcond. = +38°C / Tsub = 1K) |
|---|---|---|---|---|
| R22: | -8% | -4% | 0% | |
| R404A: | +42% | +40% | +41% | |

Example how to use: Capacity: 10 kW (R449A), R22 base refrigerant, Tevap. = -10°C:
Q (R449A) / factor -4% = Q (R22) ~ 10 / 0.96 = 10.4 kW

## 3.2 Calculation of static SH response to use of R448A drop-in

### 3.2.1 T2/TE2 and TU range N

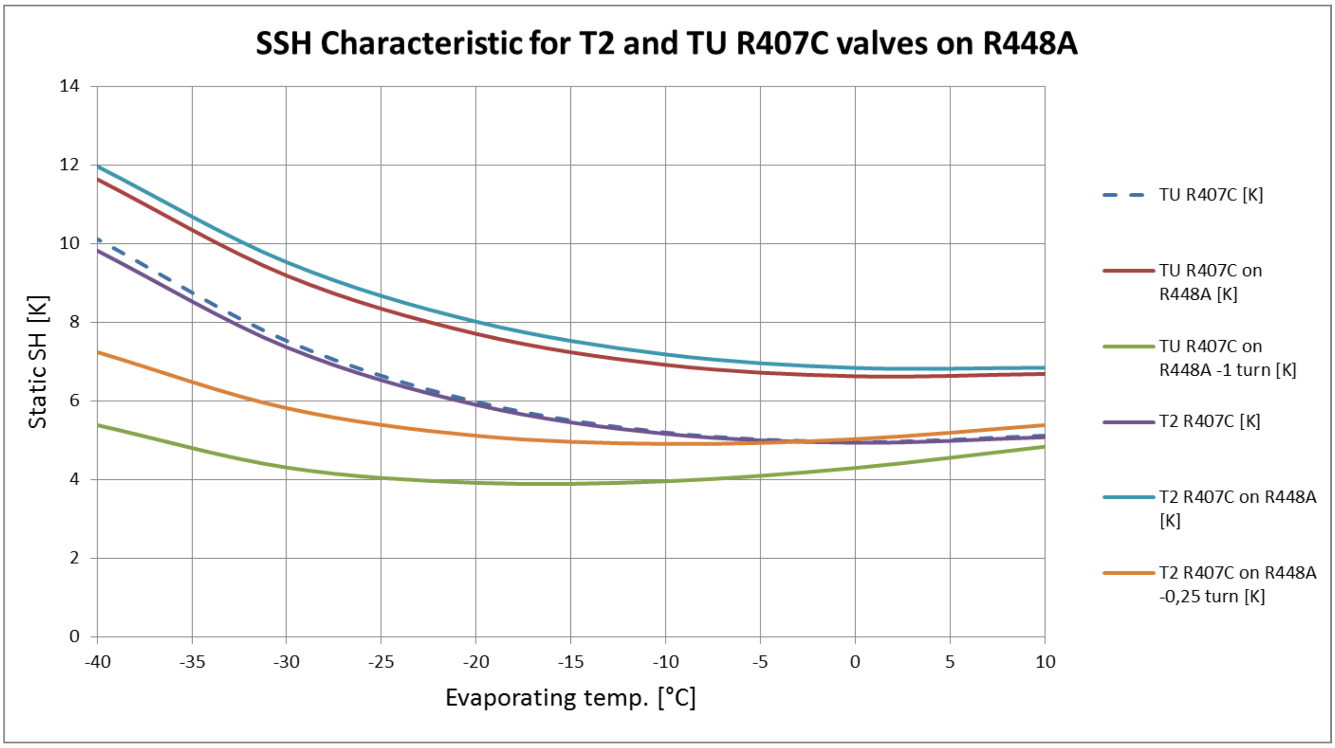



*Figure 11 SSH Characteristic for T2 and TU R407C valves on R448A*

Recommendation:
When system with R22 is retrofitted to R448A:
Leave R22 TXV. No need to change setting.

When system with R407C is retrofitted to R448A:
Leave R407C valve and reduce setting by 1 turn (TU) and ¼ turn (T2).

Capacity of R448A related to original Refrigerant:

| | | | | |
|---|---|---|---|---|
| Tevap.: | -30°C | -10°C | +5°C | (Tcond. = +38°C / Tsub = 1K) |
| R22: | -6% | -2% | +1% | |
| R407C: | -5% | -5% | -5% | |

Example how to use: Capacity: 10 kW (R448A), R22 base refrigerant, Tevap. = -10°C:
Q (R448A) / factor -2% = Q (R22) ~ 10 / 0.98 = 10.2 kW

### 3.2.1 TGE range N

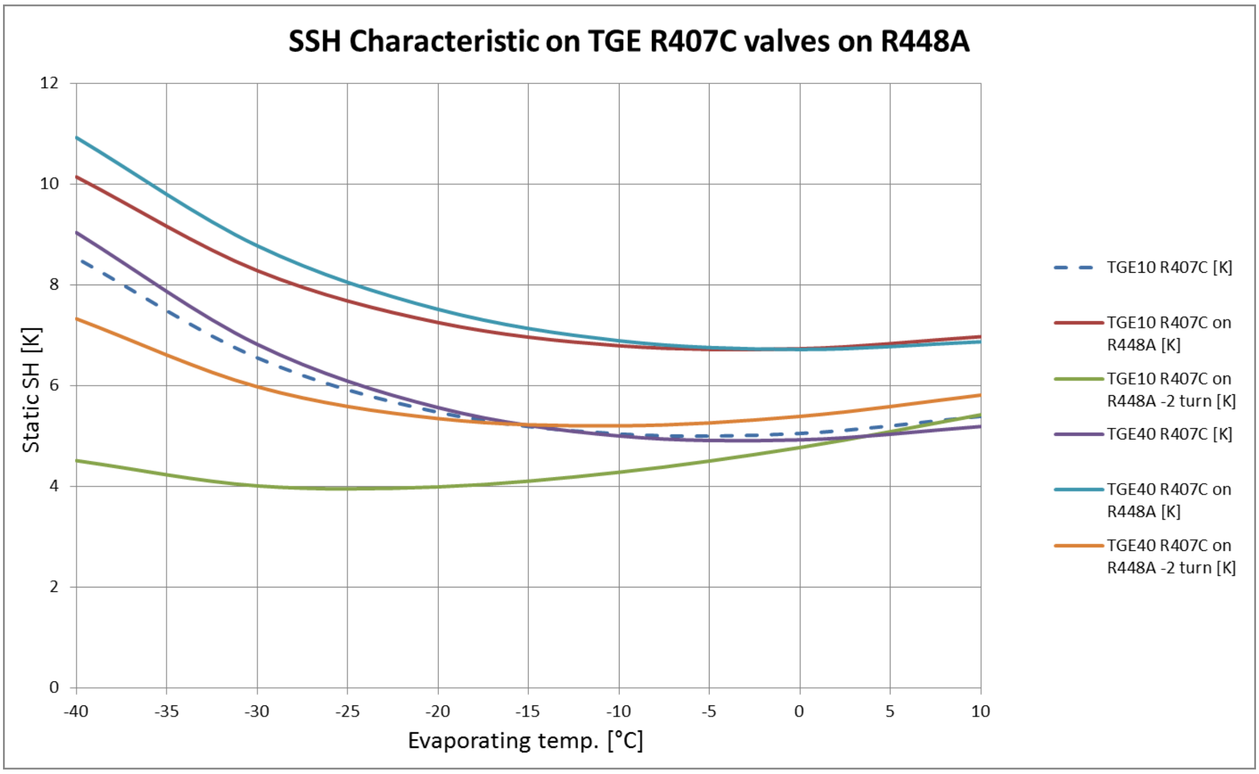



*Figure 12 SSH Characteristic on TGE R407C valves on R448A*

Recommendation:
When system with R22 is retrofitted to R448A:
Leave R22 TXV. No need to change setting

When system with R407C is retrofitted to R448A:
Leave R407C valve and decrease setting by 2 turn.

Capacity of R448A related to original Refrigerant:

| | | | | |
|---|---|---|---|---|
| Tevap.: | -30°C | -10°C | +5°C | (Tcond. = +38°C / Tsub = 1K) |
| R22: | -6% | -2% | +1% | |
| R407C: | -5% | -5% | -5% | |

Example how to use: Capacity: 10 kW (R448A), R22 base refrigerant, Tevap. = -10°C:
Q (R448A) / factor -2% = Q (R22) ~ 10 / 0.98 = 10.2 kW

### 3.2.1 TE5 – TE55 range N

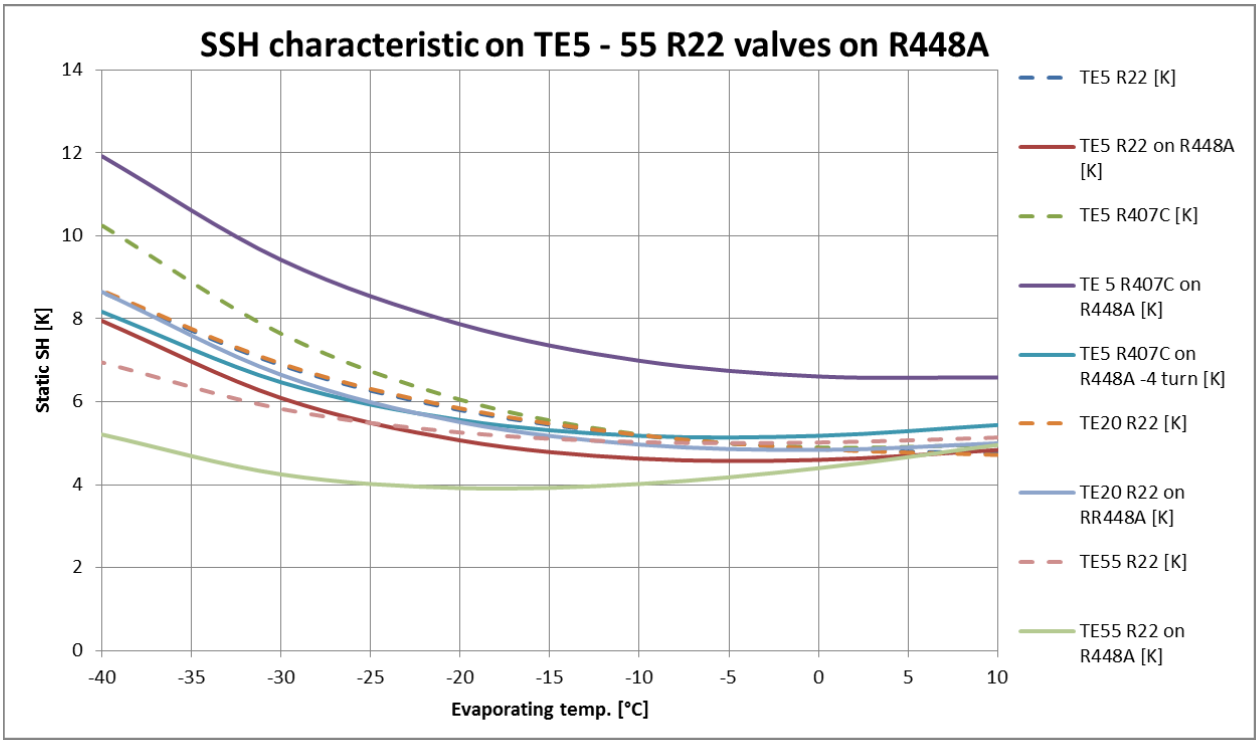



*Figure 13 SSH Characteristic on TE5 - 55 R22 valves on R448A*

Recommendation:
When system with R22 is retrofitted to R448A:
Leave R22 TXV. No need to change setting

When system with R407C is retrofitted to R448A:
Leave R407C valve and decrease setting by 3 turn, or
Change to R22 valve and keep original setting.

Capacity of R448A related to original Refrigerant:

| | | | | |
|---|---|---|---|---|
| Tevap.: | -30°C | -10°C | +5°C | (Tcond. = +38°C / Tsub = 1K) |
| R22: | -6% | -2% | +1% | |
| R407C: | -5% | -5% | -5% | |

Example how to use: Capacity: 10 kW (R448A), R22 base refrigerant, Tevap. = -10°C:
Q (R448A) / factor -2% = Q (R22) ~ 10 / 0.98 = 10.2 kW