

# Technical Digest

**HFCs**

R-410A

R-427A

R-407A

R-407C

R-134a

R-404A

R-507A

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**HCFCs**

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### HFCs

# FORANE® REFRIGERANTS

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 brochure 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.com.



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# KNOW YOUR SOURCE

All Forane® refrigerant products meet the following qualifications



## UL® CLASSIFIED

UL® (Underwriters Laboratories Inc.) has classified all Arkema Forane® refrigerant 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



All Arkema Forane® refrigerant products are blended and tested to meet AHRI 700 standards. These standards specify acceptable levels of contaminants (purity requirements) for fluorocarbon, hydrocarbon, and carbon dioxide refrigerants, regardless of source, and lists acceptable test methods.

## US-BASED MANUFACTURING

The Arkema Inc. facility that manufactures and packages our Forane® refrigerant HFC blends and R-134a is located in Calvert City, KY. Operating for more than 60 years, our plant has certified management systems for Quality, Environmental, and Safety (ISO 9001-2006, ISO 14001-2004 and OSHAs 18001-2007) and subscribes to the ACC Responsible Care Codes. Compliance of all these requirements are verified annually by successful completion of numerous audits and inspections by customers, 3rd party 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.

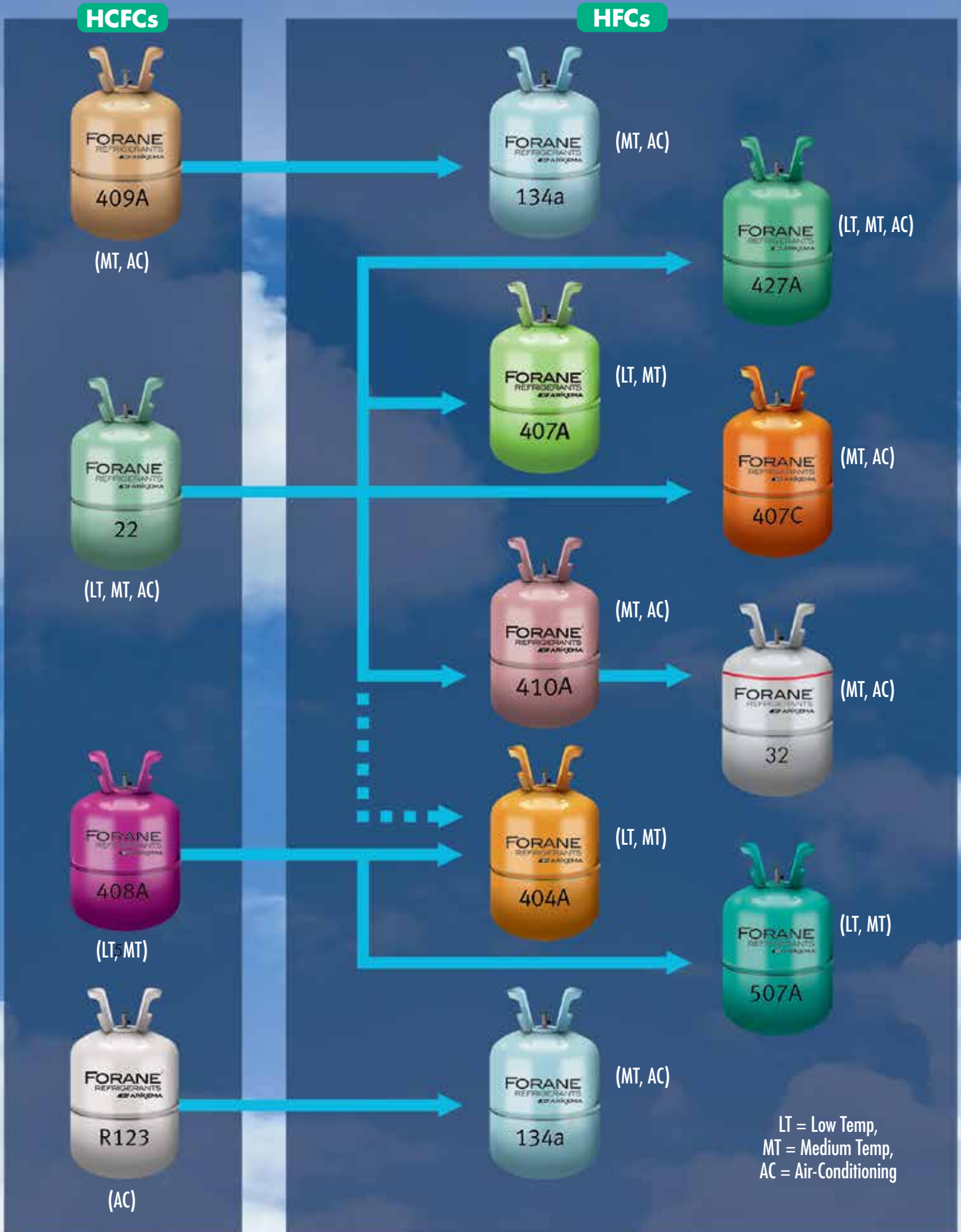
- **Authentication QR Code**
- **Human Readable Authentication Code**
- **Color-Shifting Film**
- **Holographic Film**

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



# REFRIGERANT FLOW CHART

PROGRESSION TOWARD SUSTAINABLE REFRIGERATION PRODUCTS



# APPLICATION REFERENCE GUIDE

ASHRAE #	TRADE NAME	REPLACES	TYPE	COMPOSITION (WT%)	GWP (100 YR) AR5	RECOMMENDED LUBRICANT	APPLICATIONS
R-410A	Forane® 410A	R-22	HFC Near-azeotropic blend	R-32 – 50% R-125 – 50%	1,924	POE	Replacement for R-22 in smaller size chillers, and residential and light commercial AC systems. Never use as a retrofit for R-22 equipment.
R-427A	Forane® 427A THE EASY RETROFIT™	R-22	HFC Zeotropic blend	R-32 – 15% R-125 – 25% R-143a – 10% R-134a – 50%	2,024	MO* AB* POE	Recommended retrofit for R-22 systems. Used in AC, MT and LT.
R-407A	Forane® 407A	R-22	HFC Zeotropic blend	R-32 – 20% R-125 – 40% R-134a – 40%	1,923	POE	Replacement/retrofit for R-22 in DX systems. Used in MT and LT refrigeration.
R-407C	Forane® 407C	R-22	HFC Zeotropic blend	R-32 – 23% R-125 – 25% R-134a – 52%	1,624	POE	Replacement/retrofit for R-22 systems. Used in AC and some refrigeration applications.
R-134a	Forane® 134a	R-12	HFC Single component fluid	R-134a – 100%	1,300	POE PAG (auto)	Replacement/retrofit for R-12 and R-500 systems. Recommended retrofit for R-12 automotive AC systems.
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%	3,943	POE	Replacement/retrofit for R-502 and R-22. Used in MT and LT refrigeration systems.
R-507A	Forane® 507A	R-502 R-22 R-402A R-408A	HFC Azeotropic blend	R-125 – 50% R-143a – 50%	3,985	POE	Replacement/retrofit for R-502 and R-22. Used in MT and LT refrigeration systems.
R-32	Forane® 32	R-410A	HFC Single component fluid	R-32 – 100%	677	POE	Replacement for R-410A in new residential and commercial air conditioning systems, heat pumps, dehumidifiers, and small chillers.
R-22	Forane® 22		HCFC Single component fluid	R-22 – 100%	1,760	MO AB	Used in AC, MT, and LT systems. Scheduled for phase-out.
R-408A	Forane® 408A	R-502	HCFC Near-azeotropic blend	R-125 – 7% R-143a – 46% R-22 – 47%	3,257	MO AB POE	Recommended retrofit for R-502 systems. Used in MT and LT refrigeration systems.

\*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).



# 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 is used in new residential and commercial air conditioning systems, heat pumps, dehumidifiers, and small chillers. R-410A is also being considered in some medium temperature refrigeration applications.

**Properties & Performance** R-410A is a near-azeotropic HFC refrigerant blend that meets the industry's needs for many new air conditioning systems. It has an A1 single component 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. Discharge temperature typical operating pressures of an R-410A system will be 50% to 60% higher than those in an R-22 system at comparable operating conditions. 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) AR5	1,924

# FORANE® 427A – THE EASY RETROFIT™

Forane® 427A refrigerant (R-427A) is a non-ozone depleting 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.

**Properties & Performance** R-427A is designed to meet the needs of many air conditioning, heat pump, and refrigeration systems. R-427A is a zeotropic HFC refrigerant blend, which is rated A1 by ASHRAE (lowest levels of toxicity and flammability) and has zero ozone depletion potential.

Forane® 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 performances, 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.

## 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 not perform any better with another refrigerant.

\*For complete instructions, please read the Forane® 427A Retrofit Instructions found on [forane.com](http://forane.com)

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) AR5	2,024



# FORANE® 407A

Forane® 407A (R-407A) refrigerant is a non-ozone depleting blend of HFC refrigerants R-32, R-125, and R-134a. R-407A was developed for new systems as well as retrofit refrigerant for some R-22 and R-404A applications.

<b>Application</b>	R-407A is for new and R-22 and R-404A retrofit for medium and low temperature refrigeration systems. It is not intended for air-conditioning applications, nor recommended for use in systems with flooded evaporators.
<b>Properties &amp; Performance</b>	<p>R-407A is designed to meet the needs of many new and existing refrigeration systems. R-407A is a zeotropic HFC refrigerant blend, which is rated A1 by ASHRAE (lowest levels of toxicity and flammability), having zero ozone depletion potential.</p> <p>R-407A is a close match to R-22's and R-404A's cooling capacity, making it well suited as a retrofit for R-22 and R-404A in supermarket and food storage applications. Additionally, R-407A is one of the more energy efficient R-22 and R-404A retrofit options available for refrigeration applications. Its efficiency is up to 3% higher than R-404A.</p> <p>Discharge temperatures of R-407A will be noticeably lower than those seen with R-22. Among the R-404A competitive retrofits, R-407A has a wider range of operating conditions without liquid injection. System pressures for R-407A are higher than R-22, particularly in high ambient environments. Consult the system or component OEMs for recommendations on how best to accommodate the changes in operating pressures. R-407A a 51% GWP reduction compared to R-404A.</p>
<b>Lubrication</b>	As with many HFC blends, R-407A will require polyester oil (POE) to ensure reliable oil return and circulation throughout the system. For R-22 systems currently using an oil separator, multiple oil flushes may not be required during retrofit. As an R-404A retrofit, no oil change is required.
<b>Charging</b>	Due to the zeotropic nature of the R-407A blend, it should be charged as a liquid to prevent fractionation (changes in refrigerant composition due to vapor charging. See Definitions – Fractionation). For installations where vapor is normally fed into the low side of a running system, a flash valve should be installed in the charging line to prevent liquid from entering the compressor. When retrofitting from R-22 to R-407A, the new charge weight will typically be 95 – 100% of the original charge weight of R-22.
<b>Retrofit</b>	<p>In most cases, overall system capacities and efficiencies of an R-407A retrofit will be similar to those of R-22 and R-404A. Differences in actual performance will depend largely on system design, operating conditions, and ambient temperatures. Refrigerant flow rates for R-407A are slightly higher than R-22. Expansion valves that are operating properly with R-22 will typically not have to be replaced. Slight expansion valve adjustments may be required to optimize system performance for both R-22 and R-404A retrofits.</p> <p>Operating pressures will be higher than R-22 and may require changes to cut-out settings and pressure relief devices. Inversely, the operating pressure will be lower with R-407A in R-404A retrofits. R-407A is approved as a retrofit by compressor manufacturers, including Copeland, Carlyle, and Bitzer. Always consult the OEM for recommendations before performing any system retrofit.</p>

## 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 NOT vent to atmosphere). Weigh the amount of refrigerant removed.
3. Perform any repairs identified in step 1 and fix any leaks.
4. Replace the filter-drier and, if necessary, elastomeric seals (eg. O-rings). Verify the condition of the system oil; replace, if necessary.
5. R-407A is immiscible with mineral oil and alkylbenzene and will require most of the original system oil to be replaced. Drain existing mineral oil or alkylbenzene from the compressor sump, suction line accumulators, etc. Record the amount of oil removed. No oil change is need with a R-404A retrofit so skip to Step 7.
6. Add an equivalent amount of OEM recommended POE oil.
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-407A refrigerant. Remove refrigerant as liquid only from cylinder. The initial weight should be approximately 95% of the standard charge for R-22, charging up to 100% 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.

PROPERTIES	R-407A
Average Molecular Weight (g/mol)	90.1
Normal Boiling Point (°F)	-49.0
Critical Temperature (°F)	180.1
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR5	1,923

# 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.

<b>Application</b>	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.
<b>Properties &amp; Performance</b>	R-407C is designed to meet the needs of many new and existing air conditioning and refrigeration systems. R-407C is a zeotropic HFC refrigerant blend rated A1 by ASHRAE (lowest levels of toxicity and flammability), having zero ozone depletion potential.
<b>Lubrication</b>	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.
<b>Charging</b>	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 charged into a system, a valve should be installed in the charging line to flash the liquid to vapor while charging.
<b>Retrofit</b>	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.

## 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 NOT 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 level is reached. Once the oil flushes are completed, standard 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.

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) AR5	1,624

# 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 designed to meet the needs of many air conditioning and medium temperature refrigeration systems. 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 their equipment manufacturers guidelines for specific charging instructions.

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

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) AR5	1,300



# FORANE<sup>®</sup> 404A

Forane<sup>®</sup> 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** R-404A is designed to meet the needs of many new and existing refrigeration systems. It 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) AR5	3,943





# FORANE® 507A

Forane® 507A refrigerant (R-507A) is a non-ozone depleting, azeotropic blend of HFC refrigerants R-125 and R-143a. R-507A is blended to match the properties of R-502 closely, making it a good refrigerant for some medium and most low temperature refrigeration applications.

- Application** R-507A is approved by compressor and system manufacturers for use in new refrigeration equipment, such as food display and storage cases, cold storage rooms, transportation, and process refrigeration.
- Properties & Performance** R-507A is designed to meet the needs of many new and existing refrigeration systems. R-507A is an azeotropic HFC refrigerant blend rated A1 by ASHRAE (lowest levels of toxicity and flammability), having zero ozone depletion potential.
- Lubrication** R-507A 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-507A, 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** R-507A should be charged in liquid phase to ensure the correct composition is being used in the refrigeration system. 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 while charging. R-507A will require the use of manifold gauge sets, recovery machines, and recovery tanks specifically designed for its higher pressures.
- Retrofit** R-507A can be used to retrofit many existing R-502 systems. However, 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-507A as opposed to R-502, OEM product specific retrofit recommendations should be consulted for any pressure relief modifications and/or requirements.

PROPERTIES	R-507A
Average Molecular Weight (g/mol)	98.9
Normal Boiling Point (°F)	-52.1
Critical Temperature (°F)	159.1
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP) AR5	3,985



# 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 that meets the industry's needs for many new air conditioning systems. It 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) AR5	677



# 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 18 or visit [www.forane.com](http://www.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 has properties making it a useful refrigerant in many air conditioning and refrigeration applications. 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, or 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.

## FACTS ABOUT R-22

- FACT 1:** R-22 is readily available.
- FACT 2:** R-22 will be available for years to come.
- FACT 3:** R-22 pricing has decreased, so consider the high cost of replacement.
- FACT 4:** R-22 is still the best choice for R-22 equipment.
- FACT 5:** Forane® 427A is a leading R-22 alternative for retrofit.

To learn more about all our offerings, go to our website: [www.forane.com](http://www.forane.com)

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) AR5	1,760



# FORANE® 408A

Forane® 408A refrigerant (R-408A) is a low-ozone depleting, near-azeotropic HCFC blend of R-125, R-143a, and R-22 that was designed to match the performance of R-502.

- Application** R-408A is a retrofit solution for medium and low temperature refrigeration systems that are currently using R-502. R-408A should not be mixed with R-502 or used to top off the charge of an existing system operating on R-502.
- R-408A is not intended for use in new equipment. Refrigeration applications that were previously designed to use R-502 can now be specified to use a long-term alternative HFC blend, such as R-404A. Manufacturers have developed new R-404A compressors and refrigeration systems for use in food display and storage cases, cold storage rooms, ice machines, transportation, and process refrigeration.
- Properties & Performance** When retrofitting from R-502 to R-408A, system capacity and efficiency often improve. Both low and high side pressures are nearly identical for R-502 and R-408A. An increase in head pressures of 5 psi may be seen in high ambient environments with R-408A.
- Lubrication** R-408A can be used with mineral oil, alkylbenzene, or POE lubricants. Systems operating with R-502 and mineral oil and showing adequate lubricant return to the compressor may continue to use mineral oil with R-408A. Alkylbenzene and/or POE may be used alone or in combination with mineral oil in order to improve lubricant miscibility and return to the compressor. Consult manufacturer's guidelines for additional recommendations.
- Charging** Due to the zeotropic nature of the R-408A 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. Charging weight ratios of R-408A are typically 85 – 90% of the charge weight of R-502.
- Retrofit** System components (TXVs, line sizes, compressors) offer similar performance with R-502 and R-408A and usually do not require changing when retrofitting.

## 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 NOT vent to atmosphere). Weigh the amount of refrigerant removed.
3. Perform any repairs identified in step 1 and fix any leaks.
4. Replace the filter-drier and, if necessary, elastomeric seals (eg. O-rings). Verify the condition of the system oil; replace, if necessary.
5. Evacuate the system (< 500 microns) and ensure it maintains a vacuum. If vacuum is lost, it may indicate that leaks are present in the system.
6. Charge system with R-408A refrigerant. Remove refrigerant as liquid only from cylinder. Charge ratio should be approximately 85 – 90% of the charge weight of R-502.
7. Adjust TXV set point and/or refrigerant charge to achieve the desired superheat.
8. Monitor oil level in the compressor. If necessary, adjust oil amount to attain normal operating level (mid-sight glass).
9. Label system clearly, indicating the type and amounts of system refrigerant and oil.

PROPERTIES	R-408A
Average Molecular Weight (g/mol)	87.0
Normal Boiling Point (°F)	-48.2
Critical Temperature (°F)	181.7
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.026
Global Warming Potential (GWP) AR5	3,257



## 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 – polyolester  
PAG – polyalkylene 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.

## U.S. R-22 PHASE-OUT



**EPA Allowances in Final Rule**

R-22 is the most widely used HCFC refrigerant for HVACR applications, such as residential air conditioning, refrigeration, and other cooling applications. Although R-22 has been a good solution for many different applications, it is classified as an HCFC and is subject to a manufacturing and importing phase-out according to the Montreal Protocol international treaty and the Clean Air Act in the United States.

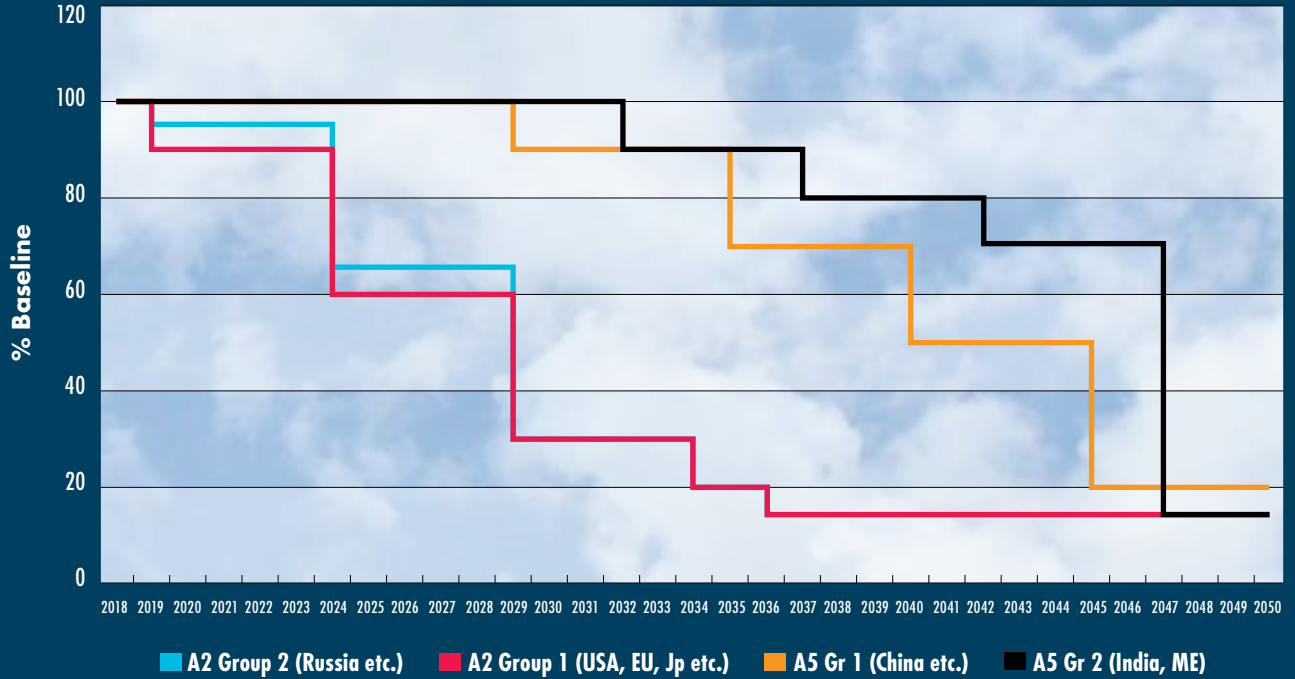
In the US, the Clean Air Act has met the requirements of the Montreal Protocol by limiting consumption of HCFC, including R-22, through a series of phase downs through 2030. Each step reduces R-22 consumption by reducing or eliminating R-22 in different market segments. As part of this phase-down, R-22 has not been permitted for use in new OEM HVACR equipment since 2010.

The EPA issued the final HCFC Rule, which covers the 2015 to 2019 R-22 production allowances. After 2019, importation or production of R22 will not be permitted in the United States, however it can still be purchased, used, and sold from existing inventory and reclaim. R-22 is still the best refrigerant for R-22 equipment, and R-22 users should review all their options before making any major changes to their R-22 equipment.

If an R-22 user needs to retrofit, Forane® 427A is your best option for most R-22 equipment. To learn more about our EASY RETROFIT™, Forane® 427A, and our other retrofit refrigerants, visit [www.r22retrofit.com](http://www.r22retrofit.com) for help with your selection.

# KIGALI AGREEMENT PHASE DOWN

Kigali % phasedown steps – 4 groups of countries



The Kigali Agreement is an Amendment to the Montreal protocol, signed in Kigali, the capital of Rwanda, in October of 2016. It sets worldwide schedules for phasing down production and consumption of HFCs by 80-85% over 20-30 years.

There are 4 groups of countries, developed and developing, with different timing, but ultimately achieving the same goal. Although it was negotiated by over 170 UN member countries, each one must ratify it internally – as of mid 2020, 100 countries have done so. The treaty went into effect at the beginning of 2019.

# FORANE® REFRIGERANT PRESSURE TEMPERATURE CHART\*

PRESSURE (PSIG)													
Sat. Temp (°F)	R-22	R-407C Liquid Pressure	R-407C Vapor Pressure	R-410A Liquid Pressure	R-427A Liquid Pressure	R-427A Vapor Pressure	R-407A Liquid Pressure	R-407A Vapor Pressure	R-12	R-134a	R-409A Liquid Pressure	R-409A Vapor Pressure	Sat. Temp (°C)
-50	6.1	2.7	11.0	5.0	3.5	11.4	0.8	9.0	15.4	18.7	12.2	18.7	-45.6
-45	2.7	0.6	8.0	7.7	0.1	8.4	1.7	5.7	13.3	16.9	9.6	16.9	-42.8
-40	0.6	2.7	4.6	10.8	2.2	5.1	3.9	2.0	11.0	14.8	6.7	14.8	-40.0
-35	2.6	5.1	0.9	14.1	4.5	1.5	6.4	1.0	8.4	12.5	3.5	12.5	-37.2
-30	4.9	7.7	1.6	17.8	7.0	1.3	9.2	3.3	5.5	9.8	0.0	9.9	-34.4
-25	7.4	10.6	3.9	21.9	9.7	3.5	12.2	5.8	2.4	6.9	1.9	7.0	-31.7
-20	10.2	13.7	6.5	26.3	12.8	6.0	15.6	8.5	0.5	3.7	4.0	3.8	-28.9
-15	13.2	17.2	9.3	31.2	16.1	8.7	19.2	11.5	2.4	0.0	6.3	0.2	-26.1
-10	16.5	20.9	12.3	36.5	19.7	11.7	23.2	14.9	4.5	1.9	8.8	1.8	-23.3
-5	20.1	25.0	15.7	42.2	23.6	15.0	27.5	18.5	6.7	4.1	11.6	4.0	-20.6
0	24.0	29.5	19.4	48.4	27.9	18.7	32.2	22.5	9.1	6.5	14.6	6.3	-17.8
5	28.3	34.3	23.5	55.2	32.6	22.6	37.3	26.9	11.7	9.1	17.8	8.8	-15.0
10	32.8	39.5	27.9	62.4	37.6	26.9	42.8	31.6	14.6	11.9	21.3	11.6	-12.2
15	37.8	45.2	32.7	70.3	43.0	31.5	48.7	36.7	17.7	15.0	25.1	14.7	-9.4
20	43.1	51.2	37.9	78.7	48.8	36.6	55.1	42.3	21.0	18.4	29.2	18.0	-6.7
25	48.8	57.7	43.5	87.7	55.0	42.1	62.0	48.3	24.6	22.1	33.6	21.6	-3.9
30	55.0	64.7	49.6	97.4	61.7	48.0	69.3	54.8	28.4	26.1	38.4	25.5	-1.1
35	61.5	72.2	56.1	107.7	68.9	54.3	77.2	61.8	32.5	30.4	43.4	29.7	1.7
40	68.6	80.2	63.2	118.8	76.6	61.2	85.6	69.4	36.9	35.0	48.9	34.2	4.4
45	76.1	88.8	70.7	130.6	84.8	68.5	94.6	77.4	41.6	40.1	54.7	39.1	7.2
50	84.1	97.9	78.8	143.2	93.6	76.4	104.2	86.1	46.6	45.4	60.9	44.3	10.0
55	92.6	107.6	87.5	156.5	102.9	84.8	114.4	95.3	51.9	51.2	67.4	49.9	12.8
60	101.6	118.0	96.8	170.7	112.8	93.8	125.2	105.2	57.6	57.4	74.5	55.9	15.6
65	111.3	128.9	106.7	185.8	123.3	103.4	136.7	115.8	63.7	64.0	81.9	62.3	18.3
70	121.4	140.5	117.3	201.8	134.4	113.7	148.8	127.0	70.1	71.1	89.8	69.1	21.1
75	132.2	152.8	128.6	218.7	146.2	124.6	161.7	138.9	76.8	78.7	98.2	76.4	23.9
80	143.6	165.8	140.5	236.5	158.6	136.1	175.3	151.6	84.0	86.7	107.0	84.2	26.7
85	155.7	179.6	153.2	255.4	171.8	148.4	189.7	165.1	91.6	95.2	116.4	92.5	29.4
90	168.4	194.1	166.7	275.4	185.7	161.5	204.8	179.3	99.6	104.3	126.2	101.2	32.2
95	181.8	209.4	181.0	296.4	200.3	175.3	220.8	194.5	108.0	114.0	136.6	110.5	35.0
100	195.9	225.5	196.1	318.6	215.8	189.9	237.7	210.4	116.9	124.2	147.6	120.3	37.8
105	210.8	242.4	212.1	341.9	232.0	205.4	255.3	227.4	126.3	135.0	159.1	130.7	40.6
110	226.4	260.3	229.0	366.4	249.1	221.7	273.9	245.2	136.1	146.4	171.2	141.7	43.3
115	242.8	279.0	246.9	392.3	267.0	238.9	293.5	264.1	146.4	158.4	183.9	153.3	46.1
120	260.0	298.6	265.8	419.4	285.8	257.1	314.0	284.0	157.3	171.2	197.2	165.6	48.9
125	278.0	319.2	285.7	447.9	305.5	276.3	335.4	305.0	168.6	184.6	211.1	178.5	51.7
130	296.9	340.7	306.7	477.9	326.2	296.5	357.9	327.1	180.5	198.7	225.7	192.0	54.4
135	316.7	363.3	328.8	509.4	347.8	317.8	381.5	350.5	193.0	213.6	241.0	206.3	57.2
140	337.4	387.0	352.1	542.5	370.5	340.3	406.2	375.1	206.0	229.2	257.0	221.3	60.0
145	359.0	411.7	376.6	577.3	394.1	363.9	431.9	401.0	219.7	245.7	273.7	237.1	62.8
150	381.7	437.5	402.5	613.9	418.9	388.8	458.9	428.3	233.9	262.9	291.1	253.6	65.6

Red Numerals (in bold and italics) – 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 PRESSURE TEMPERATURE CHART\*

PRESSURE (PSIG)													
Sat. Temp (°F)	R-401A Liquid Pressure	R-401A Vapor Pressure	R-401B Liquid Pressure	R-401B Vapor Pressure	R-502	R-408A Liquid Pressure	R-402A Liquid Pressure	R-402B Liquid Pressure	R-404A Liquid Pressure	R-507A	R-123	R-32	Sat. Temp (°C)
-50	13.5	17.9	12.2	16.8	0.3	1.4	2.5	1.1	0.5	0.9	29.2	5.2	-45.6
-45	11.1	16.0	9.6	14.7	1.8	1.3	4.9	3.2	2.6	3.0	29.0	8.0	-42.8
-40	8.4	13.8	6.7	12.4	4.0	3.5	7.4	5.6	4.9	5.4	28.9	11.0	-40.0
-35	5.3	11.4	3.4	9.7	6.4	5.8	10.3	8.2	7.5	8.1	28.7	14.4	-37.2
-30	2.0	8.7	0.1	6.8	9.1	8.5	13.4	11.1	10.3	11.0	28.4	18.2	-34.4
-25	0.8	5.6	2.0	3.5	11.9	11.3	16.8	14.2	13.4	14.1	28.1	22.3	-31.7
-20	2.9	2.2	4.1	0.1	15.1	14.5	20.5	17.7	16.8	17.6	27.8	26.8	-28.9
-15	5.1	0.7	6.5	2.0	18.5	17.9	24.5	21.4	20.5	21.4	27.4	31.7	-26.1
-10	7.5	2.8	9.1	4.2	22.2	21.7	28.8	25.5	24.6	25.5	27.0	37.1	-23.3
-5	10.1	5.0	11.9	6.6	26.3	25.7	33.6	29.9	28.9	30.0	26.5	42.9	-20.6
0	13.0	7.4	14.9	9.2	30.6	30.1	38.7	34.6	33.7	34.8	25.9	49.3	-17.8
5	16.1	10.1	18.2	12.1	35.3	34.9	44.2	39.8	38.8	40.1	25.3	56.1	-15.0
10	19.5	13.0	21.8	15.2	40.4	40.0	50.2	45.3	44.3	45.7	24.6	63.5	-12.2
15	23.1	16.2	25.7	18.6	45.8	45.5	56.5	51.3	50.2	51.8	23.8	71.4	-9.4
20	27.1	19.6	29.9	22.3	51.6	51.5	63.4	57.7	56.6	58.3	22.9	80.0	-6.7
25	31.4	23.4	34.4	26.3	57.9	57.8	70.7	64.5	63.4	65.3	21.9	89.2	-3.9
30	36.0	27.4	39.3	30.6	64.6	64.6	78.6	71.8	70.7	72.7	20.8	99.1	-1.1
35	40.9	31.8	44.5	35.2	71.7	71.9	86.9	79.7	78.6	80.7	19.5	109.7	1.7
40	46.2	36.5	50.1	40.2	79.3	79.7	95.8	88.0	86.9	89.2	18.2	121.0	4.4
45	51.8	41.6	56.0	45.6	87.4	88.0	105.3	96.9	95.8	98.3	16.6	133.0	7.2
50	57.9	47.0	62.4	51.4	96.0	96.8	115.4	106.3	105.3	108.0	15.0	145.9	10.0
55	64.3	52.8	69.2	57.5	105.1	106.2	126.1	116.3	115.3	118.3	13.2	159.5	12.8
60	71.2	59.0	76.5	64.1	114.7	116.1	137.4	127.0	126.0	129.2	11.2	174.1	15.6
65	78.5	65.7	84.2	71.2	125.0	126.7	149.4	138.2	137.3	140.8	9.0	189.5	18.3
70	86.3	72.8	92.3	78.7	135.8	137.8	162.1	150.1	149.3	153.0	6.6	205.8	21.1
75	94.5	80.3	101.0	86.7	147.2	149.6	175.5	162.7	162.0	165.9	4.0	223.2	23.9
80	103.2	88.4	110.2	95.2	159.2	162.1	189.7	176.0	175.4	179.6	1.2	241.5	26.7
85	112.4	96.9	119.9	104.2	171.9	175.3	204.6	190.0	189.5	194.1	0.9	260.9	29.4
90	122.2	106.0	130.1	113.8	185.3	189.2	220.3	204.7	204.5	209.3	2.5	281.3	32.2
95	132.5	115.6	140.9	123.9	199.4	203.8	236.8	220.2	220.2	225.4	4.2	302.9	35.0
100	143.3	125.8	152.3	134.7	214.1	219.2	254.2	236.5	236.8	242.3	6.1	325.7	37.8
105	154.8	136.5	164.3	146.0	229.7	235.3	272.5	253.7	254.2	260.1	8.1	349.7	40.6
110	166.8	147.8	176.9	158.0	246.0	252.3	291.6	271.7	272.5	278.8	10.3	374.9	43.3
115	179.4	159.8	190.1	170.6	263.1	270.2	311.8	290.5	291.8	298.5	12.6	401.4	46.1
120	192.7	172.4	204.1	183.9	281.0	288.9	332.9	310.3	312.1	319.2	15.1	429.3	48.9
125	206.6	185.7	218.6	197.9	299.8	308.6	355.0	331.0	333.3	340.9	17.7	458.7	51.7
130	221.2	199.7	233.9	212.6	319.4	329.2	378.1	352.7	355.7	363.8	20.6	489.5	54.4
135	236.5	214.5	250.0	228.1	340.0	350.7	402.4	375.4	379.1	387.8	23.6	521.8	57.2
140	252.5	229.9	266.7	244.3	361.6	373.3	427.8	399.2	403.7	413.0	26.8	555.8	60.0
145	269.3	246.2	284.3	261.4	384.1	397.0	454.5	424.0	429.6	439.5	30.2	591.4	62.8
150	286.8	263.2	302.6	279.3	407.7	421.7	482.3	450.0	456.8	467.4	33.8	628.8	65.6

Red Numerals (in bold and italics) – Inches Hg Below 1 ATM

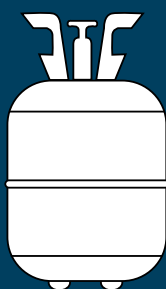
# FORANE® REFRIGERANT BASIC PROPERTY DATA CHART

PROPERTIES	R-410A	R-427A	R-407A	R-407C	R-134a	R-404A	R-507A	R-22	R-408A	R-32	R-123
Average Molecular Weight (g/mol)	72.6	90.4	90.1	86.2	102.0	97.6	98.9	86.5	87.0	52.02	152.9
Normal Boiling Point (NBP) (°F)	-60.6	-45.3	-49.0	-46.5	-14.9	-51.2	-52.1	-41.5	-48.2	-61.0	82.1
Latent Heat of Vaporization @ NBP (BTU/lb)	117.4	101.8	101.3	107.2	93.4	86.4	84.7	100.6	97.1	164.3	73.2
Critical Temperature (°F)	160.4	185.6	180.1	186.9	213.9	161.7	159.1	205.1	181.7	172.6	362.6
Critical Pressure (psia)	711.0	637.0	654.9	671.4	588.8	540.8	537.4	723.7	622.9	838.6	531.1
Density of Saturated Vapor @ NBP (lb/ft³)	0.26	0.30	0.30	0.29	0.33	0.34	0.35	0.29	0.30	0.19	0.40
Density of Saturated Liquid @ 77°F (lb/ft³)	66.1	70.5	71.5	71.0	75.3	65.2	65.4	74.3	66.1	60.0	91.4
Specific Heat of Saturated Vapor @ NBP (BTU/lb °R)	0.19	0.19	0.18	0.19	0.19	0.19	0.19	0.14	0.17	0.21	0.17
Specific Heat of Saturated Liquid @ 77°F (BTU/lb °R)	0.41	0.36	0.36	0.37	0.34	0.37	0.37	0.30	0.35	0.46	0.24
Ozone Depletion Potential (ODP) (CFC-11=1.0)	0	0	0	0	0	0	0	0.055	0.026	0	0.02
Global Warming Potential (GWP) AR5	1,924	2,024	1,923	1,624	1,300	3,943	3,985	1,760	3,257	677	79
ASHRAE Safety Group Classification	A1	A1	A1	A1	A1	A1	A1	A1	A1	A2L	B1
Occupational Exposure Limits (8 hr time/wt. Avg.)(ppm)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	50

## FORANE® REFRIGERANT CYLINDER IDENTIFICATION

TYPE	COLOR CODE	SIZE IN LBS. (CONTAINER TYPE)
R-12 CFC	White	30 (A), 50 (A), 145 (B), 2,000 (E)
R-22 HCFC	Light Green	30 (A), 50 (A), 125 (B), 1,000 (D), 1,750 (E)
R-32 HCFC	Grey	20 (A), 800 (D)
R-123 HCFC	Light Blue Grey	100 (C), 200 (C)
R-134a HFC	Light Blue	30 (A), 125 (B), 1,000 (D), 1,750 (E)
R-401A HCFC	Pinkish Red	20 (A), 30 (A), 125 (B)
R-401B HCFC	Mustard	30 (A), 125 (B)
R-402A HCFC	Sand	20 (A), 27 (A), 110 (B)
R-402B HCFC	Olive	13 (A)
R-404A HFC	Orange	20 (A), 24 (A), 100 (B), 800 (D), 1,300 (E)
R-407A HFC	Lime Green	20 (A), 25 (A), 115 (B)
R-407C HFC	Brown	25 (A), 115 (B), 950 (D), 1,600 (E)
R-408A HCFC	Medium Purple	20 (A), 24 (A), 100 (B), 1,300 (E)
R-409A HCFC	Tan	20 (A), 30 (A), 125 (B), 1,800 (E)
R-410A HFC	Rose	20 (A), 25 (A), 100 (B), 850 (D), 1,350 (E)
R-427A HFC	Green	20 (A), 25 (A) 110 (B)
R-502 CFC	Lavender	30 (A), 125 (B)
R-507A HFC	Teal	20 (A), 25 (A), 100 (B), 800 (D), 1,400 (E)

Container types drawings not to scale



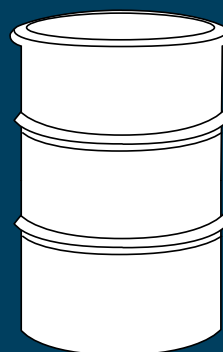
13/20/24/25/  
27/30/50 lbs.

(A)



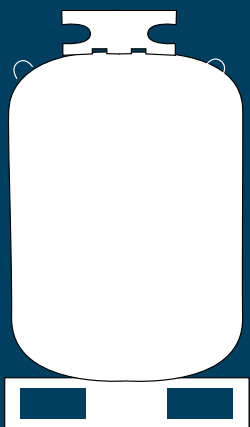
100/110/115/  
125/145 lbs.

(B)



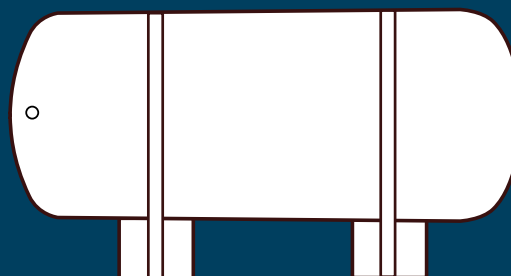
100/200 lbs.

(C)



800/850/950/1,000 lbs.

(D)



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

(E)

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