ARKEMA

FORANE®
REFRIGERANTS

TECHNICAL DIGEST

Sustainablility Sucesses

Arkema strives to bring its customers sustainable and innovative solutions contributing to the Sustainable Development Goals (SDGs) of the United Nations. To that end, Arkema operates as a responsible manufacturer and resolutely observes a policy of continuous progress and operational excellence.

Arkema's Calvert City, KY facility, manufacturer of Forane® Refrigerants in North America, has taken several steps to reduce its carbon footprint. From installing energy saving LED lighting to switching to 40% solar power, the plant has worked hard to reduce Scope 1 and 2 greenhouse gas emissions.

Forane® Refrigerants

“Arkema has over 60 years of U.S. based manufacturing.”

Arkema continues its role as an industry leader through the development and support of new and existing refrigerant solutions. This Technical Digest was created as a reference source for HVACR professionals, providing updated coverage of refrigerant-related information.

The products listed here are widely used to service the major air-conditioning and refrigeration markets.

Included in this Technical Digest are basic refrigerant properties and product descriptions, as well as application guides and retrofit procedures.

For more detailed information on any of our Forane® refrigerants, please contact our Technical Service Hotline at **(800) 738-7695**, or visit our website at **forane.arkema.com.**

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Know Your Source

All Arkema Forane® refrigerant products meet the following qualifications.

UL® CLASSIFIED

UL® (Underwriters Laboratories Inc.) has classified Arkema Forane® products as meeting the safety standards for refrigerants. These standards are written documents that outline the process in which a product is tested to help mitigate risk, injury, or danger. UL® is a standard-setting organization, combining extensive safety research, scientific expertise, and uncompromising focus on quality to help create a safer world. Arkema strives to meet the highest safety standards in the industry for its Forane® refrigerant products.

AHRI 700 STANDARDS

Arkema Forane® products are manufactured and tested to meet AHRI 700 standards. These standards outline minimum specifications for fluorocarbon, hydrocarbon, and carbon dioxide refrigerants, regardless of source, and lists acceptable test methods.

US-BASED MANUFACTURING

The Arkema Inc. refrigerants facility that manufacturers and packages our Forane® refrigerant 1233zd HTS, R32 and our HFC blends is located in Calvert City, KY. Operating for more than 60 years, our plant has certified management systems for Quality, Environmental, and Safety (ISO9000:2020, ISO 14001 and OSHA 18001) and subscribes to the ACC Responsible Care Codes. Compliance of all these requirements are verified annually by successful completion of numerous registrars, and governmental entities.

ANTI-COUNTERFEITING TECHNOLOGY

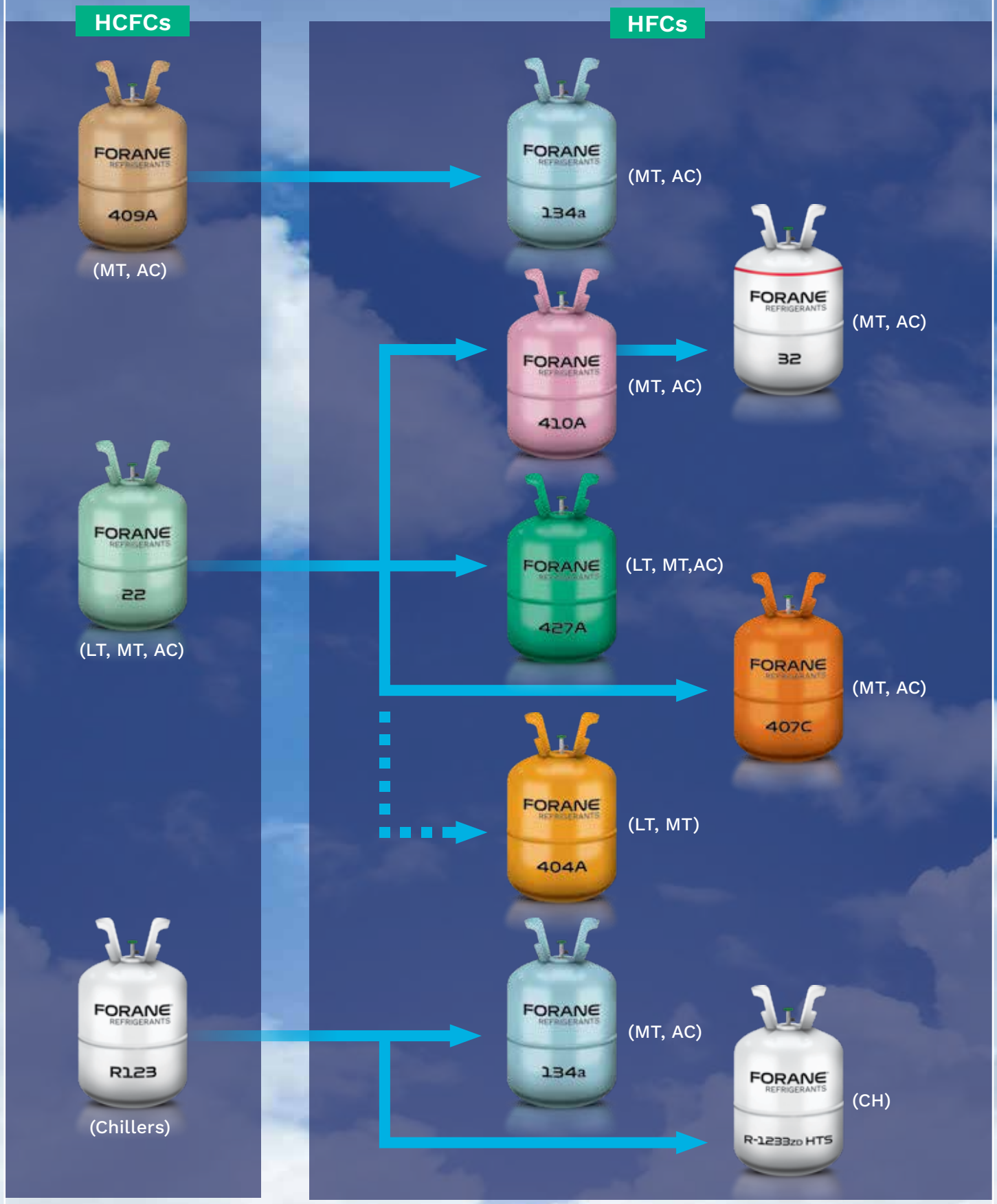
Launched in January of 2017, Arkema implemented a brand protection initiative, which helps protect our customers from purchasing possible counterfeit refrigerant cylinders. Forane® refrigerant anticounterfeit heat shrinks and labeling are on non-refillable, DOT-39 style packaging globally. The tamper resistant heat shrink and anti-counterfeit labeling can be found covering the valve of Forane® refrigerant non-refillable cylinders. The label contains several features that can easily be seen by the end user. Each of these features can be verified with the customer if a product is suspect.

- → **Authentication QR Code**
- → **Human Readable Authentication Code**
- → **Micro Optic Film**
- → **Holographic Film**

For additional information regarding Arkema's anti-counterfeit initiatives, please visit our website: forane.com/en/forane-refrigerants/anti-counterfeiting

Refrigerant Flow Chart

Progression Toward Sustainable Refrigeration Products



LT = Low Temp, MT = Medium Temp, AC = Air-Conditioning, CH = Chillers

Application Reference Guide

ASHRAE #	TRADE NAME	REPLACES	TYPE	COMPOSITION (WT%)	GWP (100 YR) AR4	RECOMMENDED LUBRICANT	APPLICATIONS
R-22	Forane® 22	N/A	HCFC Single component fluid	R-22 – 100%	1,810	MO AB	Used in AC, MT, and LT systems. Service applications only.
R-32	Forane® 32	R-410A	HFC Single component fluid	R-32 – 100%	675	POE	Replacement for R-410A in new residential and commercial air conditioning systems, heat pumps, dehumidifiers, and small chillers.
R-134a	Forane® 134a	R-12	HFC Single component fluid	R-134a – 100%	1,430	POE PAG (auto)	Service refrigerant for existing system.
R-404A	Forane® 404A	R-502 R-22 R-402A R-408A	HFC Near-azeotropic blend	R-125 – 44% R-143a – 52% R-134a – 4%	3,922	POE	Replacement/retrofit for R-502 and R-22. Used in MT and LT refrigeration systems.
R-407C	Forane® 407C	R-22	HFC Zeotropic blend	R-32 – 23% R-125 – 25% R-134a – 52%	1,774	POE	Replacement/retrofit for R-22 systems. Used in AC and some refrigeration applications.
R-410A	Forane® 410A	R-22	HFC Near-azeotropic blend	R-32 – 50% R-125 – 50%	2,088	POE	Residential, light commercial, and commercial air conditioning chillers. Available for service applications only beginning in 2025.
R-427A	Forane® 427A The Easy Retrofit™	R-22	HFC Zeotropic blend	R-32 – 15% R-125 – 25% R-143a – 10% R-134a – 50%	2,138	MO* AB* POE	Recommended retrofit for R-22 systems. Used in AC, MT and LT.
R-1233zd	Forane® 1233zd HTS	N/A	HFO Heat Transfer	R-1233zd – 100%	1 (AR5)	MO POE POVE	Used in centrifugal chillers, along with high efficiency, low environmental impact, and non-flammability.

*A lubricant change may not be required, but POE is always recommended for optimal performance.

Global warming potential (GWP) values are relative to carbon dioxide on a 100-year basis and were obtained for the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC).

Most cylinders will change to the standard gray in the future.

FORANE® 22

Forane® 22 refrigerant (R-22), an HCFC, has properties providing for a broad range of applications, including residential air conditioning, refrigeration, and other cooling applications.

R-22 importing and manufacturing is going through a mandatory phase-out, according to the schedule set by the Montreal Protocol. End-users should consult their local wholesaler or refrigerant manufacturer for more information on the R-22 phase-out. For up to date information on the R-22 phase-out, please go to page 16 or visit forane.com.

APPLICATION

R-22 is used in a variety of applications, including residential and commercial air conditioning, refrigeration, chillers, room air conditioning, transport refrigeration, and other comfort cooling and refrigeration applications.

PROPERTIES & PERFORMANCE

R-22 is a single component, non-flammable, non-toxic refrigerant with an ASHRAE A1 safety rating (lowest levels of toxicity/flammability).

LUBRICATION

R-22 works with mineral oil, alkylbenzene oil, POE oil. End-users should check with the equipment manufacturers guidelines for specific oil selection directions.

CHARGING

Charging with R-22 can be done either as a vapor or a liquid. End-users should check with the equipment manufacturer's guidelines for specific charging instructions.

PROPERTIES	R-22
Average Molecular Weight (g/mol)	86.5
Normal Boiling Point (°F)	-41.5
Critical Temperature (°F)	205.1
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.055
Global Warming Potential (GWP) AR4	1,810

FORANE® 32

Forane® 32 (R-32) refrigerant is a single component HFC fluid. It was developed as a replacement for many air-conditioning applications previously served by R-410A. Due to mild flammability and higher operating pressures, R-32 should never be used to retrofit existing R-410A systems.

APPLICATION

Forane® 32 refrigerant is used in new residential and commercial air conditioning systems, heat pumps, dehumidifiers, and small chillers.

PROPERTIES & PERFORMANCE

Forane® 32 refrigerant is a single component HFC refrigerant has an A2L safety rating (lowest levels of toxicity / mildly flammable), as assigned by ASHRAE, as well as zero ozone depletion potential and a low GWP.

R-32 is a slightly higher pressure and capacity refrigerant than R-410A, requiring equipment and components specifically designed to accommodate the resulting higher system pressures and lower flow rates needed. It is a more efficient refrigerant vs. R-410A, however its higher discharge temperatures require accommodation. Typical operating pressures of an R-32 system will be 5-10% higher than those in an R-410A system at comparable operating conditions. R-32 also has a higher volumetric capacity than R-410A under most operating conditions and a smaller charge size. This allows OEMs to manufacture equipment of similar capacity and efficiency to R-410A in a smaller package.

LUBRICATION

To ensure proper oil return, R-32 is typically used with polyolester (POE) oil. The single HFC component of R-32 is not miscible with mineral oil or alkylbenzene. Manufacturers provide new R-32 systems and compressors already charged with the appropriate lubricant. Care must be taken when handling POE lubricants because they are hygroscopic, which means that they can readily absorb moisture from the air. This is especially a concern when handling POEs in humid environments. High levels of moisture in the system can lead to oil degradation and system failure.

CHARGING

Charging with R-32 can be done either as a vapor or a liquid. End-users should check with the equipment manufacturer's guidelines for specific charging instructions.

PROPERTIES	R-32
Average Molecular Weight (g/mol)	52.0
Normal Boiling Point (°F)	-61.0
Critical Temperature (°F)	172.6
ASHRAE Safety Group Classification	A2L
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR4	675

FORANE® 134a

Forane® 134a refrigerant (R-134a) is a non-ozone depleting HFC refrigerant with properties very similar to R-12. It can be used both as a pure refrigerant in a number of traditional R-12 applications and as a component in refrigerant blends targeted to replace R-502 and R-22.

APPLICATION

Applications include automotive air conditioning, chillers, medium temperature commercial refrigeration, refrigeration appliances, and transport refrigeration.

Compressor and system manufacturers are selling equipment specifically designed for R-134a. In addition, Arkema's laboratory testing and field trials have indicated R-134a will work in the retrofit of many existing R-12 and R-500 installations.

PROPERTIES & PERFORMANCE

R-134a is a single component refrigerant rated A1 by ASHRAE (lowest levels of toxicity and flammability), having zero ozone depletion potential.

LUBRICATION

POE or PAG (for auto A/C only) lubricants must be used with R-134a since it is not miscible with mineral oil or alkylbenzene lubricants found in many systems. Special care must be taken when using POE or PAG oils due to their hygroscopicity (moisture absorption) when left exposed to the atmosphere. When retrofitting, a lubricant flush procedure is necessary to reduce the original oil content below 5% of the total oil charge. New R-134a equipment will be charged with the OEM recommended lubricant, ready to use with R-134a.

CHARGING

Charging with R-134a can be done either as a vapor or a liquid. End-users should check with equipment manufacturers guidelines for specific charging instructions.

R-134a can be used to retrofit certain, existing R-12 systems. Applications include refrigeration, automotive A/C, and many commercial A/C systems.

RETROFIT

When retrofitting R-12 systems to R-134a, it is necessary to replace the existing lubricant with POE oil, except in some automotive retrofit applications, which require PAG oil. In most cases, the mineral oil or alkylbenzene oil levels must be reduced below 5% of the new POE charge. Check with OEMs for any specific recommendations regarding oils or procedures. Remove as much of the existing lubricant as possible, add POE, and run the system on R-12 for some time. When the residual oil concentration is appropriate, remove R-12, replace the filter-drier, and charge R-134a.

PROPERTIES	R-134a
Average Molecular Weight (g/mol)	102.0
Normal Boiling Point (°F)	-14.9
Critical Temperature (°F)	213.9
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR4	1,430

FORANE® 404A

Forane® 404A refrigerant (R-404A) is a non-ozone depleting, near azeotropic blend of HFC refrigerants R-125, R-143a, and R-134a.

APPLICATION

R-404A is formulated to match the properties of R-502 closely, making it useful for a variety of medium and low temperature refrigeration applications. R-404A has been approved by many refrigeration compressor and system manufacturers for use in new refrigeration equipment, such as food display and storage cases, cold storage rooms, ice machines, transportation, and process refrigeration.

PROPERTIES & PERFORMANCE

Is a non-ozone depleting, near-azeotropic HFC refrigerant blend, with an ASHRAE A1 safety rating (lowest levels of toxicity/flammability).

LUBRICATION

R-404A is immiscible with the traditional lubricants used in R-502 systems. As such, the original oil should be replaced with POE when retrofitting to R-404A, and the presence of the old oil should be reduced to 5% or less of the original charge. Failure to do so may result in inadequate oil return or other system problems.

CHARGING

Due to the zeotropic nature of R-404A, it should be charged as a liquid to prevent fractionation (changes in refrigerant composition due to vapor charging. See Definitions – Fractionation). In situations where vapor is normally charged into a system, a valve should be installed in the charging line to flash the liquid to vapor during charging. Testing shows that fractionation due to system leaks is typically not a problem for R-404A. Fix the leak and top off the charge.

RETROFIT

R-404A can be used to retrofit many existing R-502 systems. The physical and thermodynamic properties of the blend cause it to behave much like R-502 when used as a retrofit, but it is not intended to be a direct “drop-in” for R-502 systems. Due to higher operating pressures associated with the use of R-404A as opposed to R-502, OEM product specific retrofit recommendations should be consulted for any and all pressure relief modifications and/or requirements.

PROPERTIES	R-404A
Average Molecular Weight (g/mol)	97.6
Normal Boiling Point (°F)	-51.2
Critical Temperature (°F)	161.7
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR4	3,922

FORANE® 407C

Forane® 407C refrigerant (R-407C) is a non-ozone depleting blend of HFC refrigerants R-32, R-125, and R-134a. It has been formulated to closely match the properties of R-22.

APPLICATION

Applications include residential and commercial air conditioning systems, non-flooded evaporator chillers, and some commercial refrigeration systems. Since R-407C has similar properties to R-22, it is possible (with modifications) to use it in the same equipment designed for R-22 today.

PROPERTIES & PERFORMANCE

R-407C is a zeotropic HFC refrigerant blend rated A1 by ASHRAE (lowest levels of toxicity and flammability), having zero ozone depletion potential.

LUBRICATION

POE lubricants must be used with R-407C since its components are not miscible with the mineral oil or alkylbenzene lubricants found in most R-22 systems. When retrofitting, a lubricant flush procedure is necessary to reduce the original oil content below 5%. New R-407C equipment will be charged with the OEM recommended lubricant, ready to use with R-407C.

CHARGING

Due to the zeotropic nature of R-407C, it should be charged as a liquid to prevent fractionation (changes in refrigerant composition due to vapor charging. See Definitions – Fractionation). In situations where vapor is normally into a system, a valve should be installed in the charging line to flash the liquid to vapor while charging.

RETROFIT

R-407C can be used to retrofit existing R-22 systems in positive displacement, direct expansion refrigeration, and air conditioning equipment. R-407C should not be used in centrifugal chillers or other equipment that uses a flooded evaporator, due to its high temperature glide.

PROPERTIES	R-407C
Average Molecular Weight (g/mol)	86.2
Normal Boiling Point (°F)	-46.5
Critical Temperature (°F)	186.9
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR4	1,774

Retrofit Procedure

1. Establish baseline performance. Note the oil type in use and any system operating data (if system is operating properly). Check for existing leaks and identify any needed repairs.
2. Recover the existing refrigerant charge (DO NO vent to atmosphere). Weigh the amount of refrigerant removed.
3. Drain existing oil from the compressor sump, suction line accumulators, etc. Record the amount of oil removed. Add an equivalent amount of OEM recommended POE oil.
4. Recharge the system with the recovered R-22 charge and run the system (at least 1 hour) to circulate the new lubricant.
5. Recover the R-22 charge again and check the residual oil content of the lubricant. The amount of the original lubricant in the POE must be less than 5%.
6. Repeat steps 3 – 5, as needed, until the required oil purity is reached. Once the oil flushes are completed, standard level maintenance should be conducted (i.e., filter-drier change, leak repairs).
7. Evacuate the system (less than 500 microns) and ensure it maintains a vacuum. If vacuum is lost, it may indicate that leaks are present in the system.
8. Charge system with R-407C refrigerant. Remove refrigerant as liquid only from cylinder. The initial charge weight should be approximately 90% of the standard charge for R-22, charging up to 95% if necessary.
9. Adjust TXV set point and/or refrigerant charge to achieve the desired superheat. Low side pressure control settings may also need to be adjusted.
10. Monitor oil level in the compressor. If necessary, adjust oil amount to attain normal operating level (mid-sight glass).
11. Label system clearly, indicating the type and amounts of system refrigerant and oil.

FORANE® 410A

Forane® 410A (R-410A) is a non-ozone depleting blend of HFC refrigerants R-32 and R-125. It was developed as a replacement for many air-conditioning applications previously served by R-22. Due to its higher refrigerating capacities and operating pressures, R-410A should never be used to retrofit existing R-22 systems.

APPLICATION

Forane® 410A refrigerant has been used in residential and commercial air conditioning systems, heat pumps, dehumidifiers, and chillers.

PROPERTIES & PERFORMANCE

R-410A is a near-azeotropic HFC refrigerant blend that meets the industry's needs for many new onent safety rating (lowest levels of toxicity/mildly flammability), as assigned by ASHRAE, as well as zero ozone depletion potential.

R-410A is a slightly higher pressure and capacity refrigerant than R-22, requiring equipment and components specifically designed to accommodate the resulting higher system pressures and lower flow rates needed. R-410A also has significantly higher volumetric refrigerating capacity than R-22 under most operating conditions. This allows OEMs to manufacture equipment of similar capacity and efficiency to R-22 in a smaller package.

LUBRICATION

To ensure proper oil return, R-410A is typically used with polyolester (POE) oil. The HFC components of R-410A are not miscible with mineral oil or alkylbenzene. Manufacturers provide new R-410A systems and compressors already charged with the appropriate lubricant. Care must be taken when handling POE lubricants because they are hygroscopic, which means that they can readily absorb moisture from the air. This is especially a concern when handling POEs in humid environments. High levels of moisture in the system can lead to oil degradation and system failure.

CHARGING

Charging with R-410A can be done either as a vapor or a liquid. End-users should check with their equipment manufacturer's guidelines for specific charging instructions.

PROPERTIES	R-410A
Average Molecular Weight (g/mol)	72.6
Normal Boiling Point (°F)	-60.6
Critical Temperature (°F)	160.4
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR4	2,088

FORANE® 427A
The easy retrofit™

Forane® 427A refrigerant (R-427A) is a non-ozone epleting blend of HFC refrigerants R-32, R-125, R-143a, and R-134a. R-427A was developed as a retrofit refrigerant for many R-22 applications.

APPLICATION
R-427A is the easy R-22 retrofit for low and medium temperature refrigeration and air conditioning systems. R-427A was designed to meet the needs of many air conditioning, heat pump, and refrigeration systems.

PROPERTIES & PERFORMANCE
R-427A is rated A1 by ASHRAE (lowest levels of toxicity / flammability) and has zero ozone depletion potential.orane® 427A is a simplified and cost-effective retrofit solution for existing R-22 installations in a large range of applications. Forane® 427A is the closest match to R-22 in terms of performance, mass flow rates, and operating pressures over the whole range of temperatures. R-427A has comparable capacity to R-22 and better efficiency than most other R-22 replacements. R-427A's discharge temperatures are typically 25°– 45°F lower than those of R-22, and it has one of the lowest global warming potentials (GWP) of the R-22 retrofits.

LUBRICATION
A lubricant change may not be required, but POE is always recommended for optimal performance. Confirming oil quality is important. Check the oil for moisture, acidity, and metal shavings or sediments. If the oil does not meet the desired specification, then a complete oil change using POE is recommended.

Systems with complex piping schemes could impede proper oil return. In these cases, adding or changing over to POE is recommended. Examples include: vertical risers of about 20 feet or more, long line sets, evaporators positioned below compressors.

CHARGING
Due to the zeotropic nature of the R-427A blend, it should only be charged as liquid to prevent fractionation (changes in the designed refrigerant composition, See Definitions – Fractionation). In situations where vapor would normally be charged into a system, a valve should be installed in the charging line to flash liquid from the cylinder into vapor. Never introduce liquid into a running system, as compressor damage may result. Manifold gage sets, charging machines, and tanks used with R-22 should be compatible for use with R-427A, provided they have been properly evacuated to prevent mixing of the two gases.

RETROFIT
R-427A was developed to minimize the work necessary during an R-22 system retrofit: Therefore, retrofits to R-427A do not require change-out of expansion valves or other major components. Expansion devices may need to be adjusted to optimize system performance. Forane® 427A is Copeland Discus™ and Bitzer approved for R-22 retrofits.

PROPERTIES	R-427A
Average Molecular Weight (g/mol)	90.4
Normal Boiling Point (°F)	-45.3
Critical Temperature (°F)	185.6
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR4	2,138

Retrofit Procedure
1. Record how the system is running on R-22. If the system is not running, determine a target superheat/subcooling, air temperature drop, and AMP draw. Example: How should the system run on R-22? What would the pressure/temperatures, superheat/subcooling, and AMP draw be if the system were running on R-22?*
2. Recover the R-22 charge.
3. Determine if changing or adding POE oil is needed.*
4. Check oil quality for contamination and/or acidity.
5. Install new filter dryer then leak check system.*
6. Replace rubber and neoprene external seals and gaskets.*
7. Charge 90% liquid of the original R-22 charge and let the system run for 20 minutes.
8. Add liquid refrigerant to attain target superheat/subcooling. Different systems, different compressors, and the age/condition of the installation could all impact performance when transitioning to another refrigerant. Poor airflow and design load could also impact performance. Be aware of these conditions before retrofitting. Systems that are not running properly on R-22 most likely do not perform any better with another refrigerant.

*For complete instructions, please read the Forane® 427A Retrofit Instructions found on forane.com

FORANE® 1233zd HTS

Forane® 1233zd HTS is a high purity trans-1-chloro-3,3,3-trifluoropropene, for use in centrifugal chillers and related applications, throughout the world.

APPLICATION

R-1233zd HTS offers an excellent balance of refrigerant properties for use in centrifugal chillers.

PROPERTIES & PERFORMANCE

R-1233zd HTS has GWP of 1, low environmental impact, and ASHRAE Class A1 rating. This low pressure refrigerant is non-flammable and features the lowest level of toxicity.

LUBRICATION

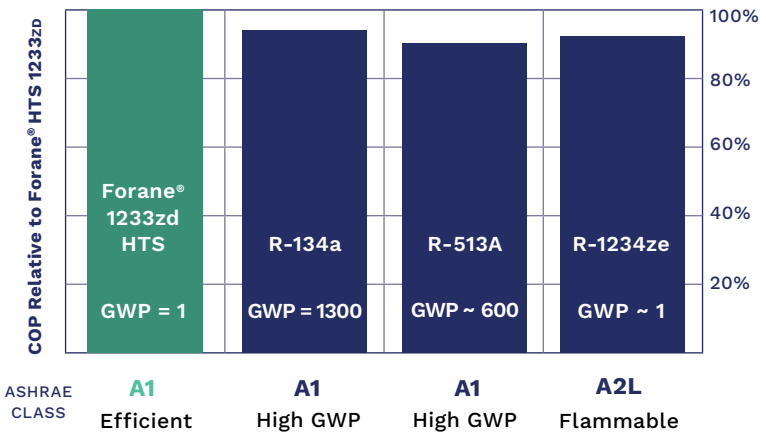
R-1233zd HTS can be used with typical lubricants: mineral oil, polyolester (POE) oil, and polyvinyl ether (PVE). Care must be taken when handling POE lubricants because they are hygroscopic, which means that they can readily absorb moisture from the air. This is especially a concern when handling POEs in humid environments. High levels of moisture in the system can lead to oil degradation and system failure.

CHARGING

Charging with R-1233zd HTS can be done either vapor or a liquid. End-users should check the equipment manufacturer's guidelines for specific charging instructions.

PROPERTIES	R-1233zd HTS
Average Molecular Weight (g/mol)	130.5
Normal Boiling Point (°F)	64.9
Critical Temperature (°F)	331.6
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR5	1

EFFICIENCY COMPARISON



Definitions

Bubble Point (Saturated Liquid Temperature)

The temperature (for a given pressure) at which the liquid of a refrigerant blend (any 400 or 500 series refrigerant) begins to evaporate or boil. This is similar to the saturated liquid temperature of a single component refrigerant.

Dew Point (Saturated Vapor Temperature)

The temperature (for a given pressure) at which the vapor of a given refrigerant blend (any 400 or 500 series refrigerant) begins to condense or liquefy. This is similar to the saturated vapor temperature of a single component refrigerant.

Fractionation

The change in composition of a refrigerant blend (any 400 or 500 series refrigerant) as it changes phase from liquid to vapor (evaporation) or from vapor to liquid (condensation). This behavior in blends explains the permanent changes to refrigerant composition from leaks, causing the blend to deviate outside the tolerances of the designed composition.

Glide

The difference in temperature between the evaporator outlet and inlet due to fractionation of the blend. Theoretically, this can be calculated by finding the difference between the dew and bubble temperatures at constant pressure. Actual measurements may differ slightly depending on the state of the liquid refrigerant at either end of the evaporator (or condenser). Pressure losses through the evaporator may also affect glide.

Normal Boiling Point (NBP)

The temperature at which a given refrigerant begins to boil while at atmospheric pressure (14.7 psia).

Abbreviations

AB – alkylbenzene
GWP – global warming potential
MO – mineral oil
ODP – ozone depletion potential
OEM – original equipment manufacturer
POE – polyester
PAG – polyakylene glycol

OTHER TOPICS

Refrigerant Lubricants

The phase-out of ozone depleting refrigerants has impacted air-conditioning and refrigeration equipment design in many ways. One of the most significant changes to these systems is the transition of the compressor lubricants. Use of an appropriate lubricant is important when servicing, installing, or retrofitting a system. The following information may be helpful as general background information on refrigerant lubricants; however, always follow OEM recommendations for proper lubricant selection.

Mineral Oil: Mineral oil has been the lubricant of choice for systems utilizing many of the CFC and HCFC refrigerants. Both the CFCs and HCFCs tend to have adequate miscibility with mineral oil, helping to ensure acceptable oil return under normal operating conditions. Sometimes a synthetic lubricant (i.e. AB or POE) is required under certain conditions, such as reduced miscibility with CFC retrofit blends or high discharge temperatures with products like R-22.

Alkylbenzene: Alkylbenzene is a synthetic refrigerant compressor lubricant used in new refrigeration systems and for retrofits from CFCs to HCFCs. Typically, alkylbenzene has better miscibility with HCFCs than mineral oil, resulting in more reliable oil return. For retrofits of older CFC equipment, a partial oil change from mineral oil to alkylbenzene may be acceptable.

Polyolester: HFC refrigerants serve as the replacements for the ozone-depleting CFCs and HCFCs. However, both mineral oil and alkylbenzene have poor miscibility with HFCs, making oil return with these products unreliable in many systems. POEs are synthetic oils commonly used in new HFC systems and for retrofitting older CFC and HCFC equipment to HFC refrigerants. Special care must be taken when using POE oils due to their quick absorption of moisture when left exposed to the atmosphere (hygroscopic).

Polyalkylene Glycol: In addition to POE oils, polyalkylene glycol (PAG) lubricants are used with R-134a in automotive air-conditioning applications. Like POEs, PAGs are hygroscopic synthetic oils and must be treated with care to minimize exposure to moisture. While both POEs and PAGs are used with R-134a in automotive systems, the two oil types are not interchangeable and should not be mixed.

Material Compatibility

Whenever retrofitting air-conditioning or refrigeration systems, compatibility of system materials is always a concern. Items such as elastomers, hoses, and filter-driers respond differently to different refrigerants and oils. For these reasons, before performing any refrigerant retrofit, Arkema recommends contacting the OEM for specific recommendations. Arkema's Technical Service Hotline can also be reached at (800) 738-7695.

Leak Detection

Leak checking should be a routine practice whenever performing maintenance on or servicing an air-conditioning or refrigeration system. As elastomers and other sealing components may react differently to new refrigerants and oils, leak checking should always be performed after any refrigerant retrofit.

Certain older style leak detectors have difficulty detecting newer refrigerants. It is important to verify whether or not your leak detector is rated for the type of refrigerant (CFC, HCFC, or HFC) you will be working with. Also, some refrigerant dyes are only compatible with specific refrigerant oils. Always check with the manufacturer before using a leak dye in an air-conditioning or refrigeration system.

Forane® Refrigerant Pressure Temperature Chart*

PRESSURE (PSIG)											
Sat. Temp (°F)	R-22	R-32	R-134a	R-404A Liquid Pressure	R-407C Liquid Pressure	R-407C Vapor Pressure	R-410A	R-427A Liquid Pressure	R-427A Vapor Pressure	R-1233zd	Sat. Temp (°C)
-50	6.1	5.2	18.7	0.5	2.7	11.0	5.0	3.5	11.4	14.1	-45.6
-45	2.7	8.0	16.9	2.6	0.6	8.0	7.7	0.1	8.4	14.0	-42.8
-40	0.6	11.0	14.8	4.9	2.7	4.6	10.8	2.2	5.1	13.9	-40.0
-35	2.6	14.4	12.5	7.5	5.1	0.9	14.1	4.5	1.5	13.8	-37.2
-30	4.9	18.2	9.8	10.3	7.7	1.6	17.8	7.0	1.3	13.6	-34.4
-25	7.4	22.3	6.9	13.4	10.6	3.9	21.9	9.7	3.5	13.3	-31.7
-20	10.2	26.8	3.7	16.8	13.7	6.5	26.3	12.8	6.0	13.0	-28.9
-15	13.2	31.7	0.0	20.5	17.2	9.3	31.2	16.1	8.7	12.8	-26.1
-10	16.5	37.1	1.9	24.6	20.9	12.3	36.5	19.7	11.7	12.4	-23.3
-5	20.1	42.9	4.1	28.9	25.0	15.7	42.2	23.6	15.0	12.1	-20.6
0	24.0	49.3	6.5	33.7	29.5	19.4	48.4	27.9	18.7	11.8	-17.8
5	28.3	56.1	9.1	38.8	34.3	23.5	55.2	32.6	22.6	11.2	-15.0
10	32.8	63.5	11.9	44.3	39.5	27.9	62.4	37.6	26.9	10.8	-12.2
15	37.8	71.4	15.0	50.2	45.2	32.7	70.3	43.0	31.5	10.1	-9.4
20	43.1	80.0	18.4	56.6	51.2	37.9	78.7	48.8	36.6	9.6	-6.7
25	48.8	89.2	22.1	63.4	57.7	43.5	87.7	55.0	42.1	8.9	-3.9
30	55.0	99.1	26.1	70.7	64.7	49.6	97.4	61.7	48.0	8.0	-1.1
35	61.5	109.7	30.4	78.6	72.2	56.1	107.7	68.9	54.3	7.1	1.7
40	68.6	121.0	35.0	86.9	80.2	63.2	118.8	76.6	61.2	6.2	4.4
45	76.1	133.0	40.1	95.8	88.8	70.7	130.6	84.8	68.5	5.2	7.2
50	84.1	145.9	45.4	105.3	97.9	78.8	143.2	93.6	76.4	4.0	10.0
55	92.6	159.5	51.2	115.3	107.6	87.5	156.5	102.9	84.8	2.9	12.8
60	101.6	174.1	57.4	126.0	118.0	96.8	170.7	112.8	93.8	1.4	15.6
65	111.3	189.5	64.0	137.3	128.9	106.7	185.8	123.3	103.4	0.0	18.3
70	121.4	205.8	71.1	149.3	140.5	117.3	201.8	134.4	113.7	1.7	21.1
75	132.2	223.2	78.7	162.0	152.8	128.6	218.7	146.2	124.6	3.3	23.9
80	143.6	241.5	86.7	175.4	165.8	140.5	236.5	158.6	136.1	5.2	26.7
85	155.7	260.9	95.2	189.5	179.6	153.2	255.4	171.8	148.4	7.3	29.4
90	168.4	281.3	104.3	204.5	194.1	166.7	275.4	185.7	161.5	9.6	32.2
95	181.8	302.9	114.0	220.2	209.4	181.0	296.4	200.3	175.3	11.9	35.0
100	195.9	325.7	124.2	236.8	225.5	196.1	318.6	215.8	189.9	14.4	37.8
105	210.8	349.7	135.0	254.2	242.4	212.1	341.9	232.0	205.4	17.1	40.6
110	226.4	374.9	146.4	272.5	260.3	229.0	366.4	249.1	221.7	20.0	43.3
115	242.8	401.4	158.4	291.8	279.0	246.9	392.3	267.0	238.9	23.1	46.1
120	260.0	429.3	171.2	312.1	298.6	265.8	419.4	285.8	257.1	26.4	48.9
125	278.0	458.7	184.6	333.3	319.2	285.7	447.9	305.5	276.3	30.0	51.7
130	296.9	489.5	198.7	355.7	340.7	306.7	477.9	326.2	296.5	33.8	54.4
135	316.7	521.8	213.6	379.1	363.3	328.8	509.4	347.8	317.8	37.8	57.2
140	337.4	555.8	229.2	403.7	387.0	352.1	542.5	370.5	340.3	42.0	60.0
145	359.0	591.4	245.7	429.6	411.7	376.6	577.3	394.1	363.9	46.5	62.8
150	381.7	628.8	262.9	456.8	437.5	402.5	613.9	456.8	467.4	51.2	65.6

Green Numerals in bold - Inches Hg Below 1 ATM

*This data was generated using the NIST REFPROP Database (Lemmon, E.W., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 9.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2010).

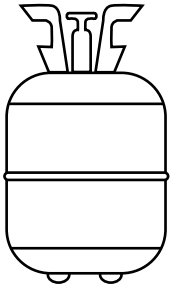
Forane® Refrigerant Basic Property Data Chart

PROPERTIES	R-22	R-32	R-134a	R-404A	R-407C	R-410A	R-427A	R-1233zd
Average Molecular Weight (g/mol)	86.5	52.02	102.0	97.6	86.2	72.6	90.4	130.5
Normal Boiling Point (NBP) (°F)	-41.5	-61.0	-14.9	-51.2	-46.5	-60.6	-45.3	64.9
Latent Heat of Vaporization @ NBP (BTU/lb)	100.6	164.3	93.4	86.4	107.2	117.4	101.8	N/A
Critical Temperature (°F)	205.1	172.6	213.9	161.7	186.9	160.4	185.6	331.6
Critical Pressure (psia)	723.7	838.6	588.8	540.8	671.4	711.0	637.0	
Density of Saturated Vapor @ NBP (lb/ft^3)	0.29	0.19	0.33	0.34	0.29	0.26	0.30	
Density of Saturated Liquid @ 77°F (lb/ft^3)	74.3	60.0	75.3	65.2	71.0	66.1	70.5	
Specific Heat of Saturated Vapor @ NBP (BTU/lb °R)	0.14	0.21	0.19	0.19	0.19	0.19	0.19	
Specific Heat of Saturated Liquid @ 77°F (BTU/lb °R)	0.30	0.46	0.34	0.37	0.37	0.41	0.36	
Ozone Depletion Potential (ODP) (CFC-11=1.0)	0.055	0	0	0	0	0	0	0
Global Warming Potential (GWP) AR4	1,810	675	1,430	3,922	1,744	2,088	2,138	1
ASHRAE Safety Group Classification	A1	A2L	A1	A1	A1	A1	A1	A1
Occupational Exposure Limits (8 hr time/wt. Avg.) (ppm)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	

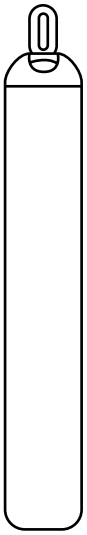
Forane® Refrigerant Cylinder Identification

TYPE		COLOR CODE	SIZE IN LBS. (CONTAINER TYPE)
R-22	HCFC	Light Green	30 (A), 50 (A), 125 (B), 1,000 (C), 1,750 (D)
R-32	HCFC	Blue	20 (A), 800 (C)
R-134a	HFC	Light Blue	30 (A), 125 (B), 1,000 (C), 1,750 (D)
R-404A	HFC	Orange	20 (A), 24 (A), 100 (B), 800 (C), 1,300 (D)
R-407B	HFC	Brown	25 (A), 115 (B), 950 (C), 1,600 (D)
R-410A	HFC	Rose	20 (A), 25 (A), 100 (B), 850 (C), 1,350 (D)
R-427A	HFC	Green	20 (A), 25 (A) 110 (B)
R-1233zd	HTS	Grey	

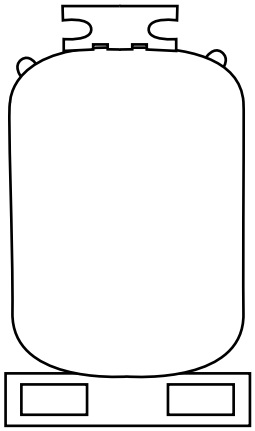
Container Types



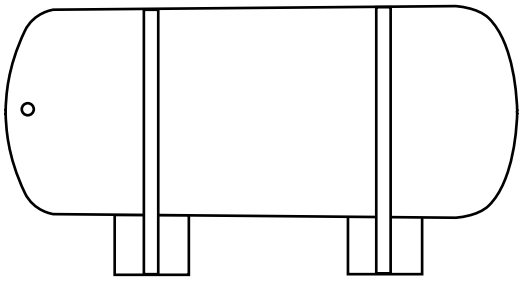
13/20/24/25/27/30/50 lbs.
(A)



100/110/115/125/145 lbs.
(B)



800/850/950/1,000 lbs.
(C)



1,300/1,350/1,400/1,600/1,750/1,800/2,000 lbs.
(D)

Container types drawings not to scale

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