ABOUT AAR

Industrial refrigeration systems using Ammonia as a refrigerant are being used since long in many food and process industry installations in India and are growing significantly over the years due to environment friendly properties of Ammonia. However, there are apprehensions and misconceptions due to toxic nature of Ammonia. In this situation, it is important that everyone must have a better understanding of the use of ammonia as a refrigerant. For the efficient and safe use of ammonia refrigeration -proper knowledge, safety and training are important for the people and organizations involved.

Keeping this in mind the **"Association of Ammonia Refrigeration (AAR)"** was formed in 2012 with an aim to promote safe use of ammonia as refrigerant through education, training, information and standards. AAR is National organization registered in Pune with 290+ individual members and 51+ corporate members from India and across the world. The members profile comprises of consultants, contractors, manufacturers, senior technical professionals and end users of various organizations engaged in the field of ammonia refrigeration. Since its inception, AAR has held seminars and training programs in number of cities across India with varied themes of efficiency, sustainability and safety. AAR has published it's own starndard **"AAR-01 SAFE DESIGN OF CLOSED - CIRCUIT AMMONIA REFRIGERATION SYSTEMS".** AAR has also published Resource Books on plant operation and maintenance, installation practices, Cold Room Design etc. The AAR website www.ammoniaindia.org shares detailed information about ammonia as refrigerant, advantages, AAR newsletters and the various presentation made at AAR training programs.

RESOURCE BOOKS, STANDARD AND WEBSITE


News Letters


Standard



Technical Manual


Posters


Website

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Association of AMMONIA REFRIGERATION

Want highly Efficient Refrigeration Plant Design?

Use

Ammonia Refrigerant (NH_3)

Natural Refrigerant with No Global Warming

www.ammoniaindia.org

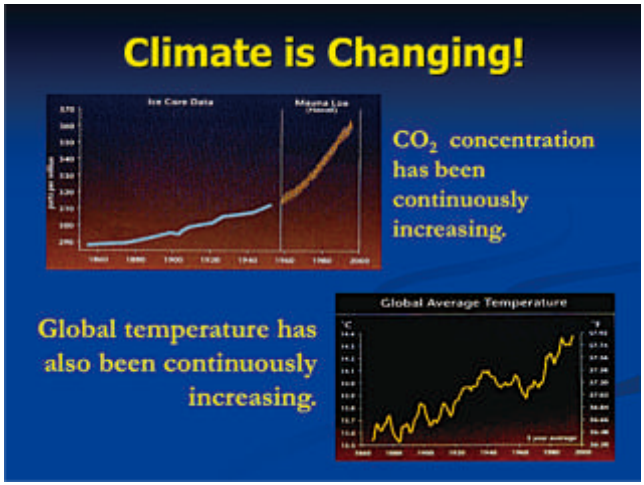
HFC PHASEOUT SCHEDULE DOCUMENT

Hydrofluorocarbons (HFCs)

HFCs are a family of greenhouse gases (GHGs) that are largely used in refrigerants in home, car air-conditioners and air sprays etc. These factory-made gases had replaced CFCs under the 1987 Montreal Protocol to protect Earth's fragile protective Ozone layer and heal the ozone hole over the Antartica.

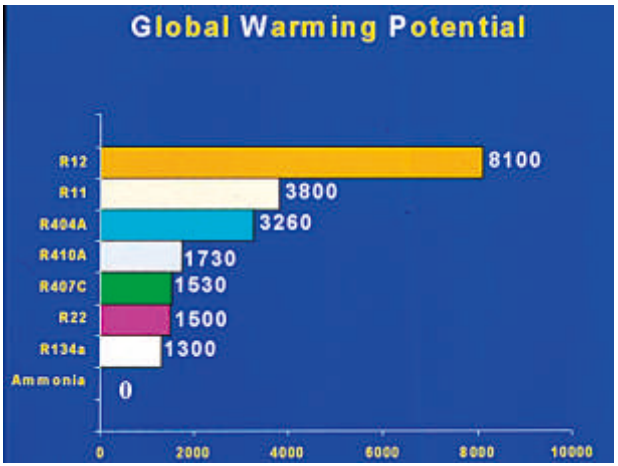
Harmfulness of HFCs

In recent times, it was found that HFCs have several thousand times capacity in retaining heat in the atmosphere compared to carbon dioxide (CO2), a potent GHG. Thus, it can be said that HFCs have helped ozone layer but exacerbated global warming. Currently, HFCs are currently the world's fastest GHGs, with emissions increasing by up to 10% each year.



Significance of the Kigali Amendment

The 28th Meeting of the Parties (MOP28) to the Montreal Protocol held in Kigali, Rwanda on October 15, 2016 led to an international agreement to phase-down of the production and consumption of hydrofluorocarbons (HFCs), often used to replace the CFCs initially targeted by the Protocol.



The Kigali Amendment amends the 1987 Montreal Protocol that was designed to close growing ozone hole by banning ozone-depleting coolants like chlorofluorocarbons (CFCs). Thus, amended Montreal Protocol which was initially conceived only to plug gases that were destroying the ozone layer now includes HFCs responsible for global warming. This move will help to prevent a potential 0.5-degree Celsius rise in global temperature by the end of the century.

A historic global climate deal was reached in Kigali, Rwanda at the Twenty-Eighth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer (MOP28). The Kigali Amendment which amends the 1987 Montreal Protocol aims to phase out Hydrofluorocarbons (HFCs), a family of potent greenhouse gases by the late 2040s. Under Kigali Amendment, in all 197 countries, including India have agreed to a timeline to reduce the use of HFCs by roughly 85% of their baselines by 2045.

The Kigali Agreement or amended Montreal Protocol for HFCs reduction will be binding on countries from 2019. It also has provisions for penalties for non-compliance.

The Paris agreement which will come into force by 2020 is not binding on countries to cut their emissions. The Kigali Amendment is considered absolutely vital for reaching the Paris Agreement target of keeping global temperature rise to below 2°C compared to pre-industrial times.

TIMELINES FOR DIFFERENT GROUPS UNDER KIGALI AMENDMENT

HFC PHASE OUT SCHEDULE

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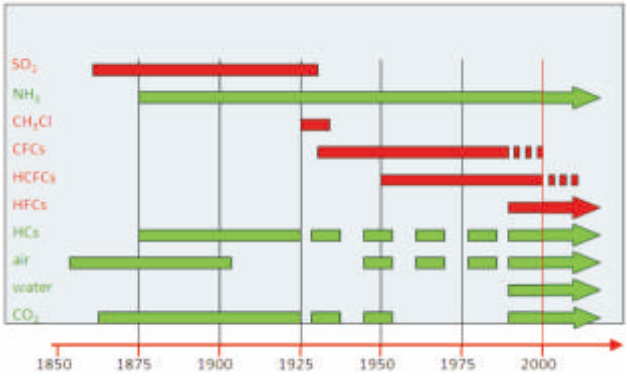
HFC PHASE OUT SCHEDULE

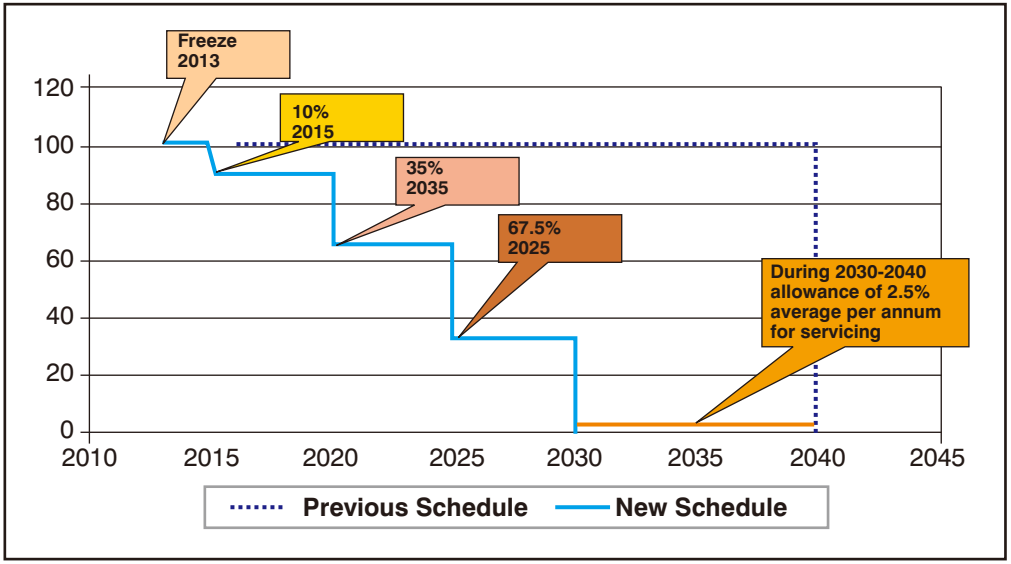
Average HFC consumption levels for 2011, 2012, & 2013+15% of HCFC base line	
2019	-10%
2024	-40%
2029	-70%
2034	-80%
2036	-85%

REFRIGERANTS TIME-LINE



ACCELERATED PHASE-OUT SCHEDULE

Year	% of Phaseout from Baseline (avg 2009 and 2010)
2013	Freeze
2015	10%
2020	35%
2025	67.5%
2030	Full phaseout*
2040	100% phaseout



* 2.5% of the baseline allowed for servicing- to be revieed in 2025

ODP / GWP OF REFRIGERANTS

Refrigerant		Atmos-pheric Lifetime (Years)	Ozone Depletion Potential (ODP) (100 Year)	Global Warming Potential (GWP)
Ammonia	R-717	-	0	<1
CFC (no more)	CFC-11 (Baseline ODP)	50	14000	
	CFC-12	102	1	10900
HCFCs	HCFC-22	13.3	0.055	1820
	HCFC-123	1.4	0.02	93
	HCFC-141b	9.4	0.11	630
HFCs	HFC-134a	14.6	0	1300
	HFC-245fa	7.3	0	820
	R-32	-	0	675
HCs	HC-290 (Propane)	-	0	3
	R-1270 (Propylene)	-	0	<2
HFC Blends	R-404A	-	0	3260
	R-407A	-	0	1770
	R-407C	-	0	1530
	R-410A	-	0	1730
CO_2	R-744	-	0	1
HFOs	1234yf, 1234ze	-	0	4, 7

AMMONIA THE NATURAL CHOICE

Ammonia has a number of characteristics which make it the ideal refrigerant for refrigeration and Air conditioning purposes:

- Like other natural refrigerants, ammonia (R717) represents no threat to either the ozone layer or the earth's climate.
- A well-known and acknowledged refrigerant which has been used safely in refrigeration for more than 100 years
- Better efficiency, refer table Ammonia coefficient of performance (C.O.P.)
- Better heat transfer coefficient
- Available and low-priced all over the world
- Non-miscible with lubricating oil
- Less energy required for pumping
- Suitable for all temperature ranges (from Low Temperature -50°C to High Temperature +70°C)
- Ideal for both reciprocating and screw compressors
- Very flexible when plant modifications and extensions are required
- Suitable for all refrigeration needs small to large capacity

AMMONIA AS A PREFERRED REFRIGERANT

Cold Storages

Fish & Other Seafood

Meat & Poultry

Dairy & Ice Cream

Brewery & Beverage

Process Cooling & Air Conditioning

MISCONCEPTIONS ABOUT AMMONIA WHEN USED AS A REFRIGERANT

Misconception	Fact
Ammonia is Toxic	• Ammonia has a pungent odour and even small leaks as low as 5 PPM is detectable by smell and serves as an early warning, so that the maintenance staff can arrest them. • Almost all human beings can detect levels up to 25 PPM and continuous exposure to 50 PPM levels is permitted in most countries for 8 hours per day per week. • Laboratory trials have proved that continuous exposure levels for 10 to 15 years up to and exceeding 24 PPM has no adverse effect on human beings. • Installation of ammonia leak detection sensors assists in ensuring safe operation.
Ammonia is Flammable	• Ammonia is extremely hard to ignite even up to 650 °C. Ammonia breaks at 450 °C. Flammable limit by volume in air at atmospheric pressure is as high as 16% to 28% concentration. • It is now classified as a B2L, which is less flammable as compared with many hydrocarbons and other fuels which are used in day to day life. • Due to the high affinity of ammonia for atmospheric humidity, it is rated as hardly flammable.
Ammonia cannot be used for air cooled applications	• Ammonia air cooled condensers are available and also hybrid (Evaporative + Air cooled) Condensers are becoming popular around the world.
Ammonia systems are flooded operation and require lot of refrigerant as compared to other refrigerants	• Low charge factory made packaged refrigeration systems of less than 0.3kg of ammonia / Ton of Refrigeration are available.
Small capacity & Direct expansion Ammonia systems are not available	• Ammonia compressors with 7kW capacity have been developed for small capacity package units. • Semi hermetic as well as hermetic compressors using aluminum winding motors are now developed. • Direct expansion systems with miscible oils using electronic expansion valves are available.
Ammonia cannot be used for air conditioning	• Due to increased use of natural refrigerants and due to its excellent energy saving properties, many countries are using ammonia with secondary fluids like, water, brines and CO2 in air conditioning plants. • Some of them listed below. - Oslo Air Port -Norway - Heathrow Terminal - 5 - Singapore Air Port - Stuttgart Airport Terminal 3
Ammonia plants cannot be made automatic and requires team operators	• Fully automatic Ammonia refrigeration plants are being being used all over the world and as well in India since last 30 years. • These plants are remote controlled from central control panel.
Ammonia is going to be banned	• This is a myth. In fact, the man made refrigerants are on the way out in most of the developed countries. • Ammonia is not going to be banned. Manufacturers of synthetic refrigerants and manufacturers of air conditioning and refrigerant systems suitable for only synthetic refrigerants are trying their best to safeguard their products by spreading drawback of Ammonia. This is a futile attempt hopefully till they are geared up to start using Ammonia. Recently being introduced so called "safe and nature friendly synthetic refrigerants" are petroleum based which have its own drawbacks. • Being natural refrigerant, its use is increasing globally.

TABLE AMMONIA (R-717) PROPERTIES OF SATURATED LIQUID AND SATURATED VAPOR *

°C	Bar g	PSI g
-50	-0.59	-8.41
-40	-0.28	-4.03
-38	-0.20	-2.89
-36	-0.12	-1.64
-34	-0.02	-0.29
.-33.33b	0.01	0.19
-32	0.08	1.17
-30	0.19	2.76
-28	0.32	4.48
-26	0.45	6.34
-24	0.59	8.34
-22	0.74	10.50
-20	0.90	12.81
-18	1.08	15.30
-16	1.26	17.96
-14	1.46	20.82
-12	1.68	23.87
-10	1.91	27.13
-8	2.15	30.60
-6	2.41	34.30
-4	2.69	38.23
-2	2.98	42.41
0	3.29	46.85
2	3.62	51.55
4	3.97	56.53
6	4.35	61.80
8	4.74	67.38
10	5.15	73.26
12	5.59	79.46
14	6.05	86.00
16	6.53	92.88
18	7.04	100.12
20	7.57	107.74
22	8.14	115.73
24	8.73	124.12
26	9.35	132.92
28	9.99	142.13
30	10.67	151.79
32	11.38	161.89
34	12.12	172.44
36	12.90	183.48
38	13.71	194.99
40	14.55	207.01
42	15.44	219.54
44	16.35	232.59
46	17.31	246.21
48	18.31	260.36
50	19.34	275.08

b = Normal boiling point g = Gauge pressure

** ASHRAE Fundamentals 2013, page 30.39*

PHYSICAL PROPERTIES OF AMMONIA (R717)

Boiling Point	-33.4°C at 1.013 Bar
Ignition Temperature	650°C
Critical Temperature	134.4°C
Explosion Concentration	16% to 28% by volume
Detection Threshold	5 ppm
Tolerance Limit	500 - 1000 ppm

AMMONIA C.O.P. (EFFICIENCY) COMPARISON WITH OTHER REFRIGERANTS FOR VARIOUS APPLICATIONS

Refrigerant	Condensing Temperature +40°C			
	Evaporating Temperature 2°C	Evaporating Temperature -5°C	Evaporating Temperature -25°C	Evaporating Temperature -40°C
Ammonia-R717	6.2	4.965	2.91	2.06
R410A	5.43	4.8	2.5	1.75
R134a	5.88	4.67	2.7	Not used
R404A	5.18	4.07	2.26	1.52
R22*	5.93	4.74	2.79	1.98

*new equipment banned from 2016