ASHRAE
American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASHRAE™ Spain Chapter

IBÉRICA ATMOsphere

Business Case for Natural Refrigerants

24/10/17 - Madrid

José Romanillos Velasco
Responsable del Comité de Refrigeración
del AHSRAE Spain Chapter

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ASHRAE – Quienes somos

- **ASHRAE** es una asociación técnica global, sin ánimo de lucro, que tiene como objetivo promover el bienestar humano, proporcionando recursos tecnológicos esenciales para el proyecto, construcción y explotación de edificios, eficientes y confortables y el de sus instalaciones, incluidas las específicas de refrigeración. Fundada en EE.UU. en 1894 y formada, actualmente, por más de 56.000 socios repartidos en más de 130 países.

- **ASHRAE Spain Chapter** es el capítulo oficial de ASHRAE en España fundado en el año 2007 y perteneciente a la Región XIV Europa.

- Promovemos y realizamos, desde un punto de vista técnico, **Jornadas**, **Coloquios, Cursos**, etc. sobre temas de interés relacionados con el sector HVAC&R.

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Refrigerantes, Retos y Realidades

"ASHRAE Y LOS REFRIGERANTES NATURALES"

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Shaping Tomorrow's
Built Environment Today

ASHRAE y los Refrigerantes

ASHRAE considera a Los Refrigerantes un tema prioritario en su campo de investigación y sus normas y publicaciones sirven de guía a los profesionales de este sector.

El **Comité Técnico TC-3.1** se creó para coordinar todas las actividades y relacionadas con este tema:

- Recopilación de datos y documentación proporcionada por los miembros de ASHRAE, otras asociaciones y la industria en general.
- Colaboración con todas las entidades interesadas, a nivel mundial: AHRI, IIR/IIFF, UNEP, etc.
- Desarrollo y creación de normas, estándares y guías.

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ASHRAE y los Refrigerantes

Los **Handbooks** de ASHRAE incluyen varios capítulos relacionados con los Refrigerantes:

- **Fundamentals** (Capítulo 29 y 30): presentan datos comprobados y consensuados sobre los refrigerantes propuestos por la comunidad mundial y revisados y reeditados cada 4 años.

- **Refrigeration**: incluye 2 capítulos sobre Sistemas utilizando Amoniaco y sobre Sistemas utilizando CO2.

ASHRAE y los Refrigerantes

CHAPTER 29

REFRIGERANTS

REFRIGERANTS are the working fluids in refrigeration, air-conditioning, and heat-pumping systems. They absorb heat from one area, such as an air-conditioned space, and reject it into another, such as outdoors, usually through evaporation and condensation, respectively. These phase changes occur both in absorption and mechanical vapor compression systems, but not in systems operating on a gas cycle using a fluid such as air. (See Chapter 2 for more information on refrigeration cycles.) The design of the refrigeration equipment depends strongly on the selected refrigerant's properties. Tables 1 and 2 list standard refrigerant designations, some properties, and safety classifications from ASHRAE *Standard* 34.

Refrigerant selection involves compromises between conflicting desirable thermophysical properties. A refrigerant must satisfy many requirements, some of which do not directly relate to its ability to transfer heat. Chemical stability under conditions of use is an essential characteristic. Safety codes may require a nonflammable refrigerant of low toxicity for some applications. Environmental consequences of refrigerant leaks must also be considered. Cost, availability, efficiency, compatibility with compressor lubricants and equipment materials, and local and national regulations are other concerns.

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Chapter 30
Thermophysical Properties of Refrigerants

THIS chapter presents data for thermodynamic and transport properties of refrigerants, arranged for the occasional user. The refrigerants have a thermodynamic property chart on pressure-enthalpy coordinates with an abbreviated set of tabular data for saturated liquid and vapor on the facing page. In addition, tabular data in the superheated vapor region are given for R-134a to assist students working on compression cycle examples.

For each cryogenic fluid, a second table of properties is provided for vapor at a pressure of one standard atmosphere; these data are needed when such gases are used in heat transfer or purge gas applications. For zeotropic blends, including R-729 (air), tables are incremented in pressure, with properties given for liquid on the bubble line and vapor on the dew line. This arrangement is used because pressure is more commonly measured in the field while servicing equipment; it also highlights the difference between bubble and dew-point temperatures (the "temperature glide" experienced with blends).

Most CFC refrigerants have been deleted. Tables for R-11, R-13, R-113, R-114, R-141b, R-142b, R-500, R-502, R-503, and R-720 (neon) may be found in the 1997 *ASHRAE Handbook—Fundamentals*. R-12 has been retained to assist in making comparisons. Hydrogen and parahydrogen (R-702 and R-702p) may be found in the 2009 *ASHRAE Handbook–Fundamentals*. A new table and diagram for R-1233zd(E) have been added, and the data for R-245fa and R-1234ze(E) have been revised. Viscosity data for R-1234yf have been revised. The formulations conform to international standards, where applicable: thermodynamic properties of R-12, R-22, R-32, R-123, R-125, R-134a, R-143a, R-152a, R-717 (ammonia), and R-744 (carbon dioxide) and refrigerant blends R-404A, R-407C, R-410A, and R-507 conform to ISO *Standard* 17584, Refrigerant Properties.

Reference states used for most refrigerants correspond to the international convention of 200 kJ/kg for enthalpy and 1 kJ/(kg·K) for entropy, both for saturated liquid at 0°C. Exceptions are water and fluids with very low critical temperatures (e.g., ethylene, cryogens).

These data are intended to help engineers make preliminary comparisons among unfamiliar fluids. For greater detail and a wider range of data, see the sources in the References.

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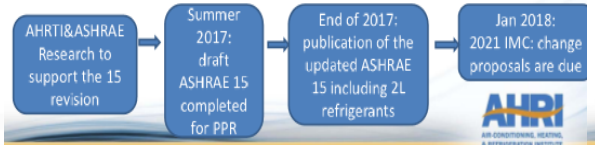
ASHRAE promueve **Proyectos de Investigación y Desarrollo** y colabora en la lucha contra el Cambio Climático provocado por los Refrigerantes.

Identified and developed high priority projects

- AHRTI Conducting:
  - AHRTI-9007: Benchmarking Risk by Real Life Leaks and Ignitions Testing
  - AHRTI-9008: Investigation of Hot surface Ignition Temperature (HSIT) for A2L Refrigerants
  - AHRTI-9009: Leak Detection of A2L Refrigerants in HVACR Equipment
- ASHRAE conducting:
  - ASHRAE-1806: Flammable Refrigerants Post-Ignition Simulation and Risk Assessment Update
  - ASHRAE-1807:Guidelines for Flammable Refrigerant Handling, Transporting, Storing and Equipment Servicing, Installation and Dismantling
  - ASHRAE-1808: Servicing and Installing Equipment using Flammable Refrigerants: Assessment of Field-made Mechanical Joints
- DOE funding:
  - ORNL: Investigate the proper basis for setting charge limits of A2L, A2, and A3 for various types of products
  - NIST: Modeling tools for low-GWP refrigerant blends flammability

AHRTI Flammable Refrigerant Research

- A collaborated research program is supported by
  - AHRI ($1 million)
  - ASHRAE ($1.3 million)
  - California Air Resource Board ($0.3 million)
  - US Department of Energy ($3 million)
- The objective is to
  - produce publicly available technical results to support code and standard activities related to the use of flammable refrigerants.
    - Facilitate a timely completion of relevant standard revision.



AHRTI Project 9007

- Task 1. testing under a controlled environment
  - A model room will be built with a standard ISO 9705 size of 3.6m x 2.4m x 2.4m
  - Various leak rates, heights, oil concentrations, room conditions will be used.
- Task 2 testing under a whole room scale
  - Residential AC: split AC in hallway application
  - Commercial AC: rooftop unit and PTAC
  - Refrigeration: self-contained reach-in and walk-in coolers
- Current testing is focused on A2Ls. Testing for A3s is scheduled in mid-2017.

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Refrigerants Track Program
Chicago AHR Expo

Seminar #1 –Next Generation of Lower or Low GWP Next Generation HVAC&R Equipment

Session Chair: Chris Seeton

Topic 1: Next Generation Low GWP Refrigerants for Chillers
Presenter: Steve Kujak - Trane

Topic 2: Low GWP Systems for Commercial Refrigeration.
Presenter: KC Kolstad - Target

Topic 3: Key Learnings from Conversions of Commercial Refrigeration Systems to Low GWP Alternatives
Presenter: Chuck Allgood, Ph.D., Andrew Pansulla, Member, Chemours, Wilmington, DE

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Seminar #2 - Some Low GWP Next Generation Refrigerant will be Flammable: What does it mean to be Flammable?:

Session Chair: Steve Eckels

Topic 1: Flammable Refrigerant Basics
Presenter: Steve Kujak

Topic 2: Developing Guidelines for Flammable Refrigerant Use
Presenter: Matt Guernsey, Navigant

Topic 3: AHRI Flammable Refrigerant Research
Presenter: Xudong Wang, AHRI

Topic 4: Investigation of Flammable Refrigerant Charge Safety using Numerical Release Studies
Presenter: Omar Abdelaziz, ORNL

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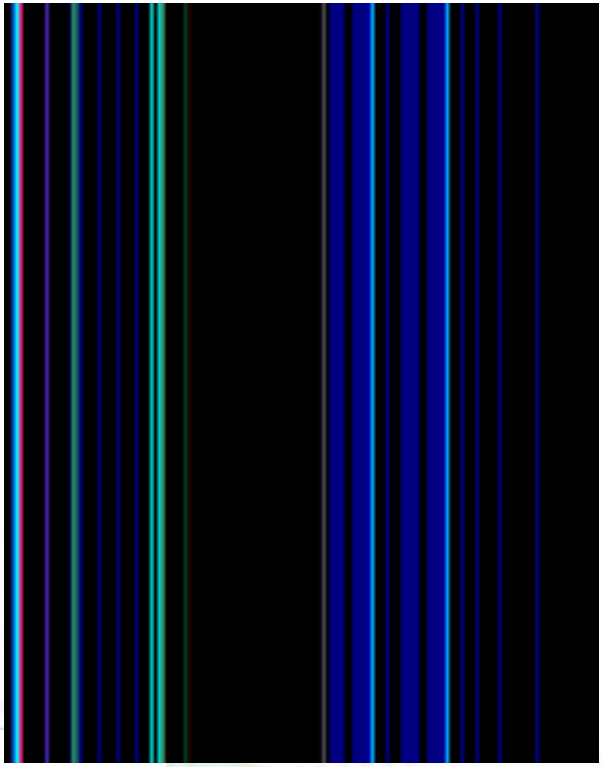
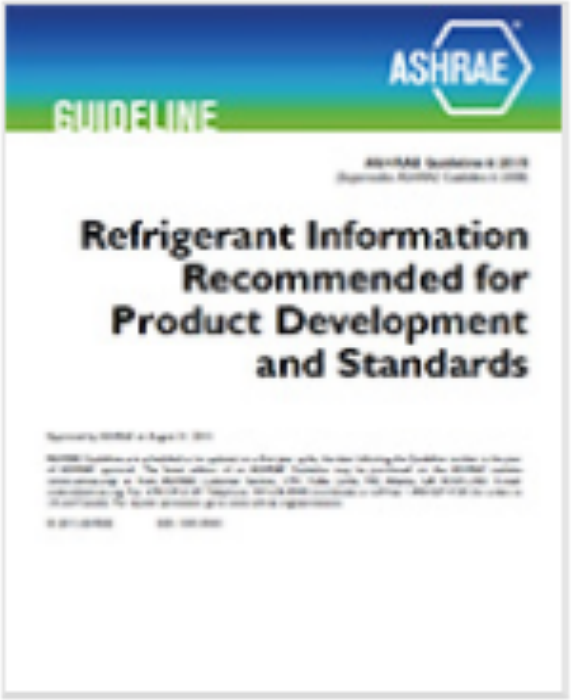
ASHRAE desarrolla **Estándares y Guías para Refrigeración**, incluyendo la descripción detallada de los refrigerantes aceptados y su nomenclatura.





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Los Socios de ASHRAE comparten su experiencia y opinión a través de:
Conferencias, Publicaciones Monográficas y el ASHRAE Journal (publicado mensualmente).

COLUMN REFRIGERATION APPLICATIONS

Andy Pearson

Are You Pro Propane?

BY ANDY PEARSON, PH.D., C.ENG., MEMBER ASHRAE

We have thought about various refrigerant choices, and now we turn to the hydrocarbon family, the most common of which, as a refrigerant, is propane. It has often been said that choosing a refrigerant is an exercise in compromise because there are so many competing factors to consider, and they are sometimes contradictory. Hence, there is no perfect refrigerant.

Propane scores very highly in all criteria bar one. It has a suitable pressure–temperature relationship (very similar to R-22); it has a relatively high latent heat but a low index of compression; it is cheap and readily available, and it is compatible with mineral oils—not a surprise as it is a kind of mineral oil itself! Environmentally, it also performs well, having no effect on the ozone layer and a low global warming potential—even lower than the HFOs.

Hydrocarbons are very widely used in the domestic refrigerator market, particularly in Europe where more than 85% of all refrigerators use one or other of the family. This was not always the case, but in the early 1990s when the Berlin Wall had recently fallen and the two halves of Germany were figuring out how to live together again after a 45-year separation, a small, struggling East German refrigerator manufacturer hooked up with Greenpeace to develop a "climate-friendly" refrigerator.

Their timing was excellent; the concept of CFC-free refrigeration was quickly adopted by the German government and translated soon after into a European regulation, and all of the major European manufacturers quickly followed suit. Early systems used a mixture of propane and isobutane to match the performance of R-12, but as the technology matured equipment was developed to use isobutane.

Andy Pearson, Ph.D., C.Eng., is group engineering director at Star Refrigeration in Glasgow, U.K.

Among the spin-off benefits of this change, it was noted that units are significantly quieter on starting than traditional R-12 and R-134a systems and the weight of refrigerant required is much less. The reduced noise is due to the absorption of refrigerant in the oil when the compressor is not running, enabling a gentle start against lower pressure. The reduced charge is due to the low liquid density—the volume of liquid required is about the same but it weighs less. They are also very efficient, helping manufacturers meet the stringent energy labeling requirements.

The labeling laws introduced in Europe in the 1990s had a scale from G (least efficient) to A (most efficient) but stepwise improvements in the requirements over the years have meant new, more efficient bands have been added; A+, then A++ and then (you've guessed it), A+++. Since mid-2012 all models must be at least A+ efficiency; it's a shame they didn't start further back in the alphabet.

The transition from CFC to HC in the European refrigerator market was quick and relatively simple because all the hard stuff took place at the factory. Production lines had to be retooled and in some cases completely reengineered to cope with the flammability of the refrigerant now being used, but the technology of the refrigerator did not change dramatically, and in the eye of the householder there was no change at all. The fridge is installed and used in exactly the same way as it always was and there has been no discernible change in product safety.

This highlights a key difficulty when introducing hydrocarbons to an existing service organization. If a tech is being introduced to CO_2 as refrigerant, he is naturally wary—the pressures are higher and the gear looks a bit different. However, his regular habits in terms of service practice will stand him in good stead and not cause problems. On the contrary, a hydrocarbon system looks and feels much like a normal HFC system but regular habits, such as sweating off an expansion valve, can cause major problems unless great care is taken to ensure the refrigerant is well out of the way. Propane has been adopted by a major UK supermarket as its preferred solution for its display cases—for them the various benefits of cost, efficiency and reliability outweigh the challenges they have had to overcome to take this road to environment-friendly refrigeration. ■

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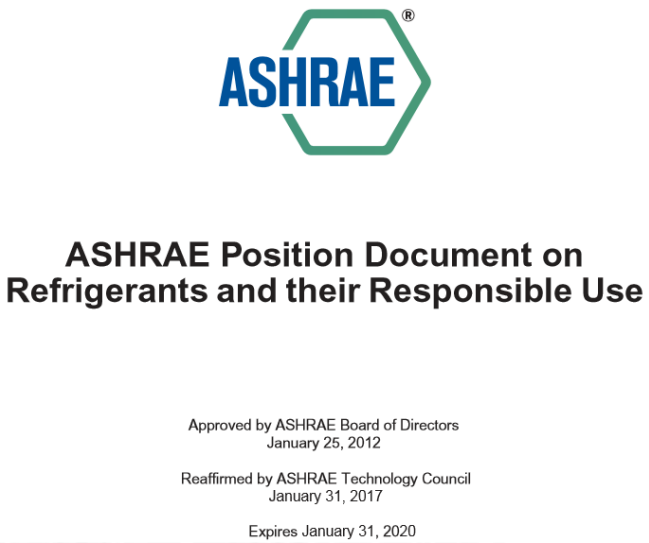
ASHRAE define su **posición** sobre:

- El Amoniaco como Refrigerante.
- El Uso Responsable de los Refrigerantes.

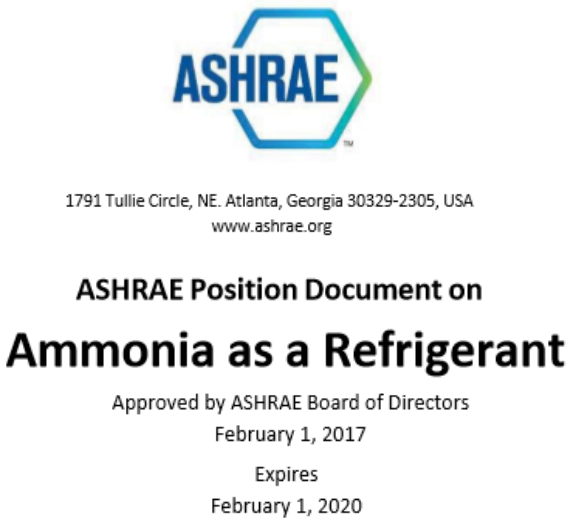


ASHRAE Position Document on
Refrigerants and their Responsible Use

Approved by ASHRAE Board of Directors
January 25, 2012

Reaffirmed by ASHRAE Technology Council
January 31, 2017

Expires January 31, 2020



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ASHRAE Position Document on

Ammonia as a Refrigerant

Approved by ASHRAE Board of Directors
February 1, 2017

Expires
February 1, 2020

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El **Objetivo** de ASHRAE es:

- Colaborar en el desarrollo de soluciones viables que ayuden a paliar el impacto medioambiental
- Mediante la utilización de nuevas tecnologías y la experiencia acumulada

"Precisamos la Colaboración de toda la Comunidad, a todos los niveles, personal, institucional y educativo para la Utilización Responsable de los Refrigerantes Naturales".

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ASHRAE E HISPANOAMÉRICA

La colaboración entre el Spain Chaper y los Chapers de Hispanoamérica se basa, principalmente en:

- Las traducciones en castellano de los estándares y guías más demandadas por el sector y que supone un beneficio para toda la Comunidad ASHRAE hispano parlante.
- El intercambio de Conferenciantes Distinguidos – ASHRAE Distinguished Lectures con el fin de intercambiar conocimientos y compartir experiencias entre los distintos países.
- En el caso de los Refrigerantes Naturales y CO2, tuvimos el placer de contar con D. Roberto Aguiló, Fellow de ASHRAE y Presidente de la Asociación Argentina del Frío, que participó en una de las Jornadas organizadas en Madrid.