New A2L refrigerants: the balanced approach

climalife®
The new A2L (mildly flammable) fluids can be used in many applications and various different processes similar to HFCs and HCFCs but at the same time need to comply with current legislation and flammability precautions (in accordance with building code standards and requirements).

Under European legislation, very low-GWP fluids must be used for certain applications, both now and in the future.

In order to meet these requirements, producers have thought ahead and developed new HFO molecules that achieve a global warming potential of less than 1. In general, lower GWP comes with flammability. A compromise therefore had to be found between flammability and GWP in order to meet professionals' needs as effectively as possible and provide solutions that are both environmentally acceptable and efficient.

A2L classification: safety and flammability

The safety classification of refrigerants is determined by the international standard ISO 817 and adopted by American standard ASHRAE 34 according to their toxicity and flammability.

The letter indicates the level of toxicity:
- A = Refrigerant with lower toxicity
- B = Refrigerant with higher toxicity

The number indicates the flammability level:
- 1 = Non-flammable
- 2L = Mildly flammable
- 2 = Flammable
- 3 = Highly Flammable

Main parameters that characterise the degree of flammability of a refrigerant fluid:
- the lower flammability limit (LFL) and upper flammability limit (UFL)
- burning velocity (BV)
- minimum ignition energy (MIE)
- heat of combustion (HOC)
Refrigeration and air conditioning equipment is designed according to the product safety standards (eg EN 60335-2-24 standard for domestic refrigeration). If the A2L classification is not yet included in this standard, the reference to be taken into account is the group safety standard. The reference in use today is European standard EN378: 2016. This does not apply to systems designed before the date on which it came into force. It does, however, apply to extensions or alterations carried out on systems after its publication, or in the event of systems being transferred and then used on a different site. It is also permitted to use a risk assessment in the EU by working with organisations certified for this purpose.

### Applicable standards for equipment safety

<table>
<thead>
<tr>
<th>Applications</th>
<th>Product safety norm</th>
<th>Norm EN 378</th>
<th>Refrigerants</th>
<th>GWP*</th>
<th>LFL kg/m²**</th>
<th>LFL %**</th>
<th>ELV***</th>
<th>PED</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Commercial / Industrial Refrigeration</strong></td>
<td>EN 60335-2-89</td>
<td>x</td>
<td>R-455A (Solstice® L40X)</td>
<td>146</td>
<td>0.431</td>
<td>11.8</td>
<td>0.414</td>
<td>Group 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R-454A (Opteon™ XL40)</td>
<td>239</td>
<td>0.278</td>
<td>8</td>
<td>0.461</td>
<td>Group 1</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>R-454C (Opteon™ XL20)</td>
<td>146</td>
<td>0.293</td>
<td>7.7</td>
<td>0.371</td>
<td>Group 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R-1234ze (Solstice® ze)</td>
<td>&lt; 1</td>
<td>0.303(2)</td>
<td>6.5(2)</td>
<td>0.28</td>
<td>Group 2</td>
</tr>
<tr>
<td><strong>Domestic refrigeration</strong></td>
<td>EN 60335-2-24</td>
<td>x</td>
<td>R-1234yf (Solstice® yf)</td>
<td>&lt; 1</td>
<td>0.289</td>
<td>6.2</td>
<td>0.47</td>
<td>Group 1</td>
</tr>
<tr>
<td><strong>Chillers</strong></td>
<td>EN 60335-2-40</td>
<td>x</td>
<td>R-1234ze (Solstice® ze)</td>
<td>&lt; 1</td>
<td>0.303(2)</td>
<td>6.5(2)</td>
<td>0.28</td>
<td>Group 2</td>
</tr>
<tr>
<td><strong>Air Conditioning</strong></td>
<td>EN 60335-2-40</td>
<td>x</td>
<td>R-32</td>
<td>677</td>
<td>0.307</td>
<td>12.7</td>
<td>0.3</td>
<td>Group 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R-452B (Solstice® L41y / Opteon™ XL55)</td>
<td>675</td>
<td>0.31</td>
<td>11.9</td>
<td>0.467</td>
<td>Group 1</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>R-454B (Opteon™ XL41)</td>
<td>466</td>
<td>0.278</td>
<td>11.7</td>
<td>0.435</td>
<td>Group 1</td>
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<td>0.28</td>
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<td><strong>Heat Pumps</strong></td>
<td>EN 60335-2-40</td>
<td>x</td>
<td>R-452B (Solstice® L41y / Opteon™ XL55)</td>
<td>675</td>
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<td>0.414</td>
<td>Group 1</td>
</tr>
<tr>
<td><strong>Car Air Conditioning</strong></td>
<td>ISO 13043[1]</td>
<td></td>
<td>R-1234yf (Solstice® yf)</td>
<td>&lt; 1</td>
<td>0.289</td>
<td>6.2</td>
<td>0.47</td>
<td>Group 1</td>
</tr>
</tbody>
</table>

*IPPC5 - **LFL = Lower flammability limit - *** ELV = Exposure Limit Value (ATEL/ODL)
(1) ISO 13043 only covers refrigerants R-134a, R-744 and R-1234yf, all others are outside of its scope. ISO 5149 1 and ISO 5149 2, specifically exclude mobile air conditioning (MAC).
(2) Non-flammable < 30°C.
Charges of A2L fluids allowed in refrigeration and air conditioning applications

**Calculation method**
As per EN378-1 - Annexe C - Requirements for maximum refrigerant charge limits

**The charge limit is determined according to**

**Fluid's characteristics**
- **Toxicity class** (A or B)
  - The higher value between ATEL / ODL or Practical limit
- **Flammability** 1-2-2L-3
  - LFL value

**Access category** a-b-c
- **Split system** fluid A
  - 20 m² x ATEL or 150 g

**Sub-category charge limit based on toxicity**
- **Location category** I II III IV
  - Maximum charge size

**Access category** a-b-c
- **Split system**
  - 1.5 kg or 20% x LFL x Volume

**Applications** comfort or other applications

**Location category** I II III IV
- Maximum charge size

The EN 378 standard can be used to calculate an installation's maximum charge, taking three criteria into consideration: the characteristics of the refrigerant selected, access category and equipment location.

Fluid charges allowed in refrigeration and air-conditioning equipment are governed by International and European standards, as well as local regulations.
Examples of how charges are calculated depending on the application according to the EN378 standard

### Split system in a 150 m² building open to the general public (categories a and I)

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Limit affected</th>
<th>Charge in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-290 (A3)</td>
<td>Flammability</td>
<td>0.15</td>
</tr>
<tr>
<td>R-455A (A2L)</td>
<td>Flammability</td>
<td>2.59</td>
</tr>
<tr>
<td>R-1234ze (A2L)</td>
<td>Flammability</td>
<td>1.81</td>
</tr>
<tr>
<td>R-448A (A1)</td>
<td>Toxicity</td>
<td>7.76</td>
</tr>
</tbody>
</table>

### For a comfort installation installed on a wall, located in a 50 m³ space for 20 m², used for beds (categories a and I)

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Limit affected</th>
<th>Charge in kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-290 (A3)</td>
<td>Flammability</td>
<td>0.34</td>
</tr>
<tr>
<td>R-455A (A2L)</td>
<td>Flammability</td>
<td>12.9 or 84 with 2 security measures</td>
</tr>
<tr>
<td>R-32 (A2L)</td>
<td>Flammability</td>
<td>4.6 or 59.9 with 2 security measures</td>
</tr>
<tr>
<td>R-452B (A2L)</td>
<td>Flammability</td>
<td>4.66 or 60.5 with 2 security measures</td>
</tr>
<tr>
<td>R-410A (A1)</td>
<td>Toxicity</td>
<td>22 or without restriction if 2 security measures</td>
</tr>
</tbody>
</table>

If stricter local regulations exist, they take precedence over EN 378.

### Comparison of alternatives and charge size limitations

Under ISO 5149 and EN 378 standards, the maximum charge size of refrigerant is calculated based on the location of the system, the type of occupancy and the safety class of the refrigerant. When using Solstice® L40X (R-455A) in a public space, and taking into account the minimum dimensions of the room, higher refrigerant charges can be used, as shown in the graph below.

![Graph showing charge size limitations for different refrigerants](image)

- **Only secondary (chiller, machinery room)**
  - 84.0 kg
- **+ two additional measures (safety shut-off valves, alarms, ventilation)**
  - 57.7 kg
- **+ one additional measure (safety shut-off valves, alarms, ventilation)**
  - 16.8 kg
- **+ added construction requirements (location class II)**
  - Standard system
- **No room size requirements below 2.6 kg**

Room height 2.5 m. LFL 431 g/m³.
Use of A2L refrigerants in refrigeration and air conditioning equipment

A2L refrigerants must only be used with **new purpose-built equipment** or with systems specially designed to operate with these products. Under no circumstances should a system operating with a non-flammable fluid be retrofitted to run on a flammable fluid without carrying out studies or preliminary reclassification and authorisation in order to ensure continued compliance with current regulations.

- **Conversion of existing equipment** designed for non-flammable refrigerants to flammable refrigerants may result in the loss of the CE marking.
- **Proper training and qualification is essential**, if not mandatory, for the safe handling of refrigerants. The EN13313 standard on «Refrigeration systems and heat pumps – Competence of Personnel» provides useful guidance on the competence levels required for all types of refrigerants.
- **Installers or users of refrigeration and air conditioning** systems must follow manufacturers’ installation and operating instructions. They must also ensure compliance with local standards and legislation.
- **An installer or user who modifies the equipment**, or assembles his own equipment, becomes a «manufacturer» and will therefore be responsible for the safety of this equipment.

*The generic system safety standard EN378: 2016 and safety standards for devices such as EN60335-2-40, EN60335-2-89 provide recommendations to ensure, for example, that the refrigerant charge size in a specific area do not exceed the maximum permitted limits.*
**Use of A2L refrigerants**

**Packaging of A2L fluids**
- Recognisable by the red shoulder.
- Red label with the flame.
- Test pressure engraved on the packaging.
- Valve connection with left hand thread.

**Recovery bottles**
- The recovery of A2L fluids is mandatory from a regulatory requirement and must be carried out in packaging specific to flammable fluids labelled and identified in accordance with the regulations.

**Specific equipment suitable for low flammability fluids A2L**
- Recovery machine.
- Vacuum pump (backflow protection by means of an isolating solenoid valve in the event of a power failure - switch isolated or remote from the discharge zone).
- Leak detector and room controller.
- Manifold and standard hoses: pressure gauges and hoses suitable for the fluid pressure.

**Transport and storage (MSDS – section)**
- Safety and implementation: comply with the safety instructions for use, transport and storage of refrigerants.
<table>
<thead>
<tr>
<th><strong>Safety precautions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Consult the Safety Data Sheet. All appropriate risk safety measures must be taken. For any handling or exposure to the product, personal protection recommended by the safety data sheet must be worn.</td>
</tr>
<tr>
<td>• The usual precautions for use must be observed and it is absolutely forbidden to weld, solder, cut, grind, or look for a possible leak with an open flame on a circuit containing refrigerant. The use of electric arcs or any other source of power ignition is prohibited.</td>
</tr>
<tr>
<td>• As the vapour of the refrigerant is heavier than air, it is necessary to ventilate the work areas by creating air movement along the floor of premises and not to use this refrigerant in the basement or cellar without taking the necessary precautions. Do not use the ventilation ducts to exhaust vapours.</td>
</tr>
<tr>
<td>• When using a refrigerant, it is important to conduct and document a risk assessment, ensuring that all risks are understood and that precautions are in place to prevent such risks from occurring.</td>
</tr>
</tbody>
</table>

**UNITED KINGDOM**
IDS Refrigeration Limited
Green Court, Kings Weston Lane
Avonmouth, Bristol BS11 8AZ
Tél.: + 44 (0) 117 980 2520
Fax: + 44 (0) 117 980 2521
climalife.com@climalife.dehon.com