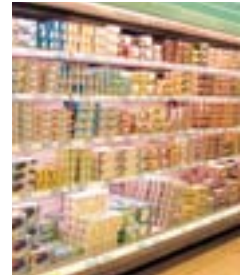


A COMPLETE RANGE OF REFRIGERANTS





## Domestic and commercial refrigeration



### NEW SYSTEMS

Commercial refrigeration includes a broad variety of systems currently used in supermarkets and retail food stores such as central refrigeration systems connected to display cases or self contained units which design is often close to that of domestic refrigerators and freezers.

A range of long term zero ODP refrigerants including FORANE<sup>®</sup> 134a, 404A and 507 is available for commercial and domestic refrigeration applications.

For domestic systems, FORANE<sup>®</sup> 134a is the main option today in the world.

For commercial applications, FORANE<sup>®</sup> 134a is mainly used in positive temperature self-contained units and glass door cabinets as FORANE<sup>®</sup> 404A is the main choice for medium and low temperatures.

FORANE<sup>®</sup> 404A and 507 are the preferred options for centralised direct and indirect systems because of their performance in low temperature applications. Equipment is now available from all manufacturers to run with FORANE<sup>®</sup> 404A and 507 with an improved energy efficiency and a reduced environmental impact.

### Product advantages

FORANE<sup>®</sup> 134a, 404A and 507 are standard refrigerants for commercial and domestic refrigeration applications and meet all the essential safety criteria of non toxicity and non flammability defined by ASHRAE standard 34.

PROPERTIES	HFC-134a	R-404A	R-507
Boiling point at 1.013 bar (°C)	- 26.1	- 46.4	- 47.1
Bubble pressure at 25°C (bar a)	6.65	12.49	12.86
Liquid density at 25°C (kg/dm <sup>3</sup> )	1.206	1.044	1.042
Critical temperature (°C)	101	72	71
Critical pressure (bar a)	40.7	37.2	37.2
Latent heat of vaporisation at 1.013 bar a (kJ/kg)	215.9	200.1	196.0

### EXISTING SYSTEMS

Based on the cooling need (low medium and high temperatures) there were two options in the past: R-502 and R-12. These refrigerants have now been replaced by retrofit refrigerants such as FORANE<sup>®</sup> FX 10 (R-408A) for R-502 existing systems and FORANE<sup>®</sup> FX 56 (R-409A) for R-12 existing systems.

# Domestic and commercial refrigeration

## General retrofit procedure for FORANE® FX 10 and FX 56

As a general rule, specific compressor manufacturer procedures must be followed as a priority.

- Gather baseline data from R-12 or R-502 and note current R-12 or R-502 charge, lubricant charge and existing operating parameters. Leak check the system.
- Recover existing R-12 or R-502 charge using recovery equipment.
- Removal of existing mineral oil in the system is not necessary when using FX 56 and FX 10 (however, some OEM may require the use of some Alkylbenzene with the mineral oil).
- Replace filter drier and repair any leaks.
- Evacuate the system to remove remaining traces of moisture.
- Charge system with FX 56 or FX 10 in the liquid phase only. The approximate FX 56 or FX 10 charge for most applications will be 80% of the original R-12 or R-502 charge. Use pressure temperature charts for the final adjustment of charge.
- Place proper markings and identification on the system to indicate the system has been retrofitted to FORANE® FX 56 or to FORANE® FX 10.
- Start the system and make final expansion valve adjustments to achieve proper superheat settings.

## Product advantages

FORANE® FX 10 (R-408A) and FX 56 (R-409A) have been approved and used worldwide to retrofit commercial and domestic refrigeration systems and meet all the essential safety criteria of non toxicity and non flammability defined by ASHRAE standard 34.

COMPARATIVE DATA	FORANE® FX 56 (vs R-12)	FORANE® FX 10 (vs R-502)
Δ Discharge pressure (bar)	+ 1.5	0
Δ Discharge temperature (K)	0 to 10	0 to 10
Δ Refrigeration capacity	+1 to 15%	+1 to 10%
Refrigerant charge	80-85%	75%
Oil selection	MO	AB or MO/AB

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## Transport refrigeration



### NEW SYSTEMS

Difficult and sometimes extreme conditions encountered in all transport refrigeration require reliable operation of equipment over a wide range of temperatures. Equipment design and refrigerant selection are key factors to fulfil these needs along with the worldwide availability of refrigerants.

Thanks to its complete range of refrigerants, Arkema offers you the solution you need for your application:

- long term HFCs for your new equipment;
- worldwide adopted retrofit blends for your existing systems.

Refrigerated vehicles use mainly engine driven systems. FORANE<sup>®</sup> 134a or FORANE<sup>®</sup> 404A are the main refrigerants of choice depending on the cooling needs.

The choice for refrigerated containers or trucks are similar since the cooling needs are not very different.

For Marine applications e.g. reefer boats R-22 has always been widely used.

Today FORANE<sup>®</sup> 404A, 507 and 410A are the main options chosen upon technology of the system.

### Product advantages

FORANE<sup>®</sup> 134a and 404A are the main standard refrigerants for transport refrigeration applications. They are available worldwide and meet all the essential safety criteria of non toxicity and non flammability defined by ASHRAE standard 34.

PROPERTIES	HFC-134a	R-404A	R-507
Boiling point at 1.013 bar (°C)	- 26.1	- 46.4	- 47.1
Bubble pressure at 25°C (bar a)	6.65	12.49	12.86
Liquid density at 25°C (kg/dm <sup>3</sup> )	1.206	1.044	1.042
Critical temperature (°C)	101	72	71
Critical pressure (bar a)	40.7	37.2	37.2
Latent heat of vaporisation at 1.013 bar a (kJ/kg)	215.9	200.1	196.0

## EXISTING SYSTEMS

In the case of refrigerated containers operating with CFC-12, FORANE® FX 56 (R-409A) has been recognized by the IICL (International Institute of Container Lessors) as the most effective drop-in solution to retrofit the systems due to its excellent properties as well as its worldwide availability through the Arkema sales network.

### General retrofit procedure for FORANE® FX 56

As a general rule, specific compressor manufacturer procedures must be followed as a priority:

- Gather baseline data from R-12 and note current R-12 charge, lubricant charge and existing operating parameters. Leak check the system.
- Recover existing R-12 charge using recovery equipment.
- Removal of existing mineral oil in the system is not necessary when FX 56 is used.
- Replace filter drier and repair any leaks.
- Evacuate the system to remove remaining traces of moisture.
- Charge system with FX 56 in the liquid phase only.  
The approximate FX 56 charge for most applications will be 85% of the original R-12 charge. Use pressure temperature charts for the final adjustment of charge.
- Place proper markings and identification on the system to indicate the system has been retrofitted with FORANE® FX 56.
- Start the system and make final expansion valve adjustments to achieve proper superheat settings.

COMPARATIVE DATA	FORANE® FX 56 (vs R-12)
Δ Discharge pressure (bar)	+ 1.5
Δ Discharge temperature (K)	0 to 10
Δ Refrigeration capacity	0 to 15%
Refrigerant charge	80-85%
Oil selection	MO

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## Comfort and commercial air conditioning



### NEW SYSTEMS

Comfort air conditioning applications include a wide range of systems from small room air conditioners to larger split or multi-split commercial systems dedicated to shops, restaurants, hotels or private houses for example. HCFC-22 has been the refrigerant of choice in the entire world for these applications for several decades. Following the implementation of the European regulation on HCFCs (EC regulation N° 2037/2000 adopted on June 29, 2000) the use of HCFCs as refrigerants in new installations is prohibited since January 1st 2004.

Consequently, alternate refrigerants are now being used for new systems in accordance with local regulations:

- FORANE® 407C, a blend of HFC-134a, 125 and 32 developed to closely match R-22 properties and performance;
- FORANE® 410A, a high pressure refrigerant blend of HFC-32 and 125 with improved cooling capacity and requiring system redesign.

These two refrigerants have gained acceptance especially in Europe, Japan and the United States as reliable refrigerants for comfort and commercial air conditioning systems.

### Product advantages

FORANE® 407C and 410A are standardized products that meet the essential safety criteria of non toxicity and non flammability defined by ASHRAE standard 34. Being based on HFCs, they have no Ozone Depletion Potential.

PROPERTIES	R-22	R-407C	R-410A
<b>Boiling point at 1.013 bar</b> (°C)	- 40.7	- 43.4	- 52.2
<b>Bubble pressure at 25°C</b> (bar a)	10.44	11.65	16.40
<b>Liquid density at 25°C</b> (kg/dm <sup>3</sup> )	1.194	1.139	1.061
<b>Critical temperature</b> (°C)	96	86.2	72.2
<b>Critical pressure</b> (bar a)	49.8	46.2	49.5
<b>Latent heat of vaporisation at 1.013 bar a</b> (kJ/kg)	233.7	249.9	271.5

# Comfort and commercial air conditioning

## EXISTING SYSTEMS

As long as regulations in force locally allow the use of HCFCs, R-22 remains the best option to service existing systems. However, in the case of a voluntary decision or a local regulation banning the use of HCFC-22 for the maintenance of existing systems, Arkema offers two options:

- R-407C for which an oil change is necessary,
- FORANE® FX 100, an HFC solution, developed to simply replace R-22 in most existing installations.

FORANE® FX 100 is a zero ODP retrofit blend developed to match R-22 properties and compatible components of the refrigerating circuit. It must be used with PolyOIEster but can tolerate high amount of residual old lubricant resulting from the retrofit.

## Product advantages

FORANE® FX 100 is a non ozone depleting refrigerant dedicated to R-22 replacement in existing installations for air conditioning type applications allowing simple retrofit operations.

COMPARATIVE DATA* (vs R-22)	R-407C	FORANE® FX 100
Δ Discharge pressure (bar)	+ 0.8	+ 0.2
Δ Discharge temperature (K)	- 8	- 12
Δ Refrigeration capacity	Equivalent	- 5%
Oil selection	POE or PVE	POE or PVE**

\* as calculated

\*\* residual AlkylBenzene or mineral oil is better tolerated

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## Air conditioning for building



### NEW SYSTEMS

In the past, medium and high power air conditioning systems usually fitted with centrifugal compressors were using CFC-11 and CFC-12, the latter being the predominant choice in Europe.

Today, FORANE® 134a is the standard solution for new systems in the case of large cooling needs.

PROPERTIES	HFC-134a
<b>Boiling point at 1.013 bar</b> (°C)	- 26.1
<b>Bubble pressure at 25°C</b> (bar a)	6.65
<b>Liquid density at 25°C</b> (kg/dm <sup>3</sup> )	1.206
<b>Critical temperature</b> (°C)	101
<b>Critical pressure</b> (bar a)	40.7
<b>Latent heat of vaporisation at 1.013 bar a</b> (kJ/kg)	215.9

### EXISTING SYSTEMS

Existing systems using R-12 can be converted to FORANE® 134a. This type of conversion requires a change of lubricant and significant modifications to the system. Nevertheless the cost of such modifications remains attractive compared to the expense of a new system.

#### Product advantages

FORANE® 134a is a widely used refrigerant for various refrigeration and air conditioning applications and meets all the essential safety criteria of non toxicity and non flammability defined by ASHRAE standard 34.

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## Mobile air conditioning applications



### NEW VEHICLES

All car manufacturers have adopted R-134a for several years as the refrigerant to be used in air conditioning systems because of its excellent properties and performance. This choice for new vehicles was also made for other mobile applications such as buses, truck cabins and agricultural vehicles.

### Product advantages

FORANE<sup>®</sup> 134a is a pure and efficient refrigerant that meets all the essential safety criteria of non toxicity and non flammability defined by ASHRAE standard 34.

PROPERTIES	HFC-134a
Boiling point at 1.013 bar (°C)	- 26.1
Bubble pressure at 25°C (bar a)	6.65
Liquid density at 25°C (kg/dm <sup>3</sup> )	1.206
Critical temperature (°C)	101
Critical pressure (bar a)	40.7
Latent heat of vaporisation at 1.013 bar a (kJ/kg)	215.9

Arkema is also offering FORANE<sup>®</sup> 134a UV glow, a special grade of FORANE<sup>®</sup> 134a, in order to provide easier leak detection for service technicians.

FORANE<sup>®</sup> 134a UV glow incorporates a unique UV dye mixed with R-134a and helps to locate leaks more quickly and decrease the cost associated with servicing mobile air conditioning systems.

Further details are available in a separate brochure.

# Mobile air conditioning applications

## EXISTING SYSTEMS

Most R-12 systems can easily be converted to FORANE® 134a with little modification due the close characteristics of these two refrigerants.

A summary of the retrofitting steps is given below.

### Retrofitting car air conditioning systems:

The information provided below is informative and the equipment manufacturers procedure should always be followed as a priority.

Retrofitting steps :

- Verify the refrigerating circuit (leak detection, state of components including compressor).
- Recover the charge of R-12.
- Recover the existing lubricant to a maximum practical level to ensure a satisfactory oil return with R-134a.
- Change flexible pipes and joints if they are not compatible with R-134a.
- Replace the filter drier.
- Evacuate the system.
- Charge the new lubricant compatible with R-134a (PAG type in most cases).
- Refill with R-134a up to 80 - 90% by weight of the original charge of R-12.
- Look for any leak in the circuit.
- Place proper markings and identification on the system to indicate it has been retrofitted to R-134a.
- Verify the system performance.

COMPARATIVE DATA (vs R-12)	FORANE® 134a
Δ Discharge pressure (bar)	+ 1.5
Δ Discharge temperature (K)	0 to -10
Δ Refrigeration capacity	0 to -15%
Refrigerant charge	85-90%
Oil selection	MO + PAG

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A global chemical player, Arkema consists of 3 coherent and balanced business segments: Vinyl Products, Industrial Chemicals, and Performance Products. Present in over 40 countries with 18,600 employees, Arkema achieves sales of 5.2 billion euros. With its 6 research centers in France, the United States and Japan, and internationally recognized brands, Arkema holds leadership positions in its principal markets.



## → THE FORANE® SOLUTIONS

The FORANE® range is based on long term solutions dedicated to new installations (HFCs) and, a series of blends especially made for the conversion of existing installations in order to postpone their end of life when the original refrigerant is no longer available.

This range of products is used and known worldwide in every application and is based on FORANE® standard refrigerants. Responsible use of these products is helping to reduce the impact of the refrigerant and air-conditioning industries on the stratospheric ozone layer (through the use of low or zero ODP products) and on greenhouse gas emissions (through improved energy efficiency).



### EXISTING SYSTEMS

#### → FORANE® 22:

The air-conditioning solution before its regulation, HCFC-22 remains a useful solution to eliminate CFCs in some applications, and for the maintenance of existing systems.

#### → FORANE® FX 10: (R-408A)

To retrofit existing installations previously running with R-502:  
+ easy and cost effective retrofit,  
+ improved performance of the system after conversion.

#### → FORANE® FX 56: (R-409A)

To retrofit most existing installations previously running with CFC-12\*:  
+ easy and cost effective retrofit.

#### → FORANE® FX 100:

A simple retrofit of R-22 existing installations:  
+ zero ODP R-22 replacement,  
+ tolerates higher amount of old lubricants in PolyOIEster,  
+ exhibiting best performance in A/C applications.

\* FORANE® FX 56 is not intended to retrofit mobile air conditioning systems using R-12.

### NEW SYSTEMS

#### → FORANE® 134a:

To replace R-12 in new installations both for refrigeration and air conditioning applications:  
+ excellent thermodynamic properties.

#### → FORANE® 404A: FORANE® 507:

Near azeotropic (R-404A) and azeotropic (R-507) blends dedicated to new systems with evaporation temperature from -45°C to +10°C :  
+ R-502 substitutes for new installations.

#### → FORANE® 407C:

To replace R-22 in new stationary air conditioning systems (mainly small and medium size systems):  
+ properties and performance similar to that of R-22,  
+ widely used by most OEMs,  
+ retrofit possible.

#### → FORANE® 410A:

To replace R-22 in new air conditioning and heat pump systems (domestic and residential) and in some refrigeration applications:  
+ enhanced cooling capacity,  
+ necessary redesign of systems due to high pressure level,  
+ good efficiency in heating mode.

Basic uses and recommendations are described in this brochure and further details on every product are included in our *More About* leaflets available to our customers upon request. In the case of installations conversions (retrofit...), the equipment manufacturer recommendations should be followed as a priority.

For your specific needs, please contact us



## FORANE® A COMPLETE RANGE OF REFRIGERANTS



### → PROPERTIES OF FORANE® REFRIGERANTS

The main characteristics of FORANE® refrigerants are given in the following table. Further information is available in our product brochures or upon request.

PHYSICAL PROPERTIES	FORANE® 409A	FORANE® 134a	FORANE® 408A	FORANE® 404A	FORANE® 507	FORANE® 22	FORANE® 407C	FORANE® 410A	FORANE® FX 100
<b>Refrigerant type</b>	HCFC-22 HCFC-124 HCFC-142b	HFC-134a	HCFC-22 HFC-143a HFC-125	HFC-125 HFC-134a HFC-143a	HFC-125 HFC-143a	HCFC-22	HFC-32 HFC-125 HFC-134a	HFC-32 HFC-125	HFC-32 HFC-125 HFC-143a HFC-134a
<b>Molecular weight (g/mol)</b>	97.4	102.0	87	97.6	98.8	86.5	86.2	72.6	90.44
<b>Bubble temperature at 1.013 bar (°C)</b>	- 34.5	- 26.1	- 44.4	- 46.4	- 47.1	- 40.7	- 43.4	- 52.2	- 42.7
<b>Temperature glide at 1.013 bar (K)</b>	7.1	0	0.7	0.9	0	0	7.2	0.1	7.1
<b>Bubble pressure at 25°C (bar)</b>	7.99	6.65	11.60	12.49	12.86	10.43	11.65	16.40	11.16
<b>Critical temperature (°C)</b>	106.8	101	83.7	72	71	96	86.2	72.2	86.8
<b>Critical pressure (bar)</b>	46	40.7	43.4	37.2	37.2	49.8	46.2	49.5	44.0
<b>Latent heat of vaporisation at 1.013 bar (kJ/kg)</b>	220.0	215.9	227.1	200.1	196.0	233.7	249.9	271.5	237.3
<b>Liquid density at 25°C (kg/dm³)</b>	1.216	1.206	1.062	1.04	1.04	1.194	1.139	1.061	1.151
<b>Density of saturated vapour at 1.013 bar (kg/m³)</b>	4.97	5.28	4.77	5.41	5.51	4.70	4.56	4.12	4.78
<b>ODP</b>	0.05	0	0.026	0	0	0.055	0	0	0



# Why choose ARKEMA as your n° 1 supplier of refrigerants?



CALVERT CITY ●

PIERRE-BÉNITE ● ▲ GIVORS

ZARAMILLO ●

CHANGSHU ●

SINGAPORE ▲

## FORANE® PRODUCTS AVAILABLE AROUND THE WORLD

Wherever you are in the world, ARKEMA can supply your refrigerant needs. We have facilities around the world designed to provide you with the fastest possible service.

### ➔ THE MOST ADEQUATE EQUIPMENT TO MEET EACH CUSTOMER REQUIREMENT

Railtanks, tanktrucks, a wide range of isotanks (last generation meeting the IMDG/DOT/SQLO/MITI/RID-ADR safety and transport rules), dot cylinders; refillable or disposable bottles.

### ➔ A SPECIALISED AND DEDICATED LOGISTIC TEAM

To bring you the quickest and most suitable answers on storage, packaging and transport, we work in partnership with a selection of worldwide logistics companies able to rapidly respond to your requirements.

## QUALITY AND CUSTOMER SERVICE

ARKEMA is committed to provide high quality products and services to its customers, particularly the SBU Fluorochemicals, including the FORANE® products. Our production plants in Europe have the ISO 9001 accreditation as well as the ISO 14001.

### ➔ CONTACTS

ARKEMA offers its customers all the necessary support:

> a worldwide sales network with local agencies or sales offices and a central department ARKEMA - Fluorochemicals

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● PRODUCTION AND PACKAGING PLANT

▲ PACKAGING FACILITY

### > technical service and R&D

This department based in the company's Pierre-Bénite Research Centre (CRR) is dedicated to provide all the necessary support to ARKEMA's customers through specific technical brochures or direct contact. ARKEMA CRR - OFA Department  
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