FORANE®
REFRIGERANTS
BY ARKEMA

Forane® 32 Technical Guide

Global regulations, such as the Kigali amendment and F-Gas in Europe due to concerns about climate change, are causing refrigerant manufacturers to explore new ways to reduce the global warming effect of refrigerants.

Most refrigerants used today are hydrofluorocarbons (HFCs). Although there are many different HFC gases, the industry has been primarily using a combination of four: R-32, R-125, R-143a, and R-134a. For example, R-410A is 50% (R-32) and 50% R-125. Whereas, R-407C is 23% (R-32), 25% (R-125) and 52% (R-134a).

The blended components are carefully formulated to provide the desired performance attributes required for their end use. However, the individual HFC component refrigerants will vary in their global warming potential relative to CO_2 (GWP=1). For instance, R-143a has a GWP of 4,800. R-125 is 3,170. R-134a is 1,300. And, R-32 is 677.

The blended average of the components will determine the final GWP value of the refrigerant (ex: R-410A at 1,924). A GWP of 750 or less is a target many countries have adopted as a short-term goal for HVAC applications. With a GWP of 677, R-32 is a good fit for this target.

The Benefits of R-32 (Di-fluoromethane)

Unlike blended refrigerants, R-32 is a single component refrigerant: Difluoromethane. Therefore, it has no glide, unlike the R-400 series blends, and technicians can become familiar with its pressure temperature characteristics more easily. Reclaim is also easier to manage, as fractionation is not a concern. R-32 has a higher capacity than R-410 and a lower mass flow rate, which typically equates to lower charge amounts and relatively smaller heat exchangers. Compressor manufacturers have developed new compressor lines to maximize the benefits of R-32, while allowing equipment designers to incorporate minimal changes to existing R-410A system layouts. In addition, R-32 will allow future SEER requirements to be attained more easily, resulting in an overall more efficient system. R-32 has been used in Japan since 2013, and Europe is quickly adapting to this refrigerant, with more than half of new HVAC equipment in 2018, as they try to meet the F-Gas quota targets.

Table 1 – R-410A vs. R-32 comparison: Calculated using NIST Cycle D-HX, Version 1.0; conditions: 45°F evaporator and 110°F condenser temperature, 10°F superheat/subcooling.

45°F EVAP 110°F CONDENSER	R-410A	R-32	DIFFERENCE
DISCH, PSI	405	414	(+)2%
CAPACITY BTU/LB	128	144	(+)10%
COP COMPRESSOR COPC	3.146	3.303	(-)5%
MASS FLOW RATE LB/HOUR	742	476	(-)36%
DISCH TEMP °F	178	214	(+)20%

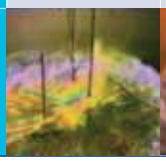
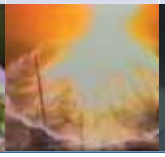
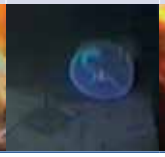
The advantages of R-32 over R-410A are clear. Better capacity and better efficiency, while using approximately 36% less mass flow rate. Using these gains, designers of equipment can reduce the amount of overall space needed for components as well as the overall cost of the equipment. R-32 has been used as a component refrigerant for many years and is widely understood among many OEMs. Individual equipment manufacturers will ultimately choose a refrigerant specific for their equipment, but R-32 remains a leading choice for many established global manufacturers.

Flammable vs Non-Flammable Refrigerants

ASHRAE Standard 34 Designation and Safety Classification of Refrigerants

In most air conditioning applications, the industry has traditionally used non-flammable refrigerants, such as R-22 or R-410A, which are designated class (A1) by ASHRAE as having "no flame propagation." Three additional refrigerant classes are A2L, A2 and A3. Three measures used to differentiate the classes are burning velocity (how fast it burns), the lowest flame limit or LFL (how much you need to burn), and heat of combustion (how much heat is generated when it burns.) R-32 is designated as A2L, which means it has a mild flammability. In general, molecules with a low amount of fluorine atoms have a low GWP, but they have a higher amount of hydrogen atoms, making them flammable under the right conditions. This does not mean that common A1 refrigerants do not burn. They can burn, however they do not propagate a flame during the test conditions. It is very important to remember that a refrigerant within a system is typically mixed with oil. Refrigerant mixed with oil has a different flammability profile. Caution should always be practiced when working on any air conditioning or refrigeration system.

Graph 1: ASHRAE safety class characteristics of selected refrigerants.

SAFETY GROUP CLASSIFICATION	A3	A2	A2L	B2L
SUBSTANCE	Propane	1,1 Difluoroethane	Difluoromethane	Ammonia
REFRIGERANT DESIGNATION	R 290	R 152a	R 32	R 717
CHEMICAL FORMULA	C_3H_8	$C_2H_4F_2$	CH_2F_2	NH_3
BURNING VELOCITY (M/S)	0.39	0.23	0.067	0.072
HEAT OF COMBUSTION (MJ/KG)	178	16	9	19
COMBUSTION IMAGE				

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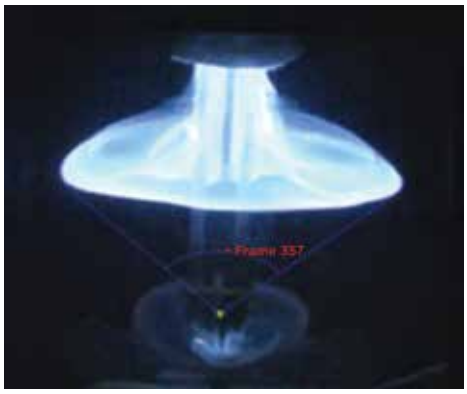
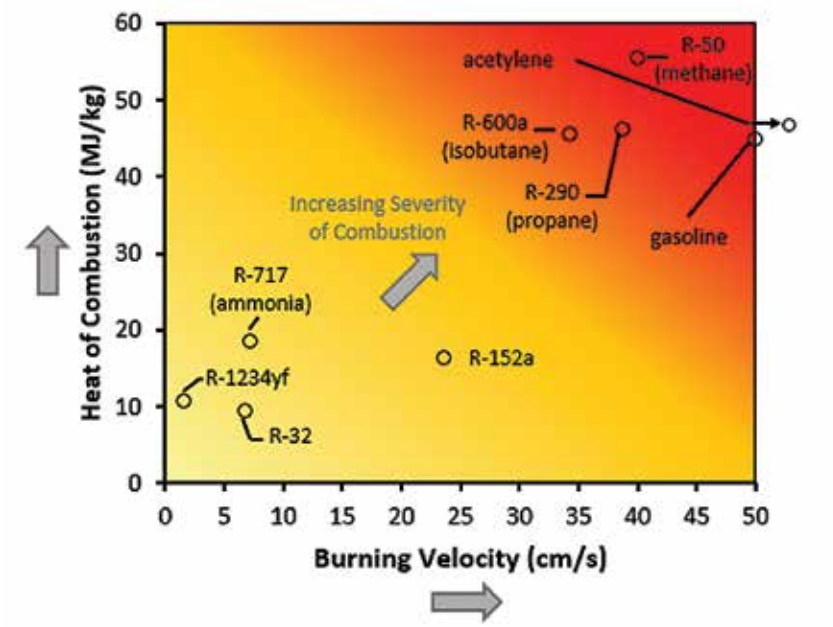
Graph 2: A2L vs A1 combustion



****ONLY WORK ON SYSTEMS IN WELL VENTILATED AREAS****

1. Read the OEM instructions specific to the system you are servicing.
2. Read the SDS for R-32. SDSs for all Forane® refrigerant products can be found online at forane.com.
3. Be mindful. If you are working in an enclosed areas, confirm you have adequate ventilation before starting service. Use approved fans and blowers when needed to inhibit the concentration of refrigerant exceeding the LFL.
4. Eliminate any sources of ignition and have a fire extinguisher available at all times.
5. Only use tools approved for A2L refrigerants. These include:
   - Leak/gas detectors
   - Recovery machines
   - Recovery cylinders
   - Fire extinguisher rated for A2L refrigerants nearby
6. If you are leak checking a system, confirm O_2 levels after ventilating the area to assure the leak is not increasing, exceeding the LFL level.
7. Use alternate leak checking methods: Pressurized with nitrogen and/or use dyes instead of using refrigerant.
8. Purge system with nitrogen before repairing the leak or before opening the system to atmosphere.

Graph 3: Severity of combustion



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Ignition Requirements for R-32

Unlike A3 refrigerants, such as propane, which can ignite in low concentrations when temperatures exceed 800°F, R-32 requires higher concentrations and higher temperatures. Igniting A2L refrigerants is complex and requires certain conditions to be met. Studies have shown that open flame sources, such as a burning candle and resistive electrical elements like a furnace igniter, have successfully ignited A2L refrigerants, where a cigarette, light switch, or a cordless drill have not. *(2018 Viability of Various Ignition Sources to Ignite A2L Refrigerant Leaks, Purdue Pub.)* Different environments can present different conditions needed for ignition or inhibit ignition. In order to increase awareness and knowledge in the industry, studies are continuing to test the combustibility of A2L refrigerants. Having a workable understanding of the difference in flammability will prove helpful when working on A2L systems. Moreover, when working with any flammable substance, caution must be exercised, and safety guidelines must be read and understood before any work can begin.

Working Safely with R-32

Following OEM guidelines is critical when servicing A2L refrigerant systems. Equipment manufacturers can install different safety mechanisms specific to their systems. A technician must be familiar with the system they are working on in order to avoid creating an unsafe condition.

R-32 Equipment Charge Limits

A2L refrigerants, such as R-32, have charge limitations specific to the system and the area where installed. Charge limits are defined by various codes and standards listed below. In addition, equipment might have charge limitations. Please follow the equipment manufacturers' guidance in the event they differ from any specific code.

Flammability class A2L refrigerants can have up to 6 x LFL without any restrictions. Also, taking into account the higher LFL values of the A2L class refrigerants, the maximum charge allowed without restrictions is remarkably higher for A2L class refrigerants.

SAFETY STANDARDS ALLOWING R-32 USAGE AS A2L REFRIGERANT

- ISO 5149
- IEC 60335-2 Series
- IEC 60335-2-24
- IEC 60335-2-40
- IEC 60335-2-89
- ASHRAE 15
- ASHRAE 15.2

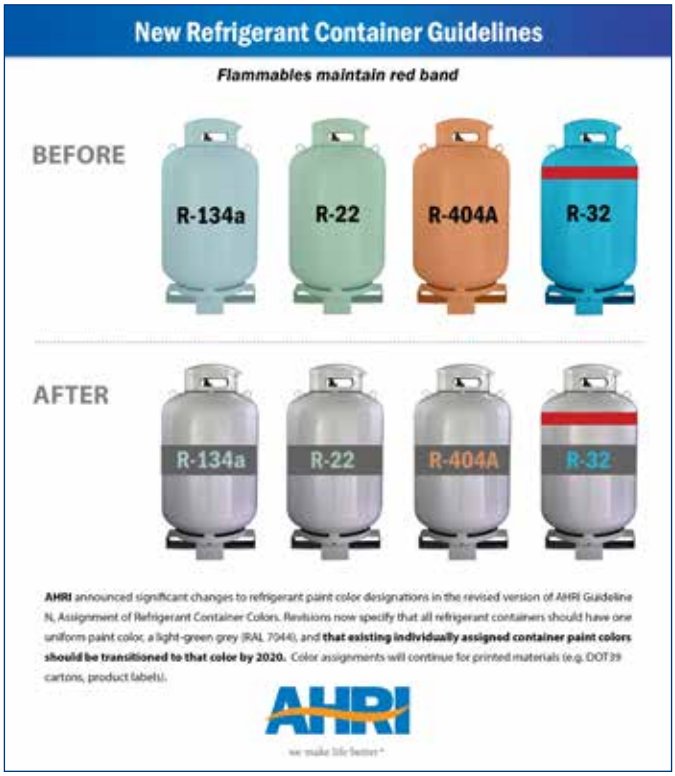
Retrofitting with R-32

R-32 refrigerant should only be used in systems designed for R-32. R-32 systems are designed for R-32 pressure; since R-32 has an A2L designation, certain safety features are built into the system by the manufacturer. Systems not designed for A2L refrigerants will lack these safety features. Life safety and the risk of death could occur if an A2L refrigerant is used in systems not designed for mildly flammable refrigerants.

Safe Handling and Storage of R-32 Cylinders

New guidelines and regulations have been placed on packaging, shipping, handling, and warehousing of flammable refrigerants. Building codes for each state are adapting regulations to ensure safe practices for storing and using A2L refrigerants. Currently, Arkema Inc. only fills R-32 in DOT-4BA cylinders, which are refillable. Below are some of the guidelines and regulations put in place specific to flammable refrigerants contained in DOT-39 and DOT-4BA/W cylinders.

1. All A2L refrigerant cylinders, according to Guideline N, should have a red stripe indicating it is a flammable gas.
2. All A2L refrigerant cylinders should be stored with the vapor space in contact with the pressure relief device, unless the cylinder is under 1.2L, according to 49 CFR 173.301.
3. All A2L refrigerant cylinders over 1.2L or 2.2lbs of R-32 are required to have a relief valve and not a rupture disc, according to DOT regulations.
4. National Fire Safety Storage Requirements:
   - Permit from local fire code official
   - Hazardous Materials Management Plan
   - Hazardous Material Inventory Statement
   - Requires visible hazard identification signs (NFPA 704 sign) around storage area
   - No smoking signs around the storage area
   - No open flames or high temperature devices (could include warehouse heaters) in storage area
   - Empty tanks/cylinders with heels to be stored and handled as a filled cylinder until placed under a full vacuum
   - SDS must be available on site
   - Upright storage to keep the vapor space in contact with the relief valve



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PPC/SDC/06-2020

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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).

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