TRAINING AND ASSESSMENT FOR TECHNOLOGIES THAT REPLACE HFC'S (FLAMMABLE REFRIGERANTS)

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With the impact on the HFC quotas beginning to impact across Europe there is now a real need to change to low GWP Refrigerants. In the main, these low GWP Refrigerants are of greater benefit for the environment but at a price. This being the increased health and safety risk, in particular flammability.

Even though the F-Gas regulations do not require technicians to be specifically assessed in the safe handling of these flammable refrigerants, there is growing impetus to encourage technicians to upskill voluntarily. Within the UK the Air Conditioning and Refrigeration Industry Board created a specification to enable attendees to understand the properties of and the application of all A2L, A2 and A3 class flammable refrigerants. The assessment specification is split into several sections including:

Properties of flammable Refrigerants

Flammability	Lower flammability limit	Practical limits
Low boiling point	Upper flammability limit	Density
Asphyxiation	Sources of ignition	

Information kindly supplied by Chemours

Refrigerant	Classification	Sat Temp °C	Practical Limit kg/m^3	LFL kg/m^3	LFL %	UFL kg/m^3	UFL %	Density kg/m^3	MIE mJ
R600a	A3	-11.8	0.011	0.043	1.8	0.203	8.4	2.44	0.25
R290	A3	-42.1	0.008	0.038	2.1	0.192	10.1	1.83	0.25
R1270	A3	-47.6	0.008	0.046	2	0.253	11.1	1.74	0.28
R170	A3	-88.6	0.0086	0.038	3	0.253	12.4	1.24	0.24
R152a	A2	-24	0.027	0.130	3.9	0.563	16.9	2.76	0.38
R32	A2L	-51.7	0.061	0.307	14.4	0.680	29.3	2.15	30-100
R1234yf	A2L	-29.5	0.058	0.289	6.2	0.573	12.3	4.77	5k-10k
R1234ze	A2L	-19	0.061	0.303	7	0.443	9.5	4.77	61k-64k
R454A	A2L	-48.3	0.056	0.278	8	0.522	15	3.34	300-1k
R454C	A2L	-45.9	0.059	0.293	7.7	0.569	15	3.78	300-1k

Refrigerant classifications from ISO817

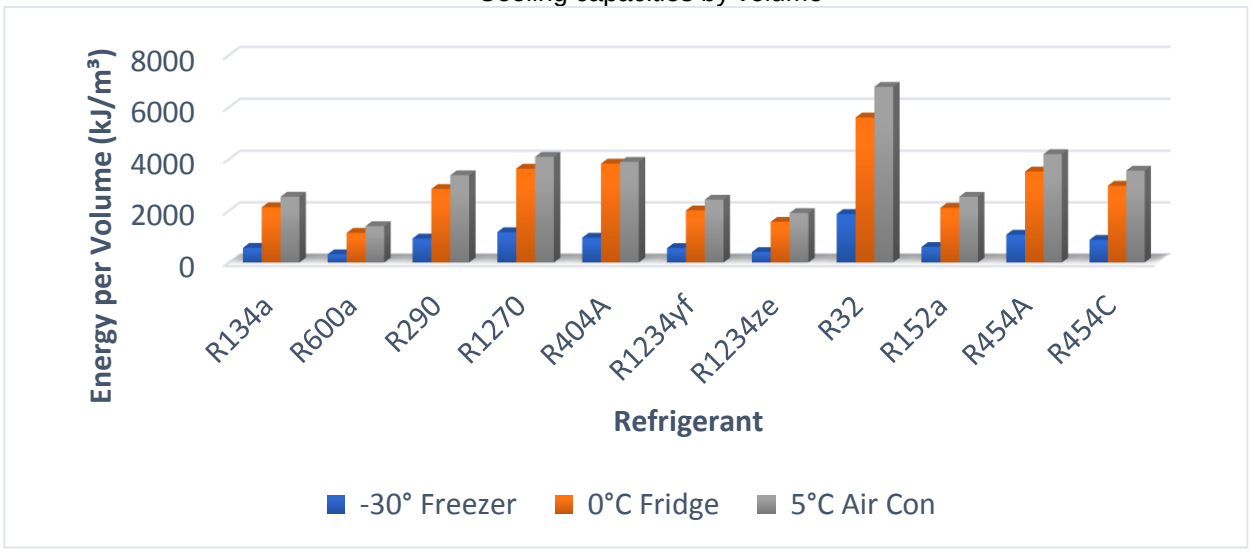
Legislation

- Regulations
  - The Management of Health and Safety at Work
  - The Control of Substances Hazardous to Health
  - Dangerous Substances and Explosive Atmospheres
  - Classification, Labelling and Packaging
  - Etc
- Codes of practice
- European standards

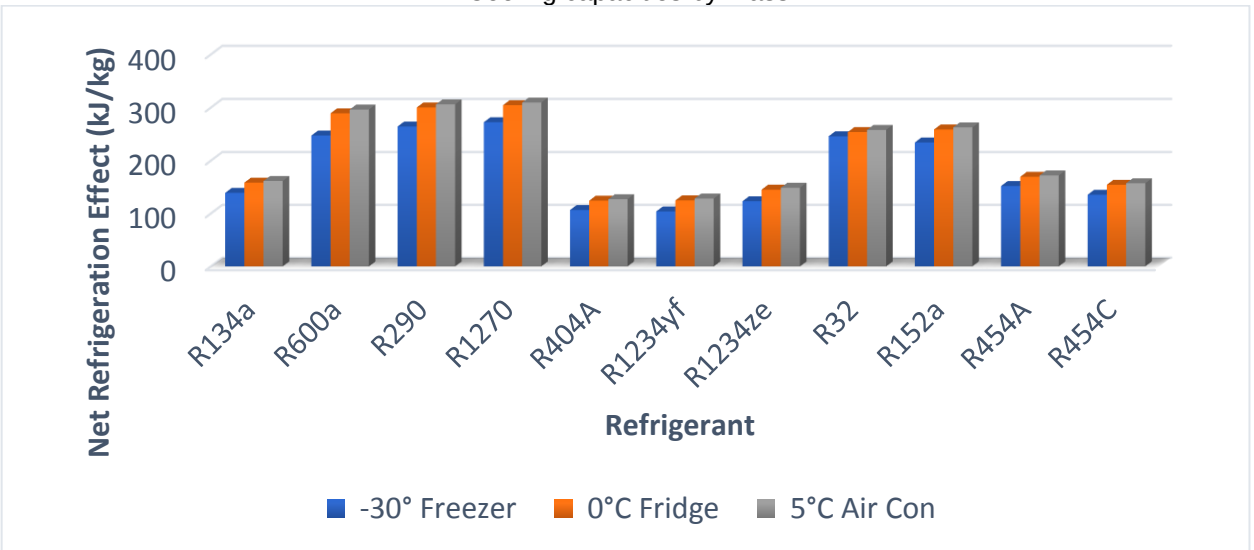
Differences between different refrigerant classes

- Electrical devices (including devices specifically designed for use with flammable refrigerants)
- Electrical enclosures
- Compressors (including starter and associated electrics)
- Critical charge systems
- Oil compatibility
- Leakage implications (direct and indirect)
- Thermodynamic properties
- Cooling capacity and energy efficiency
- Density
- Odour
- Risks associated with retro-filling

Cooling capacities by volume



Cooling capacities by mass



Specific requirements when installing or servicing systems charged with flammable refrigerants

- Completion of a site specific risk assessment
- Selection of PPE
- Flammable gas leak detector
- Ventilation fan of natural ventilation
- Recovery unit (safe for use with flammable refrigerants)
- Vacuum pump (safe for use with flammable refrigerants)
- Manifold set (safe for use with flammable refrigerants)

A2L recovery unit

Ventilation fan

Specific requirements for installing and testing RACHP systems

- Identification of access category as designated in safety standards (BS EN 378, ISO 5149)
- Maximum refrigerant charge based on location classification
- Calculate the maximum charge based on the toxicity and practical limit
- Determine from calculations the system specific maximum charge
- Methods and procedures for:
    - strength testing
    - tightness testing
    - leak testing
    - evacuation and dehydration
    - charging systems
- Determining charge size
- Commissioning of systems
- Record keeping
- Labelling of systems
- Safely vent less than 0.15kg of hydrocarbon refrigerant to atmosphere
- Procedures for purging/evacuating the circuit prior to carrying out hot works whilst monitoring lower flammability level

The main challenge for the attendees are the calculations to determine charge limits in accordance with BS EN 378. The first step is to determine the appropriate access category and location. The access category options are

a General access (Hospitals, theatres, supermarkets hotels etc)
b Supervised access (Professional offices, laboratories etc)
c Authorised access (Abattoirs, factories, cold stores etc)

Then the location of the equipment:

IV Ventilated enclosure (All refrigerant containing parts are located)
III Machinery room or open air
II Compressors in machinery room or open air
I Mechanical equipment located within the occupied space

The flammability class of the refrigerant (A2L, A2 or A3). Then the charge limit can be calculated from table C2 within BS EN 378 or use the formula 2.5 x $LFL^{1.25}$ x h_o x $\sqrt{A}$ or M1 x 1.5 for sealed refrigerating systems for class 2L or M1 for sealed refrigerating systems for class 2 or 3 or 150g for sealed refrigerating.

For Example

- Step 1: Access: a. Location Class: II
- Step 2: A (R410A ATEL = 0.42kg/m³ PL = 0.44 kg/m³) therefore we use 0.44kg/m³
- Step 3: Toxicity limit (0.44) x room volume
    - An example using C.1 of 100m³ would give a refrigerant charge of 0.44 x 100 = 44 kg. Or if using C.3 QMLV x room volume 0.42 x 100 = 42kg, but if complying with at least two specified measures then the max limit of 150kg can be used.

Safety Class	Refrigerant	Room Height	LFL	ATEL/ODL	PL	Room Area
A1	410A	3	NF	0.42	0.44	33.3
GWP	2088					
ODP	0					

Toxcity					
Toxcity Class	Access Category	Location Class	1	2	3
A	a	II	43.956	26.400	0.15
	a	I			
	b	II			
	c	III			
		IV			

Toxicity Limit	Not upper floors without emergency exits or below ground floor level or high density occupancy
43.96	

Flamability						
Flam Class	Access Category	Location Class	1	2	3	4
1	a	II	#VALUE!	NA	NA	0.15
	a	I	alternative			
	b	II				
	c	III				
		IV				
M_1	M_2	M_3	M_3 x 1.5	M_2 x 1.5	20% x LFL x m^3	
#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	

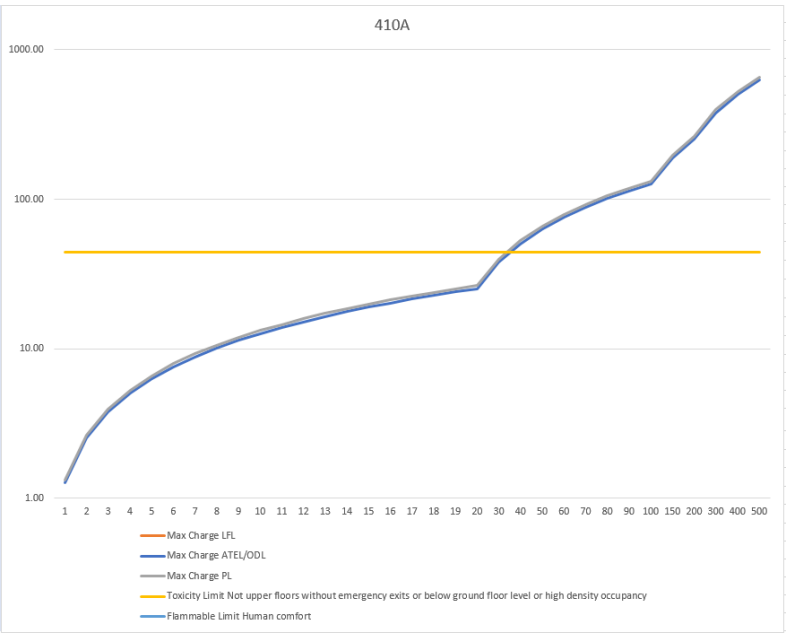
Flammable Limit	Human comfort
FALSE	

Flammable Limit	Other Applications
Non Flammable	

Flammable limit below ground
FALSE

Flammable limit above ground
FALSE

Flammable limit < 1 person per 10m³
FALSE



Unfortunately due to the fact that there is no mandatory requirement for additional training on the safe use of flammable refrigerants, the take up is relatively small within the UK. At the time of writing this article it is estimated that approximately 200 technicians have successfully completed the assessment. Hopefully within mainland Europe other schemes and training courses set up by Governments or industry bodies or indeed the Real Alternatives 4 life blended learning will be more successful to ensure that a well-trained and competent work force is prepared for the increased use of flammable refrigerants.