Based on EU regulations, industry is pressured to introduce refrigerants with lower Global Warming Potential (GWP) than in ones in the present use, like in this case R410A. Daikin and several other manufacturers decided to use R32 refrigerants in airconditioners and heat pumps because of following key benefits: lower GWP 675 compared to 2088 of R410A, easier to maintain, recover and reuse and it is safe to use, because of low flammability and toxicity - A2L classification. Conclusion is that R32 is recommendable and optimal to use in the airconditioners and heat pumps, and it fits to the EU strategy in reducing CO₂ emission.

Key words: Refrigerant, R32, R410A, Global Warming Potential, CO₂ emission, low flammability

1. What is HFC32 (R32) and its benefits compared to other refrigerants widely used?

HFC 32 (R32) is difluoromethane, a single component HFC refrigerant. It is not new in the HVAC-R industry since it is known from the blended refrigerant R410A as 50% part. (Table 1).

Table 1. Comparison among refrigerants R32, R22 and R410A

<table>
<thead>
<tr>
<th>Refrigerants</th>
<th>ODP</th>
<th>GWP (IPCC4)</th>
<th>Flammability (ISO817/EN378)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R32</td>
<td>0</td>
<td>675</td>
<td>2L</td>
</tr>
<tr>
<td>R22</td>
<td>0.055</td>
<td>1810</td>
<td>1</td>
</tr>
<tr>
<td>R410A</td>
<td>0</td>
<td>2088</td>
<td>1</td>
</tr>
<tr>
<td>50% R32</td>
<td>0</td>
<td>2088</td>
<td>1</td>
</tr>
<tr>
<td>50% R125</td>
<td>0</td>
<td>2088</td>
<td>1</td>
</tr>
</tbody>
</table>
Compared to R22, refrigerant R32 and R410A have no Ozone depleting potential, while both R22 and R410A have much bigger Global Warming Potential (GWP) – compared to R410A R32 GWP is almost 3 times lower. R32 is the only flammable refrigerant, with the class 2L what is marking the “low flammability” according to ISO817 and EN378.

Stressing key benefits of R32 we may say it is the refrigerant that addresses a range of environmental, safety and economic considerations:

- Zero Ozone depletion potential (ODP) where R22 has, and therefore it is banned for the use in EU.
- Lower Global Warming Potential (GWP) – about one third of R410A
- R32 allows for reduced refrigerant charge, compact design and high energy efficiency
- Easier to charge, recover and reuse because it is not a blend
- Safe to use in many applications because it is an A2L classified refrigerant (low toxicity and lower flammability)

Like shown in Fig.1, the potential global warming impact (GWP x kg) can reduced be up to 75% than that of R410A. Energy efficiency can also be improved by 5-10% but this is depending on airconditioner type.

2. Main differences among R22, R410A and R32

Fig 2. Comparison of R22, R410A and R32 regarding flammability, operating pressure, discharge temperature and use of refrigeration oil.
2.1. Flammability and toxicity classification

<table>
<thead>
<tr>
<th>R32 flammability characteristics</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower flammable limit LFL</td>
<td>&gt; 3.5%</td>
</tr>
<tr>
<td>Upper flammable limit UFL</td>
<td>&lt; 19</td>
</tr>
<tr>
<td>Heat of Combustion HoC</td>
<td>&lt; 19</td>
</tr>
<tr>
<td>Burning velocity BV</td>
<td>&lt; 10 cm/s</td>
</tr>
<tr>
<td>Minimum ignition energy MIE</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 3. Flammability characteristic of R32**

Flammability classification of R32 is in the major change process towards the previous standard versions, and this represented the major obstacle in understanding and accepting the value of R32 as optimal refrigerant to be used in widest HVAC applications instead of R22 and R410A. According to a new EN378-1:2016 voted in August this year, R32 has the new classification of 2L as in ISO 817 and ISO 5149 standards. This 2L class (low flammable refrigerant) is added, to differentiate from class 2 refrigerants, since it represents substantially lower risk in handling and using than classical class 2 refrigerant.

In the new version of product standard IEC 60335-2-40, which is at the moment in the voting phase, it is expected to achieve the same categorization as in the standards ISO 817, ISO 5149 and EN 378.

As R32 is environmentally acceptable due to a much lower GWP than i.e. R410A, and it is technically convenient, because it doesn’t represents major change to the use or R22 and R410A it causes low or no investments for the installation companies to continue the business in a safe way.

Toxicity classification of R32 is A class according to ISO 817 and EN 378 which means low toxicity. This represents no change to a R410A and R22, and on top, even inside this A classification, R32 has the lowest toxicity compared to mentioned two other refrigerants (Fig. 4).

Combining this 2 classification, R32 is marked as A2L class refrigerant, what means low flammable and low toxic.

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>ATEL (% in air) Higher value is safer</th>
<th>ISO 817, EN 378 ASHRAE 34 Toxicity class</th>
</tr>
</thead>
<tbody>
<tr>
<td>R32</td>
<td>22%</td>
<td>A</td>
</tr>
<tr>
<td>R410A</td>
<td>17%</td>
<td>A</td>
</tr>
<tr>
<td>R22</td>
<td>5.9%</td>
<td>A</td>
</tr>
</tbody>
</table>

*ATEL = Acute Toxicity Exposure Limit. Higher value is safer.

**Fig. 4. Toxicity of refrigerants**
3. Guidelines for installation/service works

3.1. Transport

Key guideline is for the installers and service transportation means (vans, caddies, etc). It is important to secure following:

- Permanent ventilation required (Note: R32 is heavier than air so outlet should be at the bottom)
- No smoking, no ignition sources or hot surfaces
- Follow the instructions for transport of the cylinders and equipment
- Check local and trans-border transport regulations.

Similar precautions are already required for acetylene for brazing, so it is expected that installers and service crews are already having this requirements met.

3.2. Room size charge limits

Based on EN 60335-2-40 5th edition, there are no room size limitations for refrigerant charges below 1.23 kg. But there are limitations which are based on location of the indoor unit – as shown in the Fig.5. It is different for the units installed on the floor. This is expected to change with the upcoming new version, which will be issued in 2017, and bring relaxations for all charge limits connected to new A2L class of the refrigerant – low flammable and low toxic.

Formula for minimum floor area for given flammable refrigerant charge:

\[ A_{\text{min}} = \left[ \frac{M}{(2.5 \times LFL)^{5/4} \times h_0} \right]^2 \]

\[ A_{\text{min}} = \text{minimum room area [m²]} \]

\[ M = \text{refrigerant charge [kg]} \]

\[ h_0 = \text{height of leak} \]

\[ LFL = \text{Lower Flammability Limit [kg/m³]} \]

![Fig.5. Allowed refrigerant charge per room size](image)

3.3. Brazing

When brazing, rules are the same as when in use will be R22 or R410A. The installation must be dry, clean and tight. As per common HFC or HCFC re-
frigerants such as R410A and R22, also R32 will decompose and release toxic substances if heated to high temperatures over 570°C. To avoid the possibility of this occurring during brazing, the system should be purged with dry nitrogen to ensure that there is no residual refrigerant present. The risk of toxic by-products when R32 comes in contact with a flame or very hot surface is the same risk that has existed for over 40 years with R22, and it is very low.

3.4. Pressure of R32

![Fig.6. Absolute pressure in dependence of the outside temperature](image)

Discharge pressure of R32 is similar as to R410A (Fig.6.). Important is to pressurise equipment on 4 MPa to test tightness as similarly done with R410A installation, so basically no difference is expected.

4. Refrigerant charge and recovery

Because it is not a blend, R32 can be charged in liquid or gas phase (as is/was the case for R22). Differently, R410A, as it is the blend of R32 and R125 (Table 1), it needs to be charged in liquid state. Adding R410A to the installation in a gas form may cause the refrigerant composition to change, preventing normal operation reducing the capacity of the system and causing efficiency drop. Connected with that, R32 is also easier to recover, recycle or reclaim compared to blend refrigerants.

5. Tools

Most tools are shareable for R32 and R410A. However this is not the case for R22 because R22 uses mineral oil which should not be mixed into R32/R410A equipment. Also some flare nut sizes are different for R22.

E.g. difference from R32 to R410A is that cylinder thread adaptor is different since it is for flammable gasses. Refrigerant recovery is different for every gas, therefore, right cylinder should be used and right vacuum pump. It is always advised to check with the supplier of the vacuum pump, if the pump can be used for both, R32 and R410A.
6. Conclusion

Installation/service practices for R32 are:

- Similarity with R410A: similar pressure, shareable tools
- Similarity with R410A and R22: basic rules for piping & brazing
- Difference from R22: higher pressure, different oil type
- Difference from R410A and R22: because R32 is flammable, specific guidance and regulations need to be followed (transport, room size limits, work instructions…). Always follow guidance from gas and equipment providers and the local regulations.

Additional attention points while installing equipment where R32 is used:

- Ventilate the area if brazing
- Ventilate the area in the event of any refrigerant leak
- Pressure test the system to 4.0MPa
- Evacuate the system to a minimum of 500microns
- Signpost and restrict access to the area if brazing or if a leak occurs
- Have a fire extinguisher at hand
- Remove any potential source of ignition

R32, used as a single component refrigerant, is a newer refrigerant in the world market (it is not new in terms of being part of the blended refrigerant R410A). HVAC-R industry was and is looking for the answer on the pressure coming from efforts to reduce GWP in the world and EU. New regulations and laws are being made as we speak; pressure on the industry is higher than ever to reduce GWP using environmentally friendlier refrigerants. Some producers decided to go with R32 refrigerant, since it is perceived as the best solution in given circumstances, taking lots of aspects into consideration like: reduction of CO₂ emission as very important one, technical utilisation of available technologies, economic component to keep the competitiveness and prices to the consumers, availability of the refrigerant, and other. Having all this in mind R32 is optimal (and preferable) choice as the key refrigerant for the next period when we talk about airconditioners and heat pumps.