Technical product news

Danfoss Commercial Compressors
Towards more eco-friendly commercial refrigeration systems

The refrigeration industry has made tremendous progress over the past two decades in reducing the use of ozone-depleting refrigerants. Now a trend of synthetic refrigerants is emerging, defined by the global agenda on climate change and global warming. Synthetic refrigerants will play a major role in the refrigeration industry with new low-GWP substances. Refrigerant manufacturers are responding by developing new products. Danfoss encourages the further development and application of low-GWP refrigerants. We will enable our customers to achieve these GWP goals while continuing to enhance the energy efficiency of our refrigeration equipment.

The guidelines for retrofitting or installing compressors in equipment with our current range have been updated. They include technical recommendations for replacing R404A or R507 with alternative blends available on the market, R407A, R407F.

Using R407A, R407F as drop-in of R404A systems

Introduction

These three HFC blends with similar properties all have a GWP below 2000. They have been evaluated as possible drop-in candidates.

Designation	Composition	ODP	GWP	Safety group	Boiling temp °C	Temp glide °C	Critical temp °C	Critical pressure bar	Cond temp @ 26babs
R404A	52% R143a - 44% R125 - 4% R134a	0	3900	A1	-47	0.8	71.6	37.3	55
R507	50% R143a - 50% R125	0	4000	A1	-46.7	0	71	37.15	54
R407A	40% R134a - 40% R125 - 20% R32	0	1990	A1	-38.9	6.42	82	45.15	56
R407F	40% R134a - 30% R125 - 30% R32	0	1824	A1	-46	6.4	83	47.5	57

Table 1

All these refrigerants are blends of HFC already used in the R404A refrigerant. Although these blends were originally intended as replacement for R22, they are now also used in supermarket applications where their GWP below 2000 makes them a low-GWP alternative to R404A, which has a GWP of 3900.

Lubrication and oil compatibility: using our PVE or current POE oil should ensure a good lubrication of the compressor and long-term reliability of the overall system. The new refrigerants and POE or PVE oils are fully compatible and do not affect the system components.

The alternatives have quite a large glide and no other refrigerant with a negligible glide is expected. As a result, designers will consider adaptations in the unit similar to those which we experienced in air-conditioning when switching from R22 to R407C and requalify components such as exchangers.

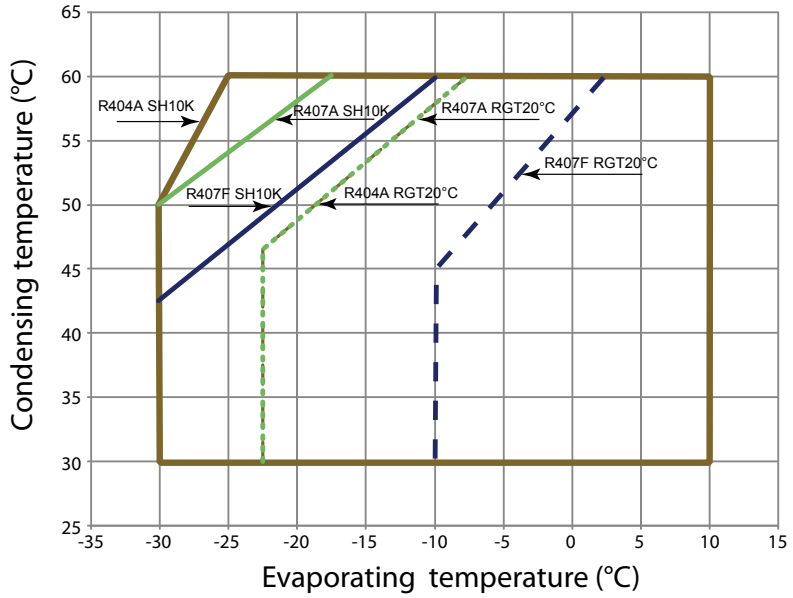
Compressor and application performance

Compressor performance calculation

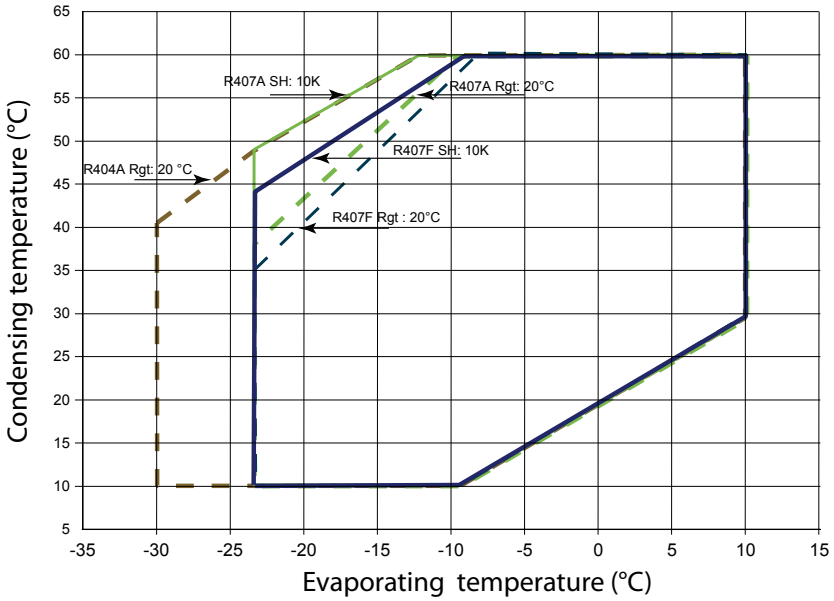
			R407A	R407F
Application effect	Cooling effect	MHP -10 / 45°C	-5%	3%
		HP +5 / 50°C	-1%	7%
	Application COP	MHP -10 / 45°C	5%	7%
		HP +5 / 50°C	7%	9%
Published Data	Compressor Capacity Dew Point	MHP -10 / 45°C	-8%	-1,20%
		HP +5 / 50°C	-3,5%	-1,5%
	Discharge temp Dew Point	MHP -10 / 45°C	2,5%	6%
		HP +5 / 50°C	5%	8%

Notes: At -35°C of evaporating temperature and 40°C of condensing temperature, the discharge temperature is increased by 20 to 30 K. Based on our experience with hermetic reciprocating compressors, this discharge temperature cannot ensure a reliable functioning of the compressor. As a result, these refrigerants are not recommended for low-temperature applications without a dedicated discharge temperature control.

Preliminary map MTZ at dew temperature



Preliminary map MLZ at dew temperature



System performance simulation

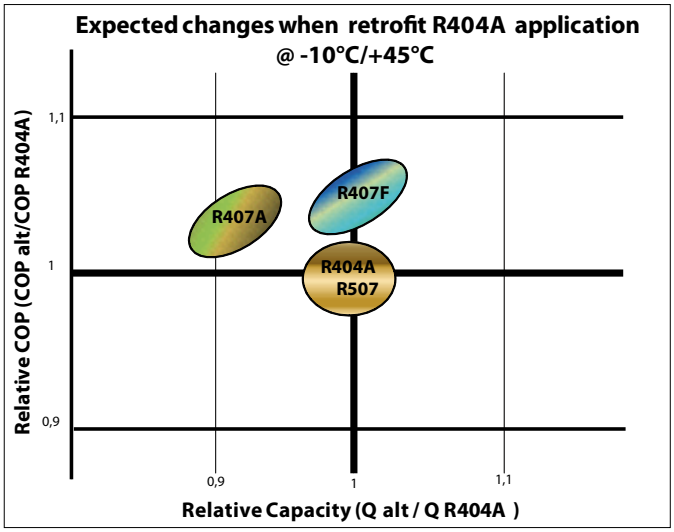


Figure 1: illustrates the gains obtained on cooling capacity and energy efficiency when using R407A, R407F refrigerants compared to using R404A.

Decision criteria before starting application of retrofit

When a drop-in is planned for a system with R404A, the following criteria must be considered:

1. First of all, conduct a thorough analysis of the installation and the costs of a retrofit. Take into account the age of the installation and its main components. Estimate how long the installation could still run and which components may require replacement soon. This can strongly influence the choice for the best retrofit process.
2. Take into account that the retrofit in this case could increase the cooling capacity. This is partly due to the thermodynamic properties of the refrigerant. On the other hand, we must consider that the large glide of some blends could reduce the heat exchanger capacity by up to 5%. The change in cooling capacity should be so low that the application design will not have to be changed.
3. Glide training will be relevant; dew and bubble temperatures/pressures can lead to errors when setting up devices.
4. The new refrigerants and POE or PVE oils are fully compatible and do not affect the system components.
5. Retrofitting does not apply to the following specific applications:
   - Installations with flooded heat exchangers, such as tube-&-shell require refrigerants with a negligible glide such as R404A or R507. Blends with large glides must not be applied.
6. Danfoss does not have enough experience with the effect of using these blends in systems which have already contained R404A, and therefore Danfoss does accept any liability for this use. Danfoss does, however, recommend strict compliance with refrigerant manufacturer instructions and procedures.

Impact on expansion device

The thermostatic expansion valve in the system is designed to work with R404A. When applied with one of the blends, please follow the instructions from the TEXV supplier.

Retrofit process

The step-by-step retrofit process has been described in many publications and can be considered as known practice. Only a few points need to be highlighted:

- Control devices — New pressure and temperature settings
- Safety devices — New pressure and temperature settings
- Expansion valve — Adjust superheat setting (use the Saturated Suction Temperature at dew point)

Conclusion

Apart from a few cases where a drop-in solution is not allowed, the synthetic refrigerants such as R407A, R407F can ensure target efficiency and performance with minimum drop-in procedures.
Always apply the recommended component replacements and adjustments.

Footnote: The above scenarios and conclusion focus on systems with POE. Most of this will apply to MLZ with PVE oil.

MTZ Recip Performances data sheet

R407F	Te	-20		-15		-10		-5		0		5		10		-10/45 EN12900 10K		
Models	Tc	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	COP
MTZ018-4	40	1 118	0.901	1 582	1.00	2 134	1.09	2 813	1.17	3 609	1.23	4 541	1.27	5 628	1.30	1 887	1.12	1.68
	50	831	0.93	1 186	1.05	1 630	1.16	2 171	1.25	2 810	1.34	3 566	1.41	4 458	1.47			
MTZ022-4	40	1 622	1.11	2 224	1.23	2 964	1.33	3 839	1.42	4 881	1.49	6 107	1.55	7 528	1.59	2 598	1.38	1.88
	50	1 177	1.13	1 651	1.29	2 233	1.43	2 951	1.56	3 806	1.67	4 817	1.77	6 012	1.86			
MTZ028-4	40	2 136	1.43	2 916	1.60	3 853	1.76	4 945	1.90	6 232	2.01	7 713	2.09	9 407	2.15	3 389	1.82	1.86
	50	1 533	1.46	2 165	1.68	2 934	1.88	3 839	2.07	4 910	2.23	6 156	2.37	7 606	2.49			
MTZ032-4	40	2 562	1.59	3 420	1.78	4 456	1.94	5 675	2.09	7 089	2.21	8 737	2.32	10 617	2.40	3 932	2.01	1.95
	50	1 869	1.62	2 570	1.86	3 418	2.08	4 422	2.28	5 600	2.46	6 984	2.63	8 580	2.78			
MTZ036-4	40	3 036	1.90	4 023	2.11	5 187	2.30	6 544	2.46	8 125	2.60	9 949	2.71	12 034	2.79	4 614	2.40	1.92
	50	2 285	1.98	3 094	2.25	4 041	2.50	5 162	2.72	6 458	2.93	7 969	3.11	9 712	3.26			
MTZ040-4	40	3 541	2.18	4 616	2.41	5 888	2.63	7 363	2.82	9 071	2.98	11 032	3.13	13 264	3.25	5 266	2.75	1.92
	50	2 700	2.30	3 598	2.60	4 634	2.87	5 853	3.12	7 267	3.35	8 895	3.55	10 765	3.73			
MTZ044-4	40	3 392	2.09	4 557	2.30	5 958	2.49	7 620	2.65	9 584	2.79	11 859	2.91	14 504	3.01	5 306	2.59	2.05
	50	2 512	2.15	3 480	2.43	4 634	2.68	6 011	2.90	7 642	3.09	9 564	3.26	11 798	3.41			
MTZ050-4	40	4 005	2.43	5 368	2.67	7 025	2.89	8 992	3.08	11 319	3.23	14 046	3.35	17 181	3.44	6 185	3.00	2.06
	50	2 967	2.52	4 043	2.82	5 365	3.10	6 958	3.36	8 854	3.58	11 091	3.77	13 707	3.94			
MTZ056-4	40	4 223	2.61	5 704	2.89	7 499	3.15	9 653	3.39	12 197	3.58	15 189	3.74	18 647	3.87	6 629	3.27	2.02
	50	3 145	2.70	4 340	3.06	5 790	3.39	7 541	3.70	9 643	3.98	12 125	4.22	15 026	4.43			
MTZ064-4	40	5 103	3.10	6 821	3.46	8 912	3.78	11 410	4.08	14 376	4.33	17 858	4.54	21 894	4.71	7 884	3.92	2.01
	50	3 768	3.16	5 160	3.62	6 867	4.04	8 922	4.43	11 388	4.77	14 312	5.08	17 742	5.35			
MTZ072-4	40	5 766	3.49	7 661	3.87	9 959	4.23	12 693	4.55	15 924	4.82	19 670	5.06	24 010	5.27	8 813	4.37	2.02
	50	4 312	3.60	5 832	4.06	7 697	4.50	9 939	4.92	12 611	5.30	15 750	5.64	19 414	5.95			
MTZ080-4	40	6 923	4.14	9 055	4.61	11 589	5.02	14 578	5.41	18 054	5.75	22 074	6.06	26 686	6.35	10 344	5.23	1.98
	50	5 281	4.32	7 028	4.90	9 109	5.42	11 558	5.90	14 445	6.33	17 809	6.73	21 697	7.09			
MTZ100-4	40	7 853	5.11	10 478	5.60	13 625	6.02	17 332	6.37	21 662	6.64	26 694	6.84	32 472	6.99	12 133	6.30	1.93
	50	5 885	5.29	8 056	5.95	10 621	6.54	13 640	7.05	17 186	7.48	21 315	7.83	26 086	8.11			
MTZ125-4	40	10 266	6.35	13 562	6.98	17 547	7.56	22 277	8.08	27 845	8.54	34 317	8.92	41 781	9.24	15 521	7.87	1.97
	50	7 714	6.61	10 340	7.40	13 555	8.15	17 411	8.86	22 008	9.51	27 403	10.10	33 682	10.64			
MTZ144-4	40	12 303	7.40	16 063	8.11	20 541	8.76	25 800	9.36	31 946	9.87	39 055	10.32	47 202	10.69	18 268	9.11	2.00
	50	9 316	7.69	12 366	8.59	16 015	9.43	20 342	10.24	25 449	10.98	31 392	11.65	38 278	12.27			
MTZ160-4	40	13 500	8.35	17 605	9.16	22 487	9.93	28 228	10.66	34 924	11.36	42 660	12.05	51 532	12.75	20 066	10.32	1.94
	50	10 286	8.71	13 631	9.73	17 636	10.70	22 385	11.63	27 963	12.53	34 465	13.42	41 977	14.32			

Qo : Cooling Capacity (W) Pe : Power Input (kW) Preliminary data / At dew point

MLZ Scroll Compressors Performances Data Sheet

R407F	Te	-20		-15		-10		-5		0		5		10		-10/45 EN12900 10K		
Models	Tc	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	Qo	Pe	COP
MLZ015T4	40	2245	1.45	2859	1.44	3566	1.43	4383	1.42	5329	1.41	6420	1.41	7672	1.43	3008	1.54	1.95
	50	-	-	2331	1.90	2962	1.87	3683	1.85	4511	1.84	5468	1.83	6574	1.84			
MLZ019T4	40	3083	1.74	3843	1.77	4727	1.79	5759	1.80	6964	1.81	8367	1.82	9990	1.84	4056	1.89	2.15
	50	-	-	3297	2.22	4078	2.26	4991	2.28	6063	2.29	7322	2.30	8798	2.31			
MLZ021T4	40	3083	1.74	3843	1.77	4727	1.79	5759	1.80	6964	1.81	8367	1.82	9990	1.84	4303	2.00	2.15
	50	-	-	3297	2.22	4078	2.26	4991	2.28	6063	2.29	7322	2.30	8798	2.31			
MLZ026T4	40	4085	2.29	5088	2.32	6266	2.35	7643	2.36	9247	2.38	11099	2.41	13219	2.47	5375	2.48	2.16
	50	-	-	4360	2.95	5401	2.98	6625	3.00	8059	3.02	9732	3.06	11673	3.13			
MLZ030T4	40	4905	2.69	6112	2.73	7539	2.77	9210	2.81	11147	2.83	13369	2.85	15890	2.87	6462	2.93	2.21
	50	-	-	5235	3.46	6487	3.50	7967	3.54	9702	3.57	11717	3.61	14038	3.64			
MLZ038T4	40	5849	3.20	7290	3.25	8989	3.31	10979	3.36	13292	3.41	15957	3.43	18996	3.41	7707	3.49	2.21
	50	-	-	6247	4.11	7740	4.16	9500	4.22	11562	4.29	13964	4.33	16740	4.35			
MLZ045T4	40	7032	3.89	8765	3.93	10815	4.00	13213	4.07	15988	4.13	19164	4.15	22760	4.11	9264	4.23	2.19
	50	-	-	7493	5.01	9295	5.05	11426	5.13	13924	5.20	16822	5.26	20152	5.27			
MLZ048T4	40	7690	4.18	9585	4.24	11794	4.30	14379	4.35	17402	4.40	20922	4.43	24990	4.45	10114	4.54	2.23
	50	-	-	8216	5.39	10161	5.44	12446	5.50	15140	5.56	18315	5.61	22038	5.64			
MLZ058T4	40	8787	5.05	11102	5.11	13931	5.17	17257	5.22	21059	5.30	25301	5.43	29939	5.62	11687	5.47	2.14
	50	-	-	8893	6.56	11434	6.55	14435	6.58	17879	6.64	21740	6.76	25987	6.98			
MLZ066T4	40	10490	5.56	13083	5.68	16104	5.79	19626	5.91	23724	6.05	28464	6.24	33906	6.48	13851	6.08	2.28
	50	-	-	11267	7.14	13962	7.24	17082	7.35	20709	7.47	24923	7.61	29805	7.79			
MLZ076T4	40	12330	6.38	15243	6.50	18653	6.64	22674	6.81	27421	6.98	33003	7.15	39522	7.31	15778	6.95	2.27
	50	-	-	12874	8.09	15592	8.25	18883	8.43	22878	8.61	27709	8.77	33508	8.92			

Qo : Cooling Capacity (W) Pe : Power Input (kW) Preliminary data / At dew point