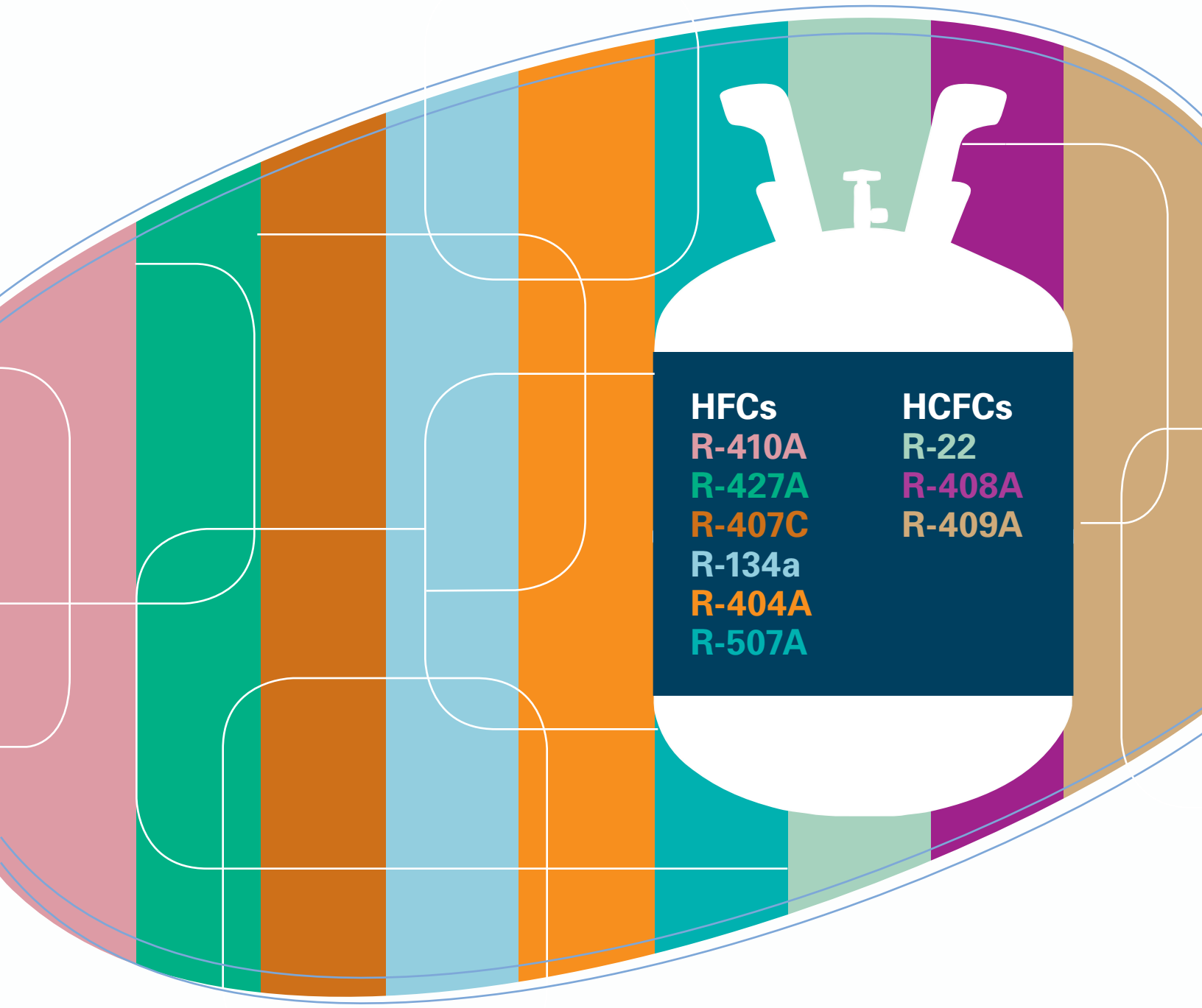
Forane®
REFRIGERANTS

TECHNICAL DIGEST



ARKEMA
The world is our inspiration

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Forane® Refrigerants

Arkema has continued to develop and support new and existing refrigerant products for use in a number of different cooling applications. This technical digest has been developed as a reference for all of Arkema's different refrigerant products used in these various applications.

The refrigerants listed in this digest are widely used to service the major air conditioning and refrigeration markets. They are non-toxic, non-flammable products meeting all industry specification requirements.

This technical digest provides a summary of physical properties of the Forane® refrigerant product line. It also provides brief summaries of the key factors when using any refrigerant. For more detailed information, please contact our Technical Service hotline at (800) 738-7695 or check our website at www.forane-us.com

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HCFCs

Refrigerant Flow Chart
Progression Toward Sustainable Products

Application Reference Guide

ASHARE #	Trade Name	Manufacturer	Replaces	Type	Composition (wt%)	Recommended Lubricant	Applications
R-410A	Forane® 410A	Arkema	R-22	HFC Near-azeotropic blend	R-32 - 50% R-125 - 50%	POE	Replacement for R-22 in smaller size chillers, and residential and light commercial A/C systems. Never used as a retrofit for R-22
	Genetron® AZ-20 Suva® 410A Puron	Honeywell Dupont					
R-427A	Forane® 427A	Arkema	R-22	HFC Zeotropic blend	R-32 - 15% R-125 - 25% R-143a - 10% R-134a - 50%	MO or AB with oil separator POE	Recommended retrofit for R-22 DX systems. Used in A/C, medium, and low temperature systems.
R-407C	Forane® 407C	Arkema	R-22	HFC Zeotropic blend	R-32 - 23% R-125 - 25% R-134a - 52%	POE	Replacement/retrofit for R-22 in DX systems. Used in A/C, medium, and low temperature systems.
	Genetron® 407C Suva® 407C	Honeywell Dupont					
R-134a	Forane® 134a	Arkema	R-12	HFC Single component fluid	R-134a -100%	POE PAG (auto)	Replacement/retrofit for R-12 and R-500 systems. Recommended retrofit for R-12 automotive A/C systems.
	Suva® 134a Genetron® 134a Klea® 134a	Dupont Honeywell INEOS					
R-404A	Forane® 404A	Arkema	R-502 R-22 HP-80 R-408A	HFC Near-azeotropic blend	R-125 - 44% R-143a - 52% R-134a - 4%	POE	Replacement/retrofit for R-502 and R-22. Used in medium and low temperature systems.
	Genetron® 404A Suva® 404A	Honeywell Dupont					
R-507A	Forane® 507A	Arkema	R-502 R-22 HP-80 R-408A	HFC Azeotropic blend	R-125 - 50% R-143a - 50%	POE	Replacement/retrofit for R-502 and R-22. Used in medium and low temperature refrigeration systems.
	Genetron® AZ-50 Suva® 507	Honeywell Dupont					
R-22	Forane® 22	Arkema		HCFC Single component fluid	R-22 - 100%	MO AB	Used in A/C, medium, and low temperature systems. Scheduled for phase-out.
	Freon® 22 Genetron® 22	Dupont Honeywell					
R-408A	Forane® FX-10	Arkema	R-502	HCFC Near-azeotropic blend	R-125 - 7% R-143a - 46% R-22 - 47%	MO AB POE	Recommended retrofit for R-502 systems. Used in medium and low temperature systems.
	Suva® 408A Genetron® 408A	Dupont Honeywell					
R-409A	Forane® FX-56	Arkema	R-12 R-500	HCFC Zeotropic blend	R-22 - 60% R-124 - 25% R-142b - 15%	MO AB POE	Recommended retrofit for R-12 /R-500 stationary DX systems. Used in A/C, medium, and low temperature systems.
	Suva® 409A Genetron® 409A	Dupont Honeywell					
R-123	Forane® 123	Arkema	R-11	HCFC Single component fluid	R-123 -100%	MO AB POE	Used in Centrifugal Chillers Scheduled for phase-out.
	Suva® 123 Genetron® 123	Dupont Honeywell					

FORANE® 410A

Forane® 410A refrigerant (R-410A) is a non-ozone depleting blend of hydrofluorocarbons (HFC) R-32 and R-125 developed as a replacement refrigerant for air conditioning applications currently designed for (HCFC) R-22. Due to the higher refrigerating capacity and pressures of R-410A, it should not be used as a retrofit refrigerant in R-22 equipment.

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 as well.

Properties & Performance

R-410A is a near-azeotropic HFC refrigerant blend that meets the industry's needs for many new air conditioning systems. R-410A has received an A1 safety rating from ASHRAE (lowest levels of toxicity and flammability) having 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)	-61.9
Critical Temperature (°F)	162.0
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP)	1,725

FORANE® 427A

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 an 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 new and existing air conditioning 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.

R-427A has comparable capacity to R-22 and better efficiency than most other R-22 replacements. R-427A's discharge temperatures are typically 15 – 40°F lower than those of R-22, and it has one of the lowest global warming potentials (GWP) of the R-22 retrofits.

Lubrication

Mineral oil and alkylbenzene are often acceptable with R-427A if the system has an oil separator and reliable oil return with R-22. Otherwise the oil must be changed to POE. If POE is required, usually only one change-out of the existing lubricant is needed, as R-427A can tolerate high levels of residual mineral oil or alkylbenzene remaining in the system.

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.

Retrofitting 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 (O-rings, sight glasses, etc.). Verify the condition of the system oil; replace if necessary.
5. Determine if an oil change is needed. If an oil separator is currently used and reliable oil return has been established with R-22, replacement of original mineral oil or alkylbezene is often not needed (skip to step 7). If no oil separator is present, drain existing mineral oil or alkylbenzene from the compressor sump, suction line accumulators, etc. Record the amount of oil removed.
6. Add an equivalent amount of OEM recommended POE oil. In most cases, no flushing is required. Only one oil change is required with up to 15% residual mineral oil or alkylbenzene accommodated.
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-427A 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-427A
Average Molecular Weight (g/mol)	90.4
Normal Boiling Point (°F)	-44.8
Critical Temperature (°F)	185.6
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP)	1,830

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.

Retrofitting 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)	-46.1
Critical Temperature (°F)	187.2
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP)	1,525

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 (polyalkylene glycol, auto 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 some existing R-12 systems including R-12 centrifugal chillers, semi-hermetic, reciprocating, and screw refrigeration applications, industrial refrigeration plants, automotive systems and some hermetic compressor applications.

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-134.

PROPERTIES	R-134a
Average Molecular Weight (g/mol)	102.0
Normal Boiling Point (°F)	-14.9
Critical Temperature (°F)	214.1
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP)	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. R-404A is near azeotropic HFC refrigerant blend rated A1 by ASHRAE (lowest levels of toxicity and flammability) having zero ozone depletion potential.

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)	-51.5
Critical Temperature (°F)	161.6
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP)	3,260

FORANE® 507A

Forane® 507A refrigerant (R-507A) is a non-ozone depleting, azeotropic blend of HFC refrigerants R-125 and R-143a. R-507 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)	98.8
Normal Boiling Point (°F)	-52.8
Critical Temperature (°F)	159.8
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0
Global Warming Potential (GWP)	3,300

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.

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 manufacturers guidelines for specific charging instructions.

PROPERTIES	R-22
Average Molecular Weight (g/mol)	86.5
Normal Boiling Point (°F)	-41.3
Critical Temperature (°F)	204.8
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.055
Global Warming Potential (GWP)	1,500

FORANE® 408A

Forane® 408A refrigerant (R-408A) is a non-ozone depleting, near-azeotropic HCFC blend of R-22, R-125 and R-143a 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.

Retrofitting 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 (O-rings, sight glasses, etc.). Verify the condition of the system oil; replace if necessary
5. Evacuate the system (< 500 microns) and insure 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	408A
Average Molecular Weight (g/mol)	87.0
Normal Boiling Point (°F)	-47.9
Critical Temperature (°F)	182.6
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.026
Global Warming Potential (GWP)	2,650

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 less than 0°F); a partial oil change (less than 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.

Retrofitting 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 (O-rings. sight glasses. etc.). 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 (greater than 30%) oil change to AB is recommended.
6. Evacuate the system (less than 500 microns) and insure 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)	-30.1
Critical Temperature	224.2
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.05
Global Warming Potential (GWP)	1,290

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

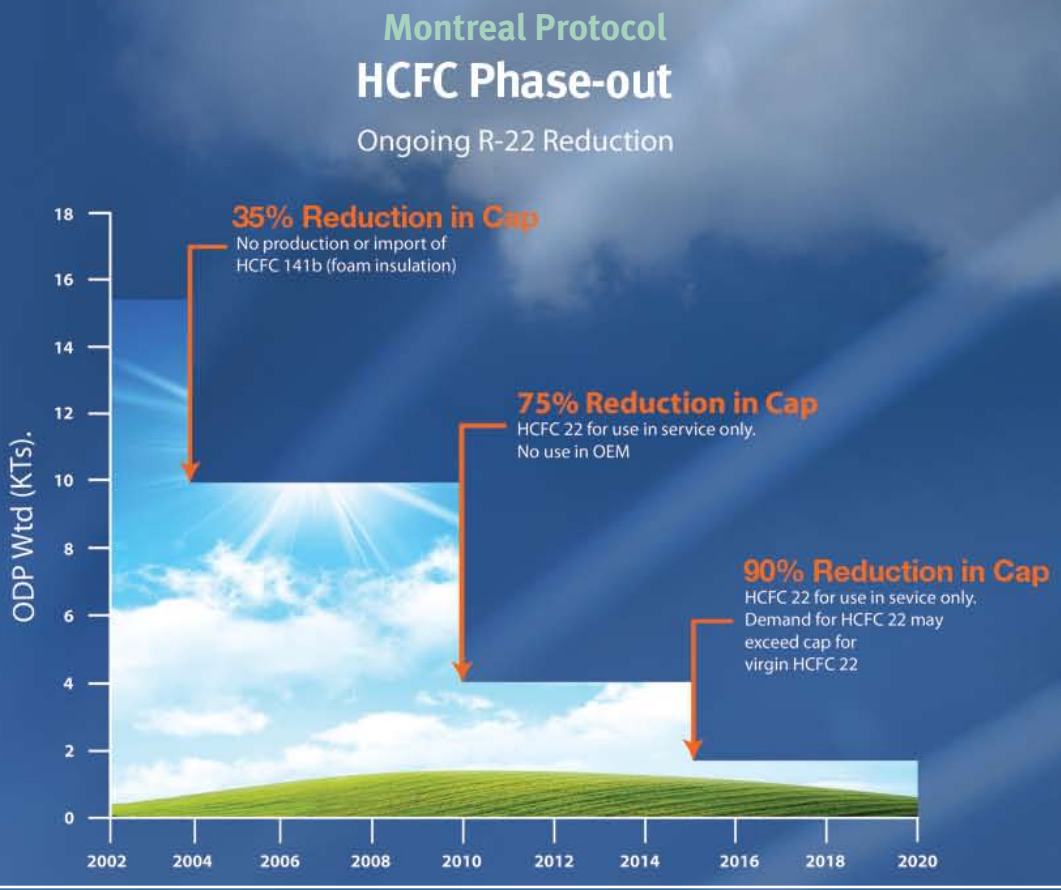
Whenever retrofitting an air-conditioning or refrigeration system, compatibility of system materials is always a concern. Items such as elastomers, hoses, and filter-driers respond differently to different refrigerants and oils. For these reasons, before performing any refrigerant retrofit, Arkema recommends 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.

R-22 Transition



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 USA, 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 will not be permitted for use in new OEM HVACR equipment in 2010, reducing the R-22 demands into this sector and helping to meet the 75% reduction in ozone depleting substances.

In 2015, R-22 will have another step change reduction of 90% of the overall allowable consumption for servicing R-22 systems in the United States.

These step-downs will continue through 2030, when R-22 will be completely phased out in the United States.

In the USA, these regulations may change in the future. Please visit www.forane-us.com

R-22 users should be aware of the need to transition to other, more sustainable refrigerants meeting the application's requirements. Current HFC refrigerants listed in this Tech Digest meet these needs and are not under any phase-out restrictions.

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) when 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

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-123	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	6.2	2.9	11.4	5.3	3.8	11.9	29.2	15.4	18.7	12.4	17.2	13.5	17.9	12.2	16.8	-45.6
-45	2.7	0.4	8.5	8.0	0.1	9.0	29.0	13.3	16.9	9.7	15.2	11.1	16.0	9.6	14.7	-42.8
-40	0.5	2.5	5.2	11.0	1.9	5.9	28.9	11.0	14.8	6.8	13.1	8.4	13.8	6.7	12.4	-40.0
-35	2.6	4.8	1.5	14.2	4.1	2.4	28.7	8.4	12.5	3.5	10.7	5.3	11.4	3.4	9.7	-37.2
-30	4.9	7.3	1.3	17.8	6.6	0.8	28.4	5.5	9.8	0.0	8.1	2.0	8.7	0.1	6.8	-34.4
-25	7.4	10.1	3.6	21.8	9.3	2.9	28.1	2.3	6.9	2.0	5.1	0.8	5.6	2.0	3.5	-31.7
-20	10.1	13.1	6.1	26.1	12.2	5.3	27.8	0.6	3.7	4.1	1.9	2.9	2.2	4.1	0.1	-28.9
-15	13.2	16.5	8.8	30.8	15.4	7.9	27.4	2.4	0.1	6.5	0.8	5.1	0.7	6.5	2.0	-26.1
-10	16.5	20.1	11.9	35.9	18.9	10.8	27.0	4.5	1.9	9.0	2.8	7.5	2.8	9.1	4.2	-23.3
-5	20.0	24.0	15.2	41.5	22.8	14.0	26.5	6.7	4.1	11.8	4.9	10.1	5.0	11.9	6.6	-20.6
0	23.9	28.3	18.9	47.5	26.9	17.5	25.9	9.1	6.5	14.8	7.2	13.0	7.4	14.9	9.2	-17.8
5	28.2	33.0	22.9	54.1	31.4	21.2	25.3	11.8	9.1	18.1	9.7	16.1	10.1	18.2	12.1	-15.0
10	32.8	38.0	27.3	61.2	36.3	25.4	24.6	14.6	11.9	21.7	12.5	19.5	13.0	21.8	15.2	-12.2
15	37.7	43.5	32.0	68.8	41.5	29.9	23.7	17.7	15.0	25.5	15.4	23.1	16.2	25.7	18.6	-9.4
20	43.0	49.3	37.2	77.1	47.2	34.7	22.8	21.0	18.4	29.6	18.7	27.1	19.6	29.9	22.3	-6.7
25	48.7	55.7	42.7	86.0	53.3	40.0	21.8	24.6	22.1	34.0	22.2	31.4	23.4	34.4	26.3	-3.9
30	54.9	62.5	48.7	95.5	59.8	45.7	20.7	28.4	26.0	38.7	26.0	36.0	27.4	39.3	30.6	-1.1
35	61.5	69.8	55.2	105.7	66.8	51.9	19.5	32.5	30.3	43.8	30.1	40.9	31.8	44.5	35.2	1.7
40	68.5	77.6	62.1	116.6	74.3	58.7	18.1	36.9	35.0	49.2	34.5	46.2	36.5	50.1	40.2	4.4
45	76.0	86.0	69.5	128.3	82.3	65.6	16.6	41.6	40.0	54.9	39.2	51.8	41.6	56.0	45.6	7.2
50	84.0	94.9	77.5	140.8	90.8	73.3	15.0	46.7	45.4	61.0	44.3	57.9	47.0	62.4	51.4	10.0
55	92.5	104.5	86.0	154.1	99.9	81.5	13.1	52.0	51.1	67.6	49.8	64.3	52.8	69.2	57.5	12.8
60	101.6	114.6	95.1	168.2	109.6	90.3	11.2	57.7	57.3	74.5	55.6	71.2	59.0	76.5	64.1	15.6
65	111.2	125.4	104.8	183.2	119.9	99.6	9.0	63.7	63.9	81.8	61.9	78.5	65.7	84.2	71.2	18.3
70	121.4	136.9	115.2	199.2	130.8	109.6	6.6	70.2	71.0	89.5	68.6	86.3	72.8	92.3	78.7	21.1
75	80	149.1	126.2	216.1	142.4	120.3	4.0	76.9	78.6	97.7	75.8	94.5	80.3	101.0	86.7	23.9
80	143.6	162.1	137.8	234.0	154.6	131.6	1.2	84.1	86.6	106.4	83.4	103.2	88.4	110.2	95.2	26.7
85	155.7	175.8	150.2	253.0	167.6	143.7	0.9	91.7	95.1	115.5	91.5	112.4	96.9	119.8	104.2	29.4
90	168.4	190.2	163.4	273.0	181.2	156.4	2.5	99.7	104.2	125.2	100.2	122.2	106.0	130.1	113.8	32.2
95	181.8	205.5	177.4	294.1	195.6	170.0	4.2	108.2	113.8	135.3	109.4	132.5	115.6	140.9	123.9	35.0
100	195.9	221.6	192.1	316.4	210.8	184.4	6.1	117.1	124.1	146.0	119.2	143.3	125.7	152.3	134.7	37.8
105	210.7	238.5	207.8	339.9	226.8	199.6	8.1	126.5	134.9	157.2	129.6	154.8	136.5	164.3	146.0	40.6
110	226.3	256.4	224.4	364.6	243.6	215.7	10.3	136.4	146.3	169.0	140.6	166.8	147.8	176.9	158.0	43.3
115	242.7	275.1	241.9	390.5	261.2	232.7	12.6	146.7	158.4	181.4	152.3	179.4	159.8	190.1	170.6	46.1
120	259.9	294.7	260.5	417.7	279.7	250.6	15.1	157.6	171.1	194.4	164.7	192.7	172.4	204.0	183.9	48.9
125	277.9	315.2	280.1	446.3	299.1	269.5	17.7	169.0	184.5	208.0	177.8	206.6	185.7	218.6	197.9	51.7
130	296.8	336.7	300.9	476.3	319.4	289.5	20.6	180.9	198.7	222.3	191.6	221.2	199.7	233.9	212.6	54.4
135	316.5	359.2	322.9	507.6	340.7	310.5	23.6	193.5	213.6	237.2	206.3	236.5	214.5	250.0	228.1	57.2
140	337.2	382.6	346.2	540.5	362.9	332.6	26.8	206.5	229.3	252.9	221.8	252.5	229.9	266.7	244.3	60.0
145	358.8	407.0	370.8	574.8	386.1	355.9	30.2	220.2	245.7	269.3	238.2	269.3	246.2	284.3	261.4	62.8
150	381.5	432.4	396.9	610.6	410.3	380.4	33.8	234.5	263.0	286.4	255.5	286.8	263.2	302.6	279.3	65.6

Red Numerals - Inches Hg. Below 1 ATM

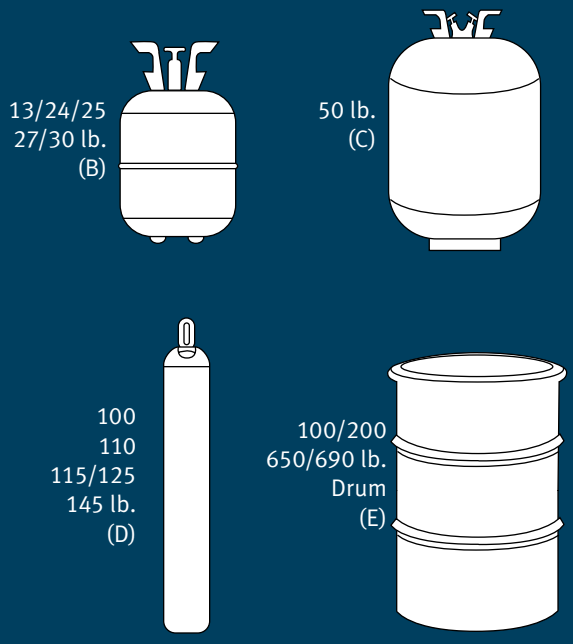
PRESSURE (PSIG)							
Sat. Temp (°F	R-502	R-408A Liquid Pressure	R-402A Liquid Pressure	R-402B Liquid Pressure	R-404A Liquid Pressure	R-507A	Sat. Temp (°C)
-50	0.2	1.6	2.5	1.1	0.6	1.1	-45.6
-45	1.9	1.1	4.9	3.2	2.7	3.3	-42.8
-40	4.1	3.3	7.4	5.6	5.0	5.7	-40.0
-35	6.5	5.6	10.3	8.2	7.6	8.3	-37.2
-30	9.2	8.2	13.4	11.1	10.4	11.2	-34.4
-25	12.1	11.0	16.7	14.2	13.4	14.3	-31.7
-20	15.3	14.1	20.4	17.6	16.8	17.8	-28.9
-15	18.8	17.5	24.5	21.4	20.5	21.6	-26.1
-10	22.6	21.2	28.8	25.4	24.5	25.7	-23.3
-5	26.7	25.2	33.6	29.8	28.8	30.1	-20.6
0	31.1	29.5	38.7	34.6	33.5	34.9	-17.8
5	35.9	34.2	44.2	39.8	38.6	40.2	-15.0
10	41.0	39.3	50.1	45.3	44.0	45.8	-12.2
15	46.5	44.8	56.5	51.3	49.9	51.8	-9.4
20	52.5	50.7	63.4	57.6	56.2	58.3	-6.7
25	58.8	57.0	70.7	64.5	63.0	65.3	-3.9
30	65.6	63.7	78.5	71.8	70.3	72.8	-1.1
35	72.8	71.0	86.9	79.6	78.1	80.8	1.7
40	80.5	78.7	95.8	88.0	86.4	89.3	4.4
45	88.7	87.0	105.3	96.9	95.2	98.4	7.2
50	97.4	95.8	115.4	106.3	104.7	108.1	10.0
55	106.6	105.1	126.1	116.3	114.7	118.5	12.8
60	116.4	115.1	137.4	127.0	125.3	129.4	15.6
65	126.7	125.6	149.4	138.2	136.6	141.1	18.3
70	137.6	136.8	162.1	150.1	148.6	153.4	21.1
75	149.1	148.7	175.5	162.7	161.2	166.4	23.9
80	161.2	161.2	189.7	176.0	174.6	180.2	26.7
85	174.0	174.4	204.6	189.9	188.8	194.8	29.4
90	187.4	188.4	220.2	204.7	203.7	210.1	32.2
95	201.4	203.1	236.8	220.2	219.4	226.3	35.0
100	216.2	218.7	254.2	236.5	235.9	243.4	37.8
105	231.7	235.4	272.4	253.6	253.4	261.3	40.6
110	247.9	252.1	291.6	271.6	271.7	280.2	43.3
115	264.9	270.2	311.7	290.5	290.9	300.0	46.1
120	282.7	289.1	332.8	310.3	311.1	320.8	48.9
125	301.4	308.9	354.9	331.0	332.3	342.6	51.7
130	320.8	329.7	378.1	352.7	354.5	365.5	54.4
135	341.2	351.5	402.4	375.4	377.8	389.4	57.2
140	362.6	374.3	427.8	399.2	402.2	414.5	60.0
145	385.0	398.1	454.4	424.0	427.7	440.7	62.8
150	408.4	423.0	482.3	450.0	454.4	468.1	65.6

Forane® Refrigerant Cylinder Identification

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

Container Types

Size not to scale



Forane® Refrigerant Basic Property Data Chart

Properties	R-410A	R-427A	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	86.2	102.0	97.6	98.8	86.5	87.0	97.4	152.9
Normal Boiling Point (NBP) (°F)	-61.9	-44.8	-46.1	-14.9	-51.5	-52.8	-41.3	-47.9	-30.1	82.1
Latent Heat of Vaporization at NBP (BTU/lb)	116.7	102.0	107.4	92.8	86.0	84.3	100.5	97.6	94.6	73.7
Critical Temp (°F)	162.0	185.6	187.2	214.1	161.6	159.8	204.8	182.6	224.2	362.7
Critical Pressure (psia)	717.9	637.1	670.1	590.3	539.5	539.5	722.3	629.5	667.2	532.9
Density of Saturated Vapor @ NBP (lb/ft^3)	0.26	0.30	0.29	0.33	0.34	0.34	0.29	0.30	0.31	0.40
Density of Saturated Liquid at 77°F (lb/ft^3)	66.3	71.9	71.1	75.3	65.2	65.0	74.5	66.3	75.9	91.3
Specific Heat of Saturated Vapor at NBP (BTU/lb °R)	0.17	0.18	0.17	0.19	0.18	0.18	0.14	0.16	0.15	0.16
Specific Heat of Saturated Liquid at 77°F (BTU/lb °R)	0.44	0.38	0.38	0.34	0.39	0.39	0.30	0.37	0.30	0.23
Ozone Depletion Potential (ODP) (CFC-11 = 1.0)	0	0	0	0	0	0	0.055	0.026	0.05	0.02
ASHRAE Safety Group Classification	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	50
Global Warming Potential (GWP)	1,725	1,830	1,525	1,300	3,260	3,300	1,500	2,650	1,290	90

See MSDS for Health & Safety Considerations
Forane® is a registered trademark belonging to Arkema

ARKEMA
The world is our inspiration

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