FORANE® REFRIGERANTS BY ARKEMA

Technical Digest

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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 issues. 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 www.forane-us.com.

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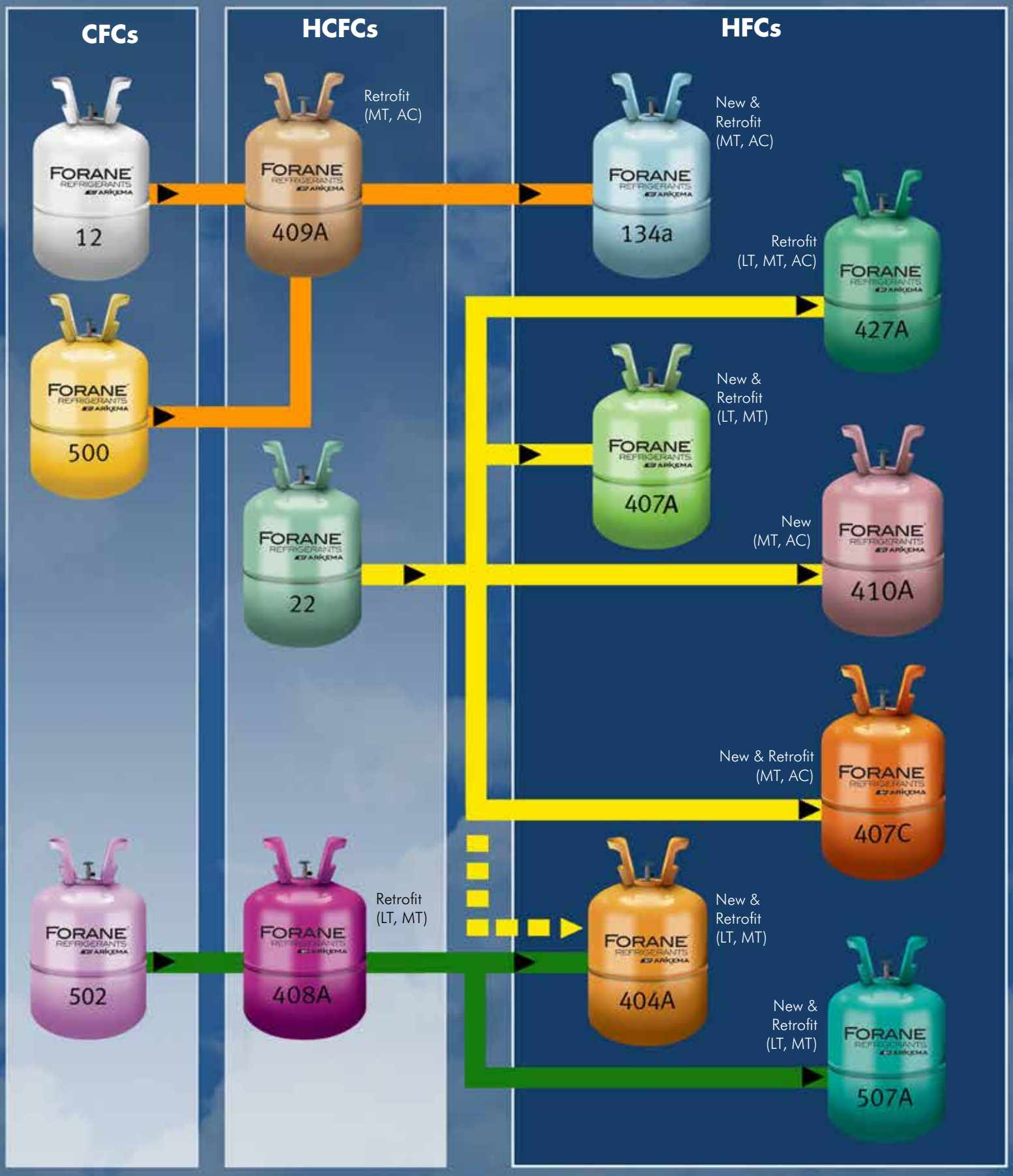
HCFCs

REFRIGERANT FLOW CHART

Progression Toward Sustainable Products



LT = Low Temp, MT = Med Temp, AC = Air-Conditioning

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-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.
R-409A	Forane® 409A	R-12 R-500	HCFC Zeotropic blend	R-22 - 60% R-124 - 25% R-142b - 15%	1,485	MO AB POE	Recommended retrofit for R-12 /R-500 stationary DX systems. Used in AC and MT 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 safety rating (lowest levels of toxicity / flammability), as assigned by ASHRAE, as well as zero ozone depletion potential.

R-410A is a 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. 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

Due to the zeotropic nature of the R-410A 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. R-410A requires the use of manifold gauge sets, recovery machines, and cylinders specifically designed and rated for its higher pressures.

Retrofit

Due to the significantly higher operating pressures and capacities of R-410A, it should never be used as a retrofit for R-22 systems. R-410A should only be used with equipment designed specifically for use with R-410A.

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 ft 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. Check the system for leaks and identify any needed repairs. Run the system using the correct OEM charge of R-22 and record performance parameters using an Arkema Retrofit Data Sheet.
2. Recover existing R-22 refrigerant (DO NOT vent to the atmosphere) and make sure not to mix with other refrigerant gases. Record the weight of refrigerant removed.
3. 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 ft or more, long line sets, evaporators positioned below compressors.
4. Replace the filter dryer and, if necessary, elastomeric seals and gaskets, such as Schrader valve core.
5. Conduct a pressure test using dry nitrogen to determine if the system has a leak, staying below the system pressure limitations. Repair any leaks as necessary. Pull a minimum vacuum of 500 microns and ensure that it maintains a vacuum. If vacuum the system does not hold vacuum, then leaks may still be present.
6. Remove refrigerant as a liquid only from the cylinder, being careful not to damage the compressor. The initial weight should be approximately 95% of the original charge for R-22, charging up to 100% if necessary.
7. Start system and record system performance, noting superheat and subcooling. Adjust TXV set-point and/or refrigerant charge to achieve the desired superheat. Low side pressure control settings may also need to be adjusted.
8. Properly label the system as being retrofitted with Forane® 427A. For Forane® 427A system labels, call Arkema's customer service at (800) 245-5858.

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.

Application

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.

Properties & Performance

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.

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.

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.

Lubrication

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.

Charging

Due to the zeotropic nature of the R-407A blend, it should be charged as a liquid to prevent fractionation (changes in the designed refrigerant composition). 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.

Retrofit

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.

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.

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.

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 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.

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 charged 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.

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 new 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® 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 closely match the properties of R-502, 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 closely match the properties of R-502, 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® 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 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, as well as our reclaim program and retrofit options, please go to page 16 or visit www.forane-us.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 A1 ASHRAE safety rating.

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 their 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) 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

Forane® 409A

Forane® 409A refrigerant (R-409A or FX-56) is a low ozone depleting blend of HCFC refrigerants R-22, R-124, and R-142b. R-409A is formulated to closely resemble the properties of R-12.

Application

Applications include many medium temperature refrigeration systems, vending machines, refrigerators, positive displacement chillers, humidifiers, and other systems using R-12 or R-500.

Properties & Performance

R-409A has properties and performance similar to R-12 and R-500. Low side pressures are similar to those of R-12, while high side pressures will typically be 15 to 25 psi higher. Equal or better heat transfer characteristics are usually obtained when retrofitting from R-12 to R-409A.

Lubrication

R-409A works well with the MO or AB found in R-12 or R-500 systems and typically does not require an oil change. For low temperature, mineral oil based R-12 applications (evaporator temperatures < 0°F), a partial oil change (≥30%) to alkylbenzene is recommended. R-409A is fully miscible with AB and POE oils.

Charging

Due to the zeotropic nature of R-409A, 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. Charging weight ratios of R-409A are usually 85 – 90% of the charge weight of R-12.

Retrofit

R-409A is the recommended retrofit for R-12 and R-500 stationary DX systems, where an oil change to POE is not practical. R-409A is not recommended for use in automotive air conditioning system or systems that utilize a flooded evaporator (i.e. centrifugal chillers). For these systems, R-134a is the recommended retrofit product.

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. Oil changes are typically not required for R-409A. For low temperature mineral oil based systems, a partial (≥ 30%) oil change to AB is recommended.
6. 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.
7. Charge system with R-409A refrigerant. Remove refrigerant as liquid only from cylinder. The initial charge amount should be approximately 85 – 90% of the standard charge for R-12 for TXV systems and 80% for cap tube systems.
8. Adjust TXV set point and/or refrigerant charge to achieve the desired superheat. Low side pressure control settings may also need to be adjusted.
9. Monitor oil levels in the compressor. If necessary, adjust oil amounts to attain normal operating level (mid-sight glass).
10. Label system clearly, indicating the type and amounts of system refrigerant and oil.

PROPERTIES	R-409A
Average Molecular Weight (g/mol)	97.4
Normal Boiling Point (°F)	-30.0
Critical Temperature	228.7
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.05
Global Warming Potential (GWP) AR5	1,485

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 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 recently 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 for help with your selection.

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 – 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-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	R-401A Liquid Pressure	R-401A Vapor Pressure	R-401B Liquid Pressure	R-401B 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*	*13.5*	*17.9*	*12.2*	*16.8*	-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*	*11.1*	*16.0*	*9.6*	*14.7*	-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*	*8.4*	*13.8*	*6.7*	*12.4*	-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*	*5.3*	*11.4*	*3.4*	*9.7*	-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*	*2.0*	*8.7*	0.1	*6.8*	-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*	0.8	*5.6*	2.0	*3.5*	-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*	2.9	*2.2*	4.1	0.1	-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*	5.1	0.7	6.5	2.0	-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	7.5	2.8	9.1	4.2	-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	10.1	5.0	11.9	6.6	-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	13.0	7.4	14.9	9.2	-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	16.1	10.1	18.2	12.1	-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	19.5	13.0	21.8	15.2	-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	23.1	16.2	25.7	18.6	-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	27.1	19.6	29.9	22.3	-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	31.4	23.4	34.4	26.3	-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	36.0	27.4	39.3	30.6	-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	40.9	31.8	44.5	35.2	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	46.2	36.5	50.1	40.2	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	51.8	41.6	56.0	45.6	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	57.9	47.0	62.4	51.4	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	64.3	52.8	69.2	57.5	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	71.2	59.0	76.5	64.1	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	78.5	65.7	84.2	71.2	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	86.3	72.8	92.3	78.7	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	94.5	80.3	101.0	86.7	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	103.2	88.4	110.2	95.2	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	112.4	96.9	119.9	104.2	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	122.2	106.0	130.1	113.8	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	132.5	115.6	140.9	123.9	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	143.3	125.8	152.3	134.7	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	154.8	136.5	164.3	146.0	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	166.8	147.8	176.9	158.0	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	179.4	159.8	190.1	170.6	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	192.7	172.4	204.1	183.9	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	206.6	185.7	218.6	197.9	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	221.2	199.7	233.9	212.6	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	236.5	214.5	250.0	228.1	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	252.5	229.9	266.7	244.3	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	269.3	246.2	284.3	261.4	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	286.8	263.2	302.6	279.3	65.6

* 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)

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

PRESSURE (PSIG)

Sat. Temp (°F)	R-502	R-408A Liquid Pressure	R-402A Liquid Pressure	R-402B Liquid Pressure	R-404A Liquid Pressure	R-507A	R-123	Sat. Temp (°C)
-50	***0.3***	***1.4***	2.5	1.1	0.5	0.9	***29.2***	-45.6
-45	1.8	1.3	4.9	3.2	2.6	3.0	***29.0***	-42.8
-40	4.0	3.5	7.4	5.6	4.9	5.4	***28.9***	-40.0
-35	6.4	5.8	10.3	8.2	7.5	8.1	***28.7***	-37.2
-30	9.1	8.5	13.4	11.1	10.3	11.0	***28.4***	-34.4
-25	11.9	11.3	16.8	14.2	13.4	14.1	***28.1***	-31.7
-20	15.1	14.5	20.5	17.7	16.8	17.6	***27.8***	-28.9
-15	18.5	17.9	24.5	21.4	20.5	21.4	***27.4***	-26.1
-10	22.2	21.7	28.8	25.5	24.6	25.5	***27.0***	-23.3
-5	26.3	25.7	33.6	29.9	28.9	30.0	***26.5***	-20.6
0	30.6	30.1	38.7	34.6	33.7	34.8	***25.9***	-17.8
5	35.3	34.9	44.2	39.8	38.8	40.1	***25.3***	-15.0
10	40.4	40.0	50.2	45.3	44.3	45.7	***24.6***	-12.2
15	45.8	45.5	56.5	51.3	50.2	51.8	***23.8***	-9.4
20	51.6	51.5	63.4	57.7	56.6	58.3	***22.9***	-6.7
25	57.9	57.8	70.7	64.5	63.4	65.3	***21.9***	-3.9
30	64.6	64.6	78.6	71.8	70.7	72.7	***20.8***	-1.1
35	71.7	71.9	86.9	79.7	78.6	80.7	***19.5***	1.7
40	79.3	79.7	95.8	88.0	86.9	89.2	***18.2***	4.4
45	87.4	88.0	105.3	96.9	95.8	98.3	***16.6***	7.2
50	96.0	96.8	115.4	106.3	105.3	108.0	***15.0***	10.0
55	105.1	106.2	126.1	116.3	115.3	118.3	***13.2***	12.8
60	114.7	116.1	137.4	127.0	126.0	129.2	***11.2***	15.6
65	125.0	126.7	149.4	138.2	137.3	140.8	***9.0***	18.3
70	135.8	137.8	162.1	150.1	149.3	153.0	***6.6***	21.1
75	147.2	149.6	175.5	162.7	162.0	165.9	***4.0***	23.9
80	159.2	162.1	189.7	176.0	175.4	179.6	***1.2***	26.7
85	171.9	175.3	204.6	190.0	189.5	194.1	0.9	29.4
90	185.3	189.2	220.3	204.7	204.5	209.3	2.5	32.2
95	199.4	203.8	236.8	220.2	220.2	225.4	4.2	35.0
100	214.1	219.2	254.2	236.5	236.8	242.3	6.1	37.8
105	229.7	235.3	272.5	253.7	254.2	260.1	8.1	40.6
110	246.0	252.3	291.6	271.7	272.5	278.8	10.3	43.3
115	263.1	270.2	311.8	290.5	291.8	298.5	12.6	46.1
120	281.0	288.9	332.9	310.3	312.1	319.2	15.1	48.9
125	299.8	308.6	355.0	331.0	333.3	340.9	17.7	51.7
130	319.4	329.2	378.1	352.7	355.7	363.8	20.6	54.4
135	340.0	350.7	402.4	375.4	379.1	387.8	23.6	57.2
140	361.6	373.3	427.8	399.2	403.7	413.0	26.8	60.0
145	384.1	397.0	454.5	424.0	429.6	439.5	30.2	62.8
150	407.7	421.7	482.3	450.0	456.8	467.4	33.8	65.6

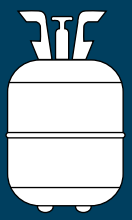
Red Numerals (in bold and italics) - Inches Hg Below 1 ATM

Forane® Refrigerant Cylinder Identification

Type		Color Code	Size in lbs. (Container Type)
R-12	CFC	White	30 (A), 50 (A), 145 (B), 2000 (E)
R-502	CFC	Lavender	30 (A), 125 (B)
R-22	HCFC	Light Green	30 (A), 50 (A), 125 (B), 1000(D), 1750 (E)
R-123	HCFC	Light Blue Grey	100 (C), 200 (C)
R-401A	HCFC	Pinkish Red	30 (A), 125 (B)
R-401B	HCFC	Mustard	30 (A), 125 (B)
R-402A	HCFC	Sand	27 (A), 110 (B)
R-402B	HCFC	Olive	13 (A)
R-408A	HCFC	Medium Purple	24 (A), 100 (B), 1300 (E)
R-409A	HCFC	Tan	30 (A), 125 (B), 1800 (E)
R-134a	HFC	Light Blue	30 (A), 125 (B), 1000 (D), 1750 (E)
R-404A	HFC	Orange	24 (A), 100 (B), 800 (D), 1300 (E)
R-407A	HFC	Lime Green	25 (A), 115 (B)
R-407C	HFC	Brown	25 (A), 115 (B), 1000 (D), 1600 (E)
R-427A	HFC	Green	25 (A) 110 (B)
R-410A	HFC	Rose	25 (A), 100 (B), 850 (D), 1350 (E)
R-507A	HFC	Teal	25 (A), 100 (B), 800 (D), 1400 (E)

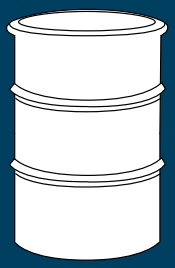
Container Types

Drawings not to scale

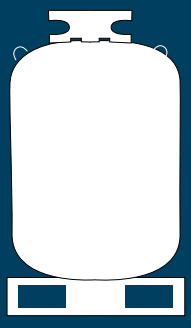


13/24/25/ 27/30/50 lb. (A)

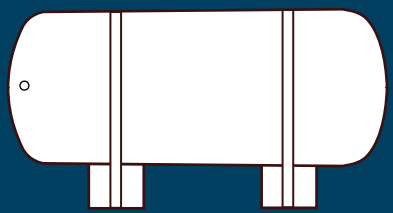
100/110/115/ 125/145 lb. (B)



100/200 lb. (C)



800/850/1000 lb. (D)



1300/1350/1400/1600/ 1750/1800/2000 lb. (E)

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-409A	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	97.4	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	-30.0	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	95.7	73.2
Critical Temperature (°F)	160.4	185.6	180.1	186.9	213.9	161.7	159.1	205.1	181.7	228.7	362.6
Critical Pressure (psia)	711.0	637.0	654.9	671.4	588.8	540.8	537.4	723.7	622.9	681.5	531.1
Density of Saturated Vapor @ NBP (lb/ft^3)	0.26	0.30	0.30	0.29	0.33	0.34	0.35	0.29	0.30	0.31	0.40
Density of Saturated Liquid @ 77 °F (lb/ft^3)	66.1	70.5	71.5	71.0	75.3	65.2	65.4	74.3	66.1	75.8	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	0.16	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	0.29	0.24
Ozone Depletion Potential (ODP) (CFC-11=1.0)	0	0	0	0	0	0	0	0.055	0.026	0.05	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	1,485	79
ASHRAE Safety Group Classification	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	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

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