# WORLD GUIDE TO LOW-CHARGE AMMONIA

AMMONIA21

# World Guide to
# Low-Charge Ammonia

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# WELCOME MESSAGE

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The use of low-charge ammonia has emerged as one of the key trends in the industrial refrigeration industry in the last few years. Moreover, the technological developments have opened up opportunities for ammonia beyond its traditional market.

With this report we aim to identify the underlying trends for low-charge ammonia technology in different parts of the world. The report is released in three parts, with this first part highlighting some of the key characteristics of ammonia as a refrigerant and outlining a brief history of its use.

The term "low-charge ammonia" is not well defined yet although there are some efforts to bring more clarity into this. A clear definition and distinction from traditional ammonia systems is essential to strengthen the position of low-charge systems especially in light of growing legislative pressure on fluorinated refrigerants. Low-charge ammonia has the potential to not only replace traditional ammonia systems but also HFCs in applications where it was not possible to use ammonia before.

We have asked key experts in the field to share their views on this important topic, which is presented in this report.

The second part of the Guide will focus on the variety of applications where low-charge ammonia technology has been used with concrete examples from around the world. In addition, it will outline standards and legislation that are key drivers for the reduction of ammonia charge in systems, but also for the use of HFC-free technology as such.

The third and final part of the report will zoom in on the key trends for low-charge ammonia technology, its advantages, drivers and major challenges in today's market. It will compare developments in different world regions, with focus on North America, Europe, Japan and Australia. Moreover, gathering data through analysis of survey, interviews with key experts it will outline the future opportunities and perspectives for low-charge $NH_3$ systems.

# ABOUT THIS GUIDE

# Introduction

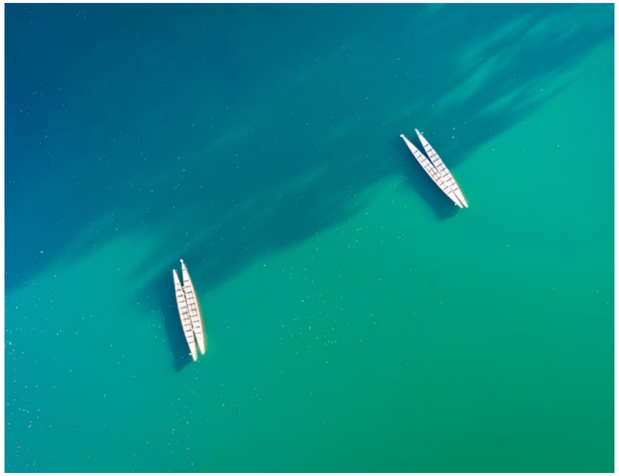
The use of ammonia as a refrigerant goes back 150 years - it is the only refrigerant that has been uninterruptedly used throughout all these years. This is especially thanks to its excellent thermodynamic properties ensuring good energy efficiency performance as well as ammonia's abundance and ease of use.

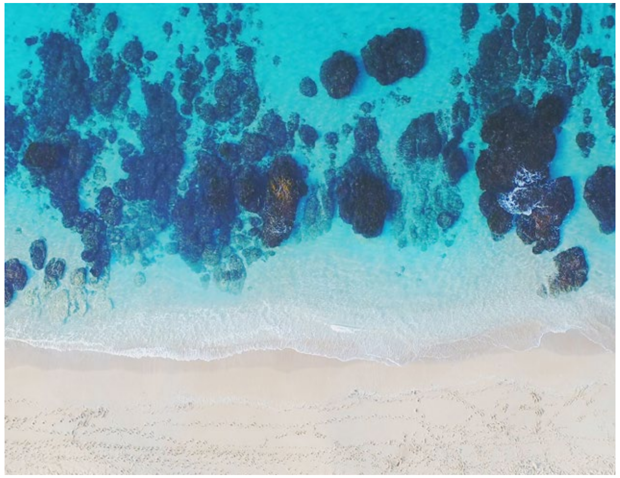
Ammonia's major drawback - toxicity - has been addressed through design to prevent any leaks. Nevertheless as a result of several major incidents the industry has focused the development efforts on reducing ammonia charge in systems as the most effective measure to improve safety of ammonia-based technologies. In the recent years the development of low-charge ammonia systems has taken a centre stage, disturbing the traditional ammonia refrigeration industry in a positive way.

Today a growing number of manufacturers offer systems that use as little as 20g/kW ammonia charge without compromising the system efficiency, but actually further improving it.

This report zooms in on the recent market and technology developments, identifies key trends, challenges and future progress across different geographical regions.

# A SHORT OVERVIEW





**CHAPTER 1:**
**Ammonia as a Refrigerant**

This chapter provides a short introduction into ammonia as a refrigerant. It takes a look at the characteristics of this molecule, its behaviour as a refrigerant, its role and history in the refrigeration industry.

**READ ON PAGE 10**

**CHAPTER 2:**
**What is 'low-charge ammonia'?**

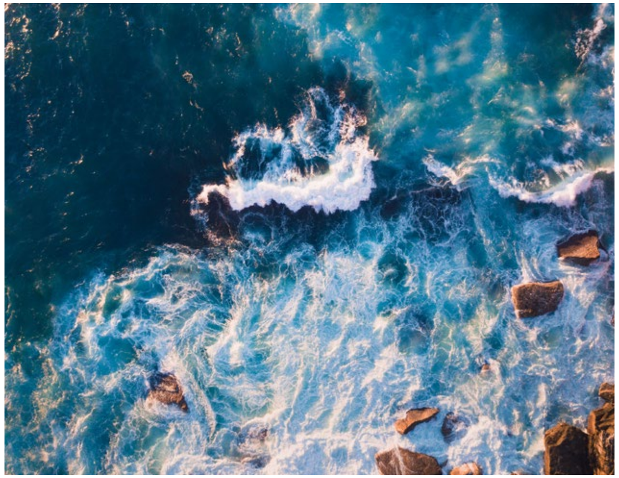
This chapter seeks to identify what is meant by 'low-charge ammonia', using industry feedback and know-how, and looks at issues of defining a technology that is relatively new in the industrial refrigeration sector. It also provides overview of key types of the technology.

**READ ON PAGE 18**

**CHAPTER 3:**
**Applications of low-charge ammonia**

This chapter delves into the applications for low-charge ammonia technology from its beginnings in traditional ammonia refrigeration, such as in cold storage, food processing and logistic facilities, to its forays into HVAC and the pharmaceutical industry.

**COMING SOON**



**CHAPTER 4:**
**Regulations and standards**

The use of ammonia as a refrigerant is regulated in most of the world due to its risk to human health. This chapter looks at how regulations and standards on high charges of ammonia could offer opportunities for lower-charged technology.

**COMING SOON**

**CHAPTER 5:**
**Low-charge ammonia today**

In this chapter, the current market for low-charge ammonia systems and applications is looked at in detail. It identifies the key trends and challenges in different world regions.

**COMING SOON**

**CHAPTER 6:**
**Future of low-charge ammonia**

Based on interviews, research, surveys and the market today this chapter anticipates the market potential for low-charge technology in the world, its future uses and the next steps that will need to be taken to make this technology successful.

**COMING SOON**

# AMMONIA AS A REFRIGERANT

# An overview

Together with carbon dioxide ($CO_2$, R744) and hydrocarbons such as propane (R290), isobutane (R600a) and propylene (R1270), ammonia ($NH_3$, R717) is one of the most commonly used natural refrigerants.

As a general classification, "natural refrigerants" are substances that exist naturally in the environment, whilst "non-natural refrigerants" or "synthetic refrigerants" are man-made chemicals, not naturally occurring in the environment.

Although the term "natural" is sometimes disputed, as these refrigerants must undergo industrial purification and manufacturing processes to be used, these substances do not contribute to ozone depletion, global warming and ecological safety, unlike man-made chemicals.

Important international agreements such as the Kigali Amendment to the Montreal Protocol (signed in 2016 and entered into force in 2019) and the European Union's F-Gas Regulation (entered into force in 2015) are progressively phasing down the use of hydrofluorocarbons (HFCs), paving the way for a wider uptake of natural refrigerants, including ammonia, for heating, air conditioning and refrigeration applications.

# AMMONIA AS A REFRIGERANT: KEY CHARACTERISTICS

Ammonia is a colourless gas at atmospheric pressure. It is part of many natural processes, so it occurs in abundance worldwide. 5% out of more than 2 billion metric tons of ammonia in the world is man-made, and less than 2% is used for refrigeration.

The refrigerant itself consists of one atom of nitrogen and three hydrogen atoms; hence the chemical formula $NH_3$.

Ammonia's refrigeration code is R717. Besides water (R718) and air (R729), ammonia is the only refrigerant with zero ozone depleting (ODP) and global warming potential (GWP).

Being lighter than air, and becoming a vapour upon release, any ammonia leakage first tends to form a cloud that stays near the ground for a short time and then gets dispersed into the sky.

Ammonia is classified as a B2L refrigerant due to its low flammability threshold (2L) and higher toxicity (B) with a pungent odour.

Flammability is not a major concern when dealing with ammonia as a refrigerant. $NH_3$ ignites at temperatures hardly encountered in conventional HVAC&R applications (above 650°C) and it needs a support flame to burn. In any case, due to its slight flammability, ammonia has to be kept away from ignition sources such as hot surfaces or sparks, for example from electric switches. In facilities that use ammonia as a refrigerant it is recommended to install ventilation and special detectors in all areas where $NH_3$ could leak.

The use of ammonia has rather been limited by its toxicity to use in large industrial or food preservation systems (in places not directly accessible by the general public) or low-charge systems. In these contexts, ammonia is usually the primary refrigerant in secondary systems, while increasingly being used in packaged systems.

Even though small amounts of ammonia are also found in cigarette smoke and even in the air we breathe, inhalation of high quantities of $NH_3$ can lead to serious health complications.

A number of technological solutions are implemented in the design of an ammonia system to prevent any leakage and minimize risks. These include for example the use of welded joints, hermetic or semi-hermetic compressors, use of shell and plate heat exchangers as condensers and chillers, installations of the system on a rooftop, amongst others. In addition, to ensure safe maintenance of ammonia systems technical personnel need to have adequate training and follow basic safety procedures. Other safety measures include frequent checks of the system, protecting the system from external damage, as well as a well-adjusted alarm system. If all the right measures are taken, the refrigerant is safe to use.

| | |
|---|---|
| Refrigerant number | R717 |
| Chemical formula | NH3 |
| Global warming potential (GWP) over 100 years | 0 |
| Ozone depleting potential (ODP) | 0 |
| Normal boiling point (°C) | -33,3 |
| Critical temperature (°C) | 133 |
| Ignition temperature (°C) | 651 |
| Critical pressure (kPA) | 11,41 |
| Odour treshold (ppm) | 5-50 |
| Safety group | B2L |
| Molecular weight (g/mol) | 17,031 |

*Table 1: Ammonia's main characteristics. Source: IIAR (2018)*

Investigations of incidents involving ammonia-based systems have indeed consistently shown a pattern of human errors, with poor maintenance and ignorance of basic safety protocols as the main causes of incidents.

To address the higher toxicity of ammonia considerable efforts have been made to develop ammonia systems with reduced refrigerant charge as the most effective way to improve safety while increasing system efficiency.

## ECONOMICAL SOLUTION

The abundance of $NH_3$ translates into low purchasing price. Due to its excellent thermodynamic properties ammonia also has relatively low running costs. It requires less energy than most competitors, because the refrigerant has a great ability to absorb a large amount of heat when it evaporates. This makes ammonia an economical choice as a refrigerant.

Compared with other commonly used refrigerants for various applications, ammonia presents a higher thermodynamic efficiency too, as measured in Coefficient of Performance (COP) in *Table 2*.

| Refrigerant | For positive temperature cold rooms (+40°C/+2°C) | For secondary fluids operation (+40°C/-5°C) | For low temperature cold rooms (+40°C/-25°C) | Blast freezers/ individual quick freezing (+40°C/-40°C) |
|---|---|---|---|---|
| **Ammonia** | **6,20** | **4,965** | **2,91** | **2,06** |
| HFC-410A | 5,43 | 4,80 | 2,50 | 1,75 |
| HFC-134a | 5,88 | 4,67 | 2,70 | 1,88 |
| HFC-404A | 5,18 | 4,07 | 2,26 | 1,52 |
| HCFC-22 | 5,93 | 4,74 | 2,79 | 1,98 |

*Table 2: Comparison of COP* of ammonia with other refrigerants. Source: Paranjpey (2018)*

* *Coefficient of performance (COP) is a number determining a ratio of useful heating or cooling provided to work required. Higher COP means lower operating costs.*

# SHORT HISTORY OF AMMONIA AS A REFRIGERANT

Even though nowadays the market is invaded by dozens of different types of man-made chemical refrigerants (HFCs, HFOs), natural refrigerants were the only substances commonly used until 1920s.

More specifically, the use of ammonia as a refrigerant goes back in history by approximately 150 years, making $NH_3$ the only refrigerant in use since day one.

As early as 1755, Dr William Cullen's experiments at Glasgow University identified aqua-ammonia solution as the most effective fluid for evaporative cooling and paved the way for the development of mechanical refrigeration.  Cullen's phrase was that the ammonia solution he used was the "most efficacious at sinking the thermometer".

Although such pioneering studies on refrigeration and cooling were completed in the 18th / early 19th centuries, the development of $NH_3$ as an industrial gas for refrigeration purposes took off only around the mid 19th century.

American David Boyle made the first commercial development of an ammonia compressor for refrigeration in 1872. German Carl von Linde in the early 1870s developed a similar machine but boasting more advanced mechanical design features.  In 1876, Linde turned his attention from dimethyl ether to ammonia and developed a new style of a compressor and cooling system. Linde saw ammonia as being a safer alternative to dimethyl ether.

Many compressor manufacturers followed the lead of Boyle and Linde in the 1880s, so that by the end of that decade ammonia was established as the most common refrigerant for industrial refrigeration on land.

In the United States, Charles A. Zilker contributed to advancing the development of the Carré's and Boyle's machines in the 1880s. Further improvements such as high-speed engine and electric motor drivers for ammonia compressors followed.

Given the growth of agricultural production in non-European countries and the development of global trade routes, the diffusion of ammonia went on and in the 1920s $NH_3$ had become the main option in industrial applications and on board ships.

As of 1930s chlorofluorocarbon (CFC) synthetic fluids, non-toxic and non-flammable, were introduced as «safe» replacements to methyl chloride and sulphur dioxide in domestic systems. CFCs were not in competition with $NH_3$ at that time. It was only with the development of hydrochlorofluorocarbons (HCFCs) in 1950s that ammonia started to be squeezed out of the market by HCFC-22 and later by CFC-502 The first low pressure receiver (LPR) systems were developed with these refrigerants in 1970s. Nevertheless $NH_3$ was never completely put out the market.

The discovery of the ozone depletion process induced by CFCs in the 1970s led to the Montreal Protocol (1987), an international agreement phasing out CFCs. The detrimental effect on global warming of their chemical "descendants", hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), became an issue soon after. International agreements to limit the use of such substances followed, including the Kigali Amendment to the Montreal Protocol (2016).

According to the international agreements the use of high GWP HFCs will gradually phase down by more than 80% over the next 30 years. This provides an impetus and renewed interest in ammonia and other low-GWP alternatives.

It is without doubt that in recent years attention was paid to reducing ammonia charges. It is especially thanks to the introduction of advanced control systems and electronic expansion valves that it was possible to reduce system charge as well as to use direct expansion (DX) technology to reduce system overfeeds to 1:1. In addition, the development of the low pressure receiver contributed greatly to reducing system charge to so called «critically charged». The first concrete prototypes of systems with low and ultra-low charges were realized in the late 1990s, typically as results of niche-level experiments performed at universities and R&D laboratories. In 2008, Mayekawa made the first installation of it's $NH_3/CO_2$ refrigeration system in Japan, marking the first commercially available ulta-low-charge ammonia system.

Today, the reduction of ammonia charge by 75% compared to traditional systems can be realized without compromising the system efficiency. Thanks to this, the use of ammonia is expanding to applications that were earlier considered too risky due to the toxicity issue (e.g. supermarkets, air conditioning). The increased focus on safety and development of low-charge ammonia systems is opening new market opportunities, and gaining growing support from end users and governments.

# THE POWER OF AMMONIA

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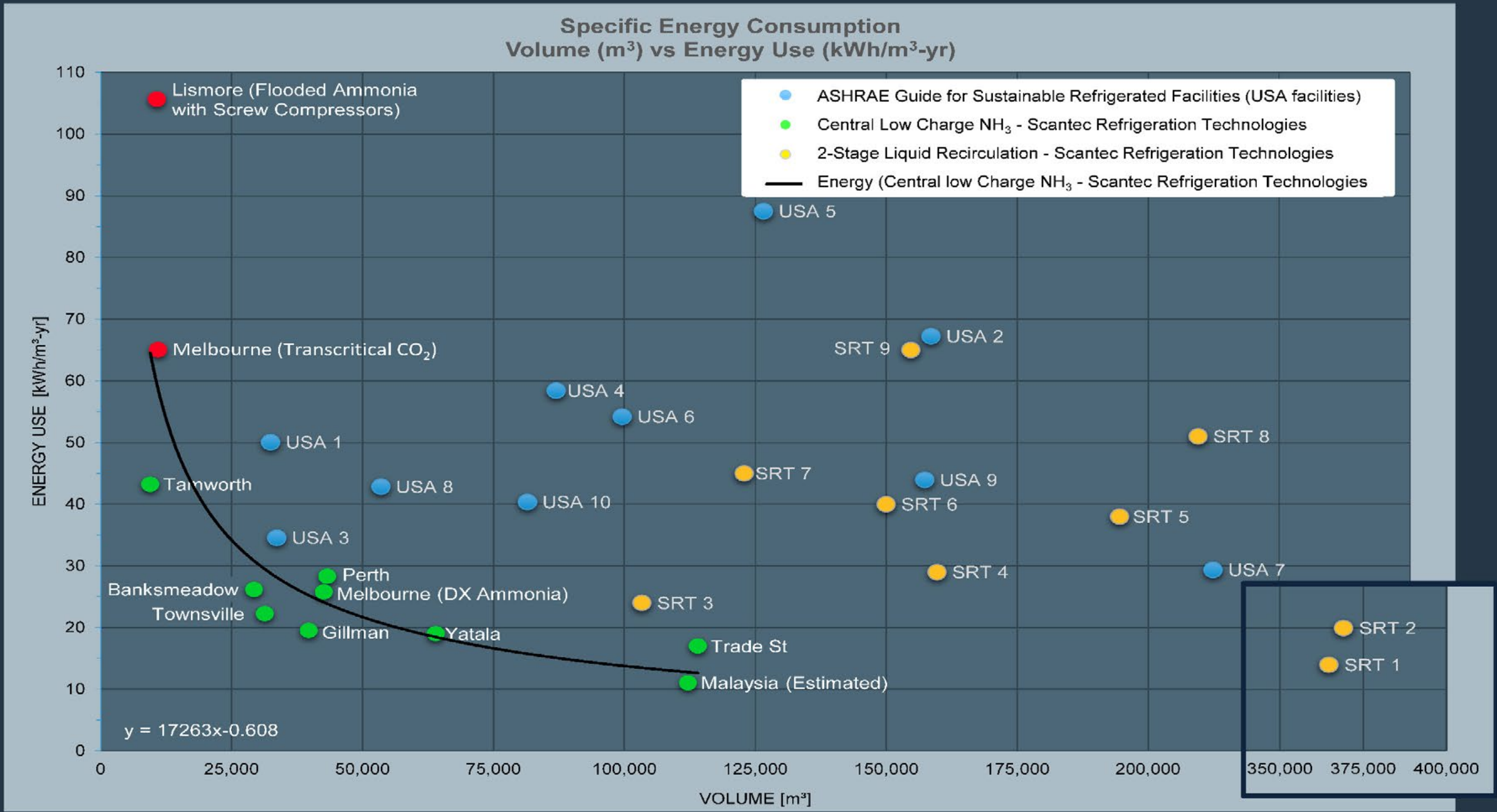


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References:

1. Douglas T.Reindl, Todd B.Jekel, Industrial Refrigeration Consortium, March 2010. Industrial Refrigeration Energy Efficiency Guidebook, University of Wisconsin- Madison
2. ASHRAE 2018, Guide for Sustainable Refrigerated Facilities and Refrigeration Systems

# TIMELINE OF LOW-CHARGE AMMONIA DEVELOPMENT

**1755**
Aqua-ammonia solution identified as the most effective fluid for evaporative cooling (W. Cullen)

**1872**
First commercial development of an ammonia compressor for refrigeration (D. Boyle)

**1890s**
Ammonia is the dominant refrigerant for land-based industrial refrigeration in Europe and North America

**1950s**
Ammonia starts to get partially replaced by HCFC-22

**1970s**
Ammonia further replaced by CFC-502

**1974**
First installation of low pressure receiver (LPR) system

**Mid-1990s**
Low-charge ammonia chillers in public buildings in Germany and the UK

**1987**
Montreal Protocol to phase out CFCs

**1989**
First installation of ammonia low-pressure receiver system

**1990s**
First prototypes with low- and ultra-low ammonia charge

Industry's first use of plate heat exchangers as low-charge condensers for ammonia plant

**2000s**
First ammonia units with microchannel condensers with low charge

**2008**
First commercially available ultra-low-charge ammonia system

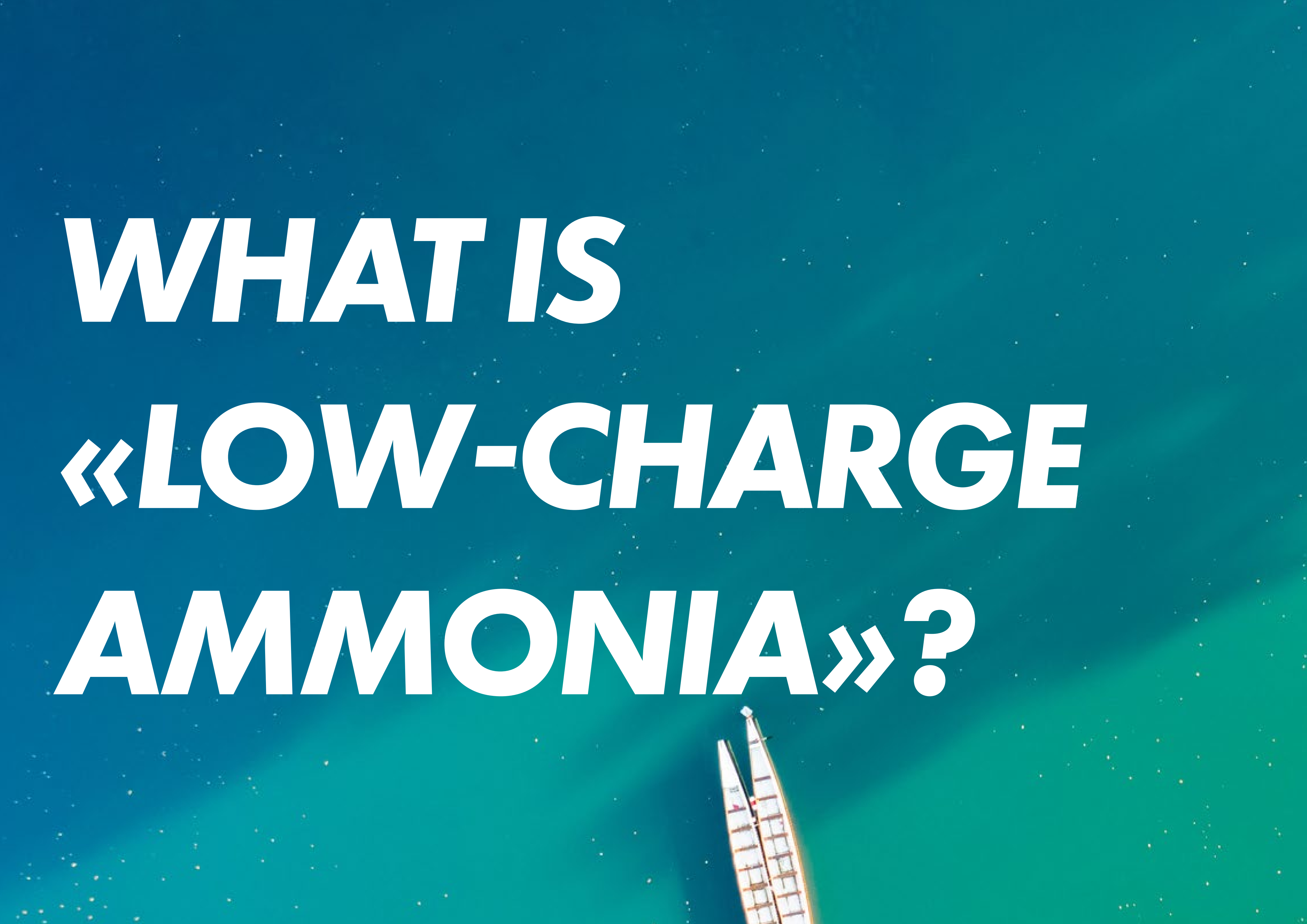
**2012**
First low-charge ammonia installation in a US supermarket

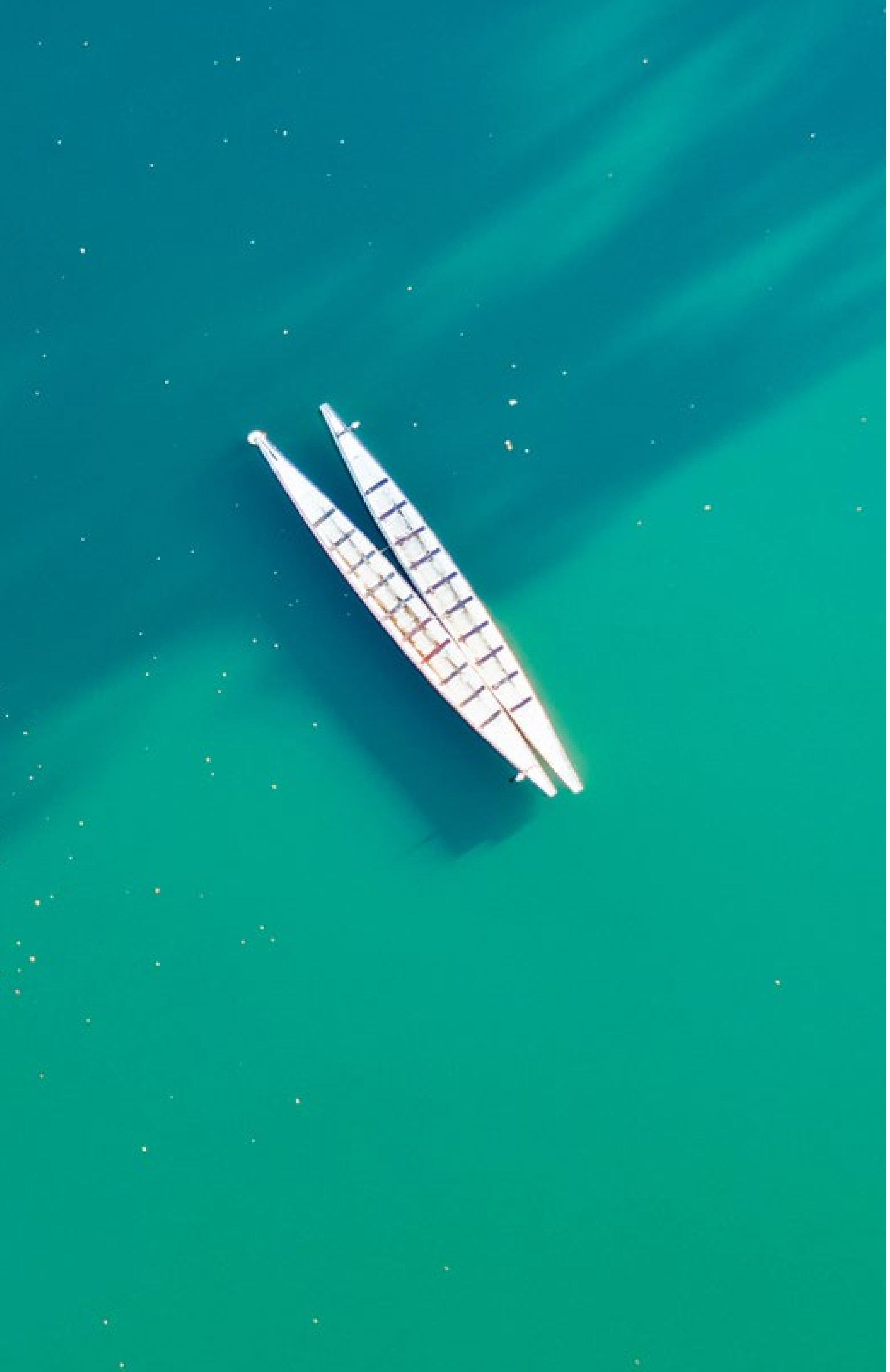
**2014**
Low-charge ammonia packages recognized in IIAR-2 standard

**2015**
First installation of low overfeed penthouse package systems

**2016**
First installation of low-charge central system

# WHAT IS «LOW-CHARGE AMMONIA»?





# An overview

Ammonia, which has traditionally been associated with high toxicity that can cause risk to human health if released, has in recent years become safer thanks to efforts to reduce its charge in systems, commonly referred to as «low-charge ammonia» technology.

Low-charge ammonia means, essentially, lowering the charge or amount of refrigerant used within a refrigeration circuit.

The U.S.-based industry groups Global Cold Chain Alliance (GCCA), International Association of Refrigerated Warehouses (IARW) and the International Association for Cold Storage Construction (IACSC) classify three types of technology as low-charge:

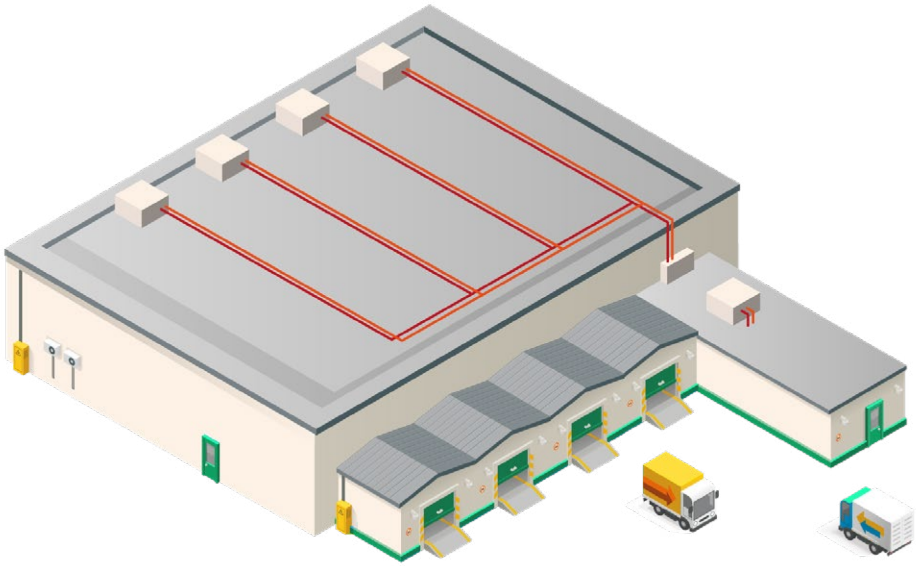
• Optimized traditional system, which use enhanced controls or evaporators to lower the charge of ammonia;

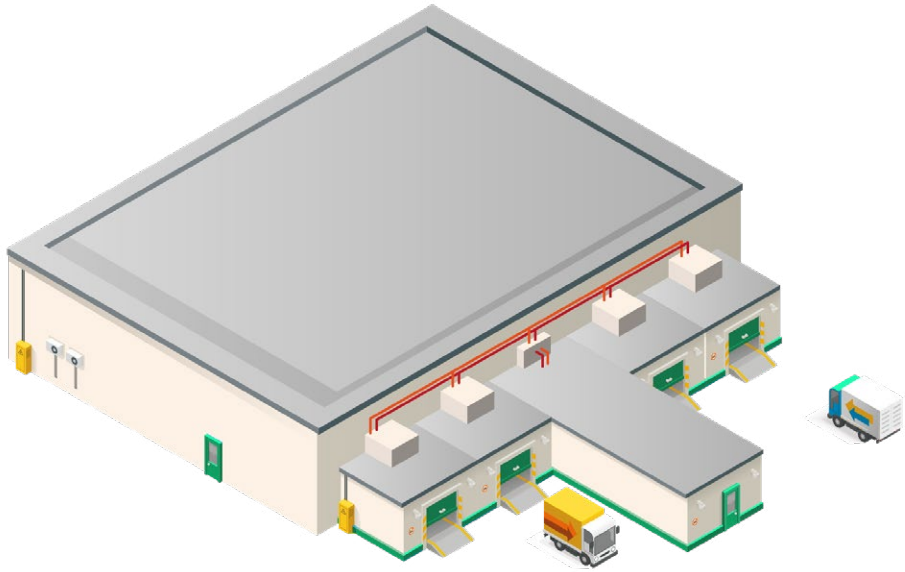
• Packaged systems, which are normally installed on the roof;

• Hybrid systems, which use $CO_2/NH_3$ in tandem to lower the charge.

These three types of low-charge ammonia technology have been installed in food processing, food storage, data centres and pharmaceutical facilities, along with supermarkets and commercial building air conditioning.

# TYPES OF AMMONIA REFRIGERATION SYSTEMS



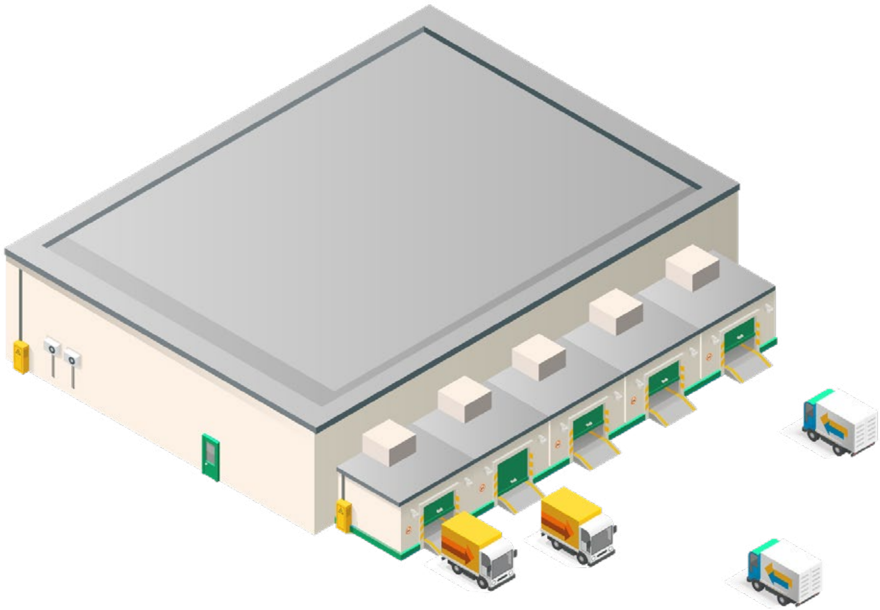


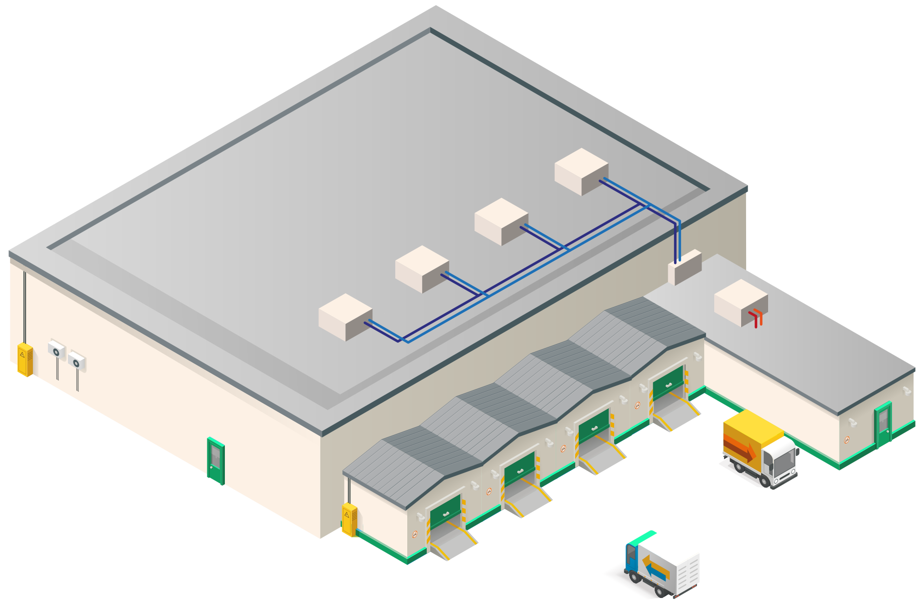
## TRADITIONAL AMMONIA SYSTEM

*A traditional ammonia refrigeration system uses over 10,000 lbs (4,536 kg) of ammonia, usually with a glycol loop, in what is called a central system. This central system uses air handling units, cooling coils, etc. located throughout the facility. The main components, such as the compressors, condensers and vessels of the system, are in a central machine room. Ammonia is then piped from the machine room to the evaporators at the load.*

## 1/ LOW-CHARGE AMMONIA: OPTIMIZED SYSTEM

*An optimized low-charge ammonia refrigeration system works by using the traditional industrial ammonia refrigeration technology and further optimizing it with low-charge components, such as specifically designed evaporators, controls, heat exchangers, compressors and condensers. A properly designed low-charge optimized system, uses less than 6,053 lbs (2,746 kg) of ammonia and requires therefore fewer vessels, fewer pipes, smaller pipe diameters and no pumps. Nevertheless it still needs a machine room.*





## 2/ LOW-CHARGE AMMONIA: PACKAGED SYSTEM

*A packaged ammonia system eliminates the huge quantities of ammonia inventory, and piping, by moving to smaller self-contained systems that are usually placed on the roof/ground outside preventing any danger from leaks. These self-contained systems have about 4.3 lbs/TR (0.55 kg/kW) ammonia charge and usually combine the compressor, evaporator valve system and control systems into one easily installed and movable packaged system.*

## 3: LOW-CHARGE AMMONIA: $NH_3$/ $CO_2$ SYSTEM

*An ammonia/$CO_2$ system can come in various formats (such as cascade, $CO_2$/$NH_3$ with pumped volatile brine and ammonia DX system using liquid $CO_2$ overfeed) but the main idea is to isolate the ammonia charge, which is usually between 4 and 6 lbs/TR (0.5 - 0.83 kg/kW), to the machine room and use the $CO_2$ as the secondary coolant that can be pumped into cold rooms in the facility. The system might require additional equipment to pump the $CO_2$, along with extra compressors and other components for the $CO_2$ side.*

## DO WE NEED A DEFINITION?

To further foster innovation in low-charge ammonia and develop the technology for the HVAC (heating and air conditioning) market, along with increasing food and worker safety in the refrigeration industry, experts agree it is necessary to clearly determine what is «low-charge».

"*Those who want to go slow are typically not interested in non-industrial applications and do not like ultra-low-charge because that requires too much new technology. They are used to go through acceptance of ammonia systems by authorities. They do not want a definition because they do not look as good. Those who would like to see ammonia used in applications where it is not typically applied today (HVAC and other chillers) would like ammonia to be treated as any other A2L (or B2L) refrigerant.*" - Professor Pega Hrnjak, the University of Illinois at Urbana-Champaign, U.S.

If the industry continues without a definition many experts warn that «low-charge» will reduce the substance of the term.

"*The reason standards organisations, industry associations, contractors, end-users and everybody else struggle with the definition of low-charge $NH_3$ systems is that there is no clear definition of such systems. The term 'Low-Charge NH3' is a marketing term commonly used for any type of ammonia refrigeration system where an effort has been made to reduce the ammonia refrigerant inventory by design,*" - Stefan Jensen, managing director and founder of Australia-based Scantec Refrigeration Technologies (Scantec) that has been developing 'low-charge' technology since 2013.

"*I would hate to say a system with 501 lbs [227.5 kg] is not a 'low-charge system' although, I'm not seeing that there would be any penalty for not falling into the definition of low-charge. So I'm not sure there's any real merit in trying to set anything in stone. I think a more qualitative definition is a better approach: 'A system that takes advantage of available and proven technology to reduce the ammonia inventory in the system such that a minimum amount of refrigerant is used while not introducing significant efficiency or reliability penalties'.*" - Caleb Nelson, vice president, Azane Inc, the U.K.-based Star Refrigeration's low-charge ammonia manufacturer for the U.S. market.

Any definition will have to keep in mind how a low-charge system can be safe, reliable and efficient while speaking to the amount of ammonia content that can be contained in a system (per lbs / kg) and the lbs/TR (kg/kW) ratio.

If a definition is agreed on it will lead to accelerated adoption of low-charge, provide quality technical information and allow for less burdensome codes and regulations to be used by the industry when working with ammonia.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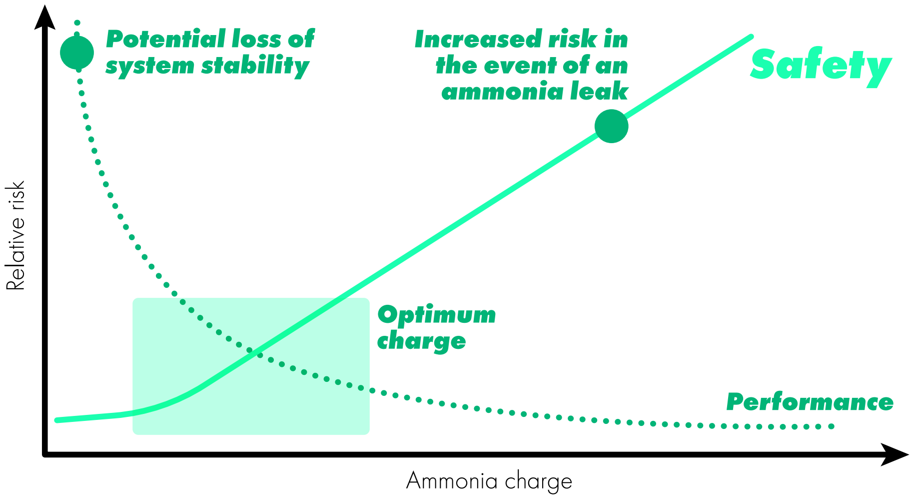
# OPTIMIZING CHARGE




*It is important when optimizing and reducing the ammonia charge in a system to take into consideration the performance and potential loss of stability within a low-charge ammonia refrigeration system when using the lowest possible charge (less than 5.51 lbs/2.5 kg). Conversely, when using higher charges (such as over 10,000 lbs/4,536 kg) a facility operator increases the risk of ammonia to human health in the event of a leak.*

## OPTIMIZING THE AMMONIA REFRIGERANT CHARGE

Manufacturers of low-charge systems have warned, for example, if the $NH_3$ content of a unit becomes too critical the smallest leak could cause a malfunction and failure of the refrigeration system. This tension between safety, charge and performance, nicely summed up in the graphic "Optimizing the ammonia refrigerant charge", is something that has to be grappled with if a definition is to be agreed on.

## TOWARDS A U.S. DEFINITION

Industry groups in the U.S. have been active on proposing a 'low-charge ammonia' definition but have not yet incorporated this into standards or codes.

The U.S.-based International Institute of Ammonia Refrigeration (IIAR) is seeking to meet that demand for a 'low-charge ammonia' definition with new guidelines designed to help users safely install, operate and maintain ammonia refrigeration systems that use a charge of 500 lbs (226.8 kg) or less (under 100 lbs /45.4 kg).

These guidelines, called Ammonia Refrigeration Management – Low-Charge (ARM-LC), are a scaled-down version of the ARM guidelines the IIAR previously issued for ammonia systems using higher charges of between 500 lbs (226.8 kg) and 10,000 lbs (4,535.9 kg).

Operators and manufacturers of low-charge ammonia systems will shoulder most of the work involved in safe operation and maintenance under ARM-LC, which have ammonia charge capacity ratios of 0.5 lbs/TR (0.065 kg/kW) to 7 lbs/TR (0.91 kg/kW) compared to 20-30 lbs/TR (2.59-3.88 kg/kW) or more in conventional systems. This will be good for end users, who have never worked with ammonia systems before, as they face less of the burden to provide safety guidelines for operating low-charge ammonia systems and can instead rely on contractors and manufactures to explain to them the day-to-day operation of a system.

However, this is not a standard or regulation but an IIAR guideline sheet that is recommended for the low-charge ammonia industry. IIAR will await feedback on the ARM-LC published guideline note and may look to incorporate it into the ammonia safety code IIAR-2 (which already has a definition for packaged systems).

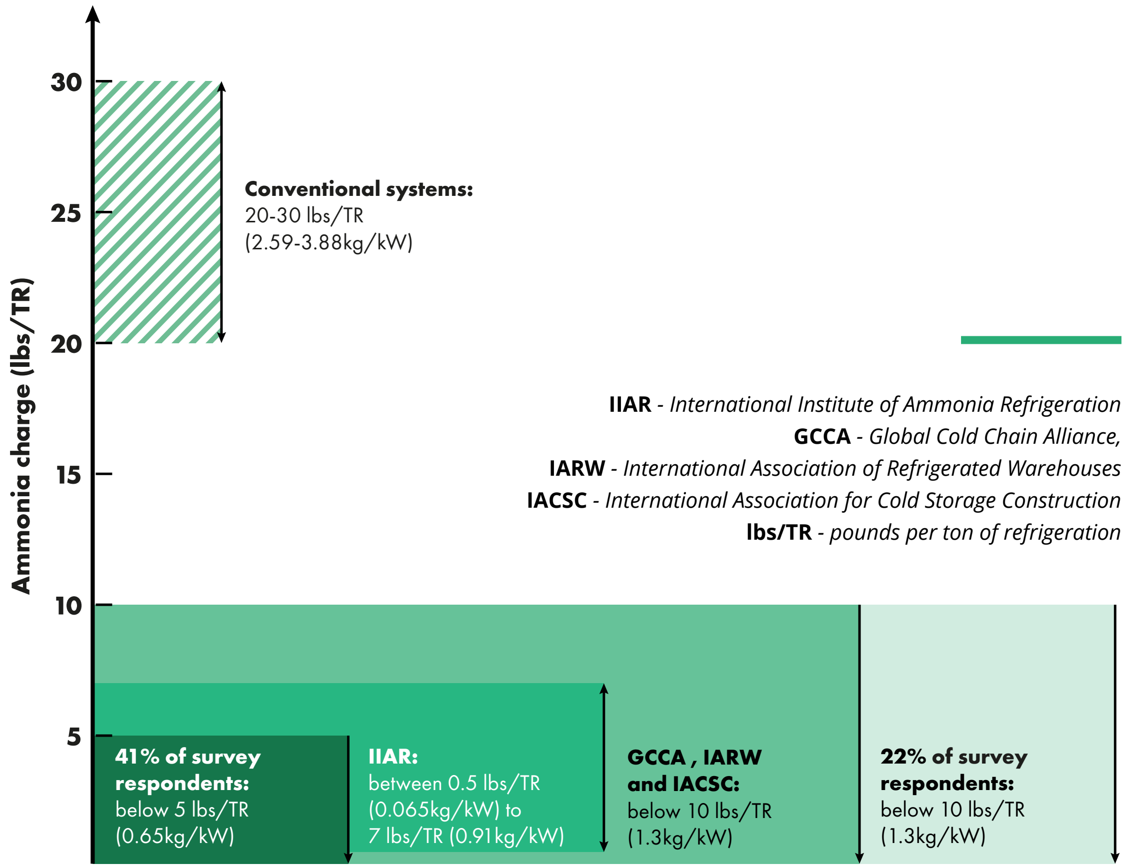
If IIAR does incorporate a definition on the charge of low-charge ammonia systems then it will provide certainty in the U.S. where the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the International Fire Code (IFC), the National Fire Protection Association (NFPA), the National Electrical Code (NEC) and the Uniform Mechanical Code (UMC) defer to IIAR standards.

Manufacturers, regardless of the lack of incorporation into codes/standards, are citing IIAR's definition of low-charge ammonia system under the ARM-LC.

Another definition, often cited in the U.S. by manufacturers and operators at international conferences, comes from the GCCA , IARW and IACSC (that all have European branches). It states low-charge is an ammonia system that requires a charge of "no more than 10 pounds of ammonia per ton of refrigeration," or (1.3 kg/kW).

Similarly, this low-charge ammonia definition has not so far been incorporated into any code or standard either and is at the moment a guideline for the industry.

## HOW LOW IS LOW-CHARGE AMMONIA?




In another effort to bring more clarity to defining 'low-charge ammonia', leading expert Professor Pega Hrnjak from the University of Illinois suggested a definition based on three categories, namely:

• Ultra-low-charge: Up to (5.51 lbs) 2.5kg charge
• Very low-charge: Up to (110.23 lbs) 50kg charge
• Low-charge: Up to (220.46 lbs) 100kg charge

*"It is possible to reduce the ammonia charge to 18 grams per kW of cooling capacity."* - Prof. Hrnjak, University of Illionois, U.S.

## WILL THE REST OF THE WORLD JUMP ON BOARD?

If the U.S. can determine a definition then South America will likely jump on board. Currently, IIAR has chapters in Mexico, Costa Rica and Caribbean, Colombia, Ecuador, Peru, Chile and Argentina that incorporate and use its current standards.

Chile, for example, when coming up with its ammonia regulation worked with an IIAR representative from the U.S. and the IIAR Chilean chapter to develop an ammonia standard for the South American country's ministry of health.

The Association of Ammonia Refrigeration (AAR) in India, the Australian Refrigeration Association in Australia and the Chinese Association of Refrigeration in China are also allied associations of IIAR and do use a mix of international and IIAR standards so it could be predicted they might incorporate IIAR standards as well.

## TAKE CHARGE EUROPE!

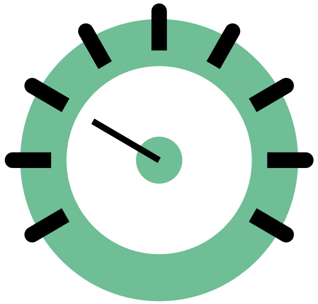
In Europe IIAR standards are not followed and bodies such as the France-headquartered International Institute of Refrigeration (IIR) do not cite a specific charge limit or propose standards for the industry to follow.

"The minimum charge in a refrigeration system is the minimum charge required for stable operation of the unit over the full range of possible operating conditions," IIR's often quoted 25th Informatory Note on Refrigeration Technologies, advocates.

The body, which does represent mainly the ammonia industry In Europe – Eurammon – has so far not set best practices or proposed industry codes to follow. Instead, it relies on European standardisation bodies such as CEN/CENELEC. Nevertheless there are indications that this industry group will focus on this topic in the near future.

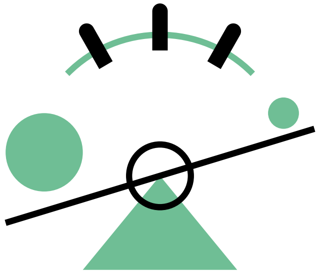
The European standard that defines safety and environmental requirements for refrigerants is EN 378 (Safety and environmental requirements for refrigerating systems and heat pumps) applicable to all types of equipment.

## HOW WOULD YOU DEFINE A LOW-CHARGE AMMONIA SYSTEM?



**65%**

**FAVOR A DEFINITION BASED ON SPECIFIC AMMONIA CHARGE**



**35%**

**FAVORING ONE BASED ON TOTAL QUANTITY OF AMMONIA ONLY**

*As part of the industry-wide survey, carried out in 2018, the experts were asked 'How should low-charge ammonia be defined?'. Most of the respondents were in favour of a definition stating a specific ammonia charge (65%), with the majority (41% vs. 22%) of those opting for low-charge as 'A closed loop system requiring a specific ammonia charge below 5 lbs/TR (0.65 kg/kW)' over 10 lbs/TR (1.3 kg/kW). Few (35%) favored a definition based on total quantity of ammonia.*

"*The most important law we have to consider regarding the use of refrigerants and measures needs to be taken against any risks comes from EN 378. It is a [harmonized] European standard so all the countries have to follow.*" - Wolfgang Dietrich, responsible for product management (chillers) at GEA.

"*There are no standards about what is low-charge.*" - Alexander Cohr Pachai, Technology and product manager ($CO_2$ systems), Johnson Controls Denmark and chair of the IIR Working Group on Refrigeration Safety.

"*We should find a common 'definition' where the limit could be to still speak as 'low-charge'. Currently I saw 'low-charge' arguments at [1.15 lbs/TR] 150 g/kW cooling capacity and I know the ambitious level is [0.39 lbs/TR] 50 g/kW cooling capacity. You see there is a wide range in interpretation.*" - Wolfgang Dietrich, responsible for product management (chillers) at GEA.

So far none of the EU standard bodies, industry or national groups have attempted to set out a definition for what is low-charge ammonia. Nevertheless the low-charge ammonia industry hopes they will look at this topic in the future.

## QUALIFYING THE DEFINITION

Regardless of whether definitions for low-charge go ahead, manufacturers and researchers believe it will also be necessary to define what is low-charge and what is ultra-low-charge so as to differentiate between the most ambitious technology and the least for end users.

There is also some concern that chillers and heat pumps, which can be packaged and non-packaged, should have separate definitions. In addition, some argue there should be different requirements for air-cooled or water-cooled chillers.

"*It depends from the technology used (factory-made chiller/local built chiller), the type of a chiller (water-cooled; air-cooled, evaporative condenser) and the temperature level of the application (low; AC or heat pump).*" - Wolfgang Dietrich, responsible for product management (chillers) at GEA.

Though there is still much disagreement among manufacturers, industry bodies and researchers about what should be considered as low-charge ammonia technology it seems clear it will be down to the specific charge of ammonia in the system (lbs/TR or kg/kW).

Regardless of the inherent difficulties with proposing a low-charge ammonia definition, a clear understanding will need to be agreed so low-charge ammonia manufacturers and contractors can sell their units in confidence and end users are well informed about what they are buying.

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Get in touch with shecco's market development team to learn more about the market for natural refrigerants or find out how we can help you in gathering market intelligence and proactively building your business with our tailored market development services, to get your technology faster to market.


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