ENGINEERING TOMORROW

Technical Article | A2L

Transitioning to A2L refrigerants: it's easier than you might think

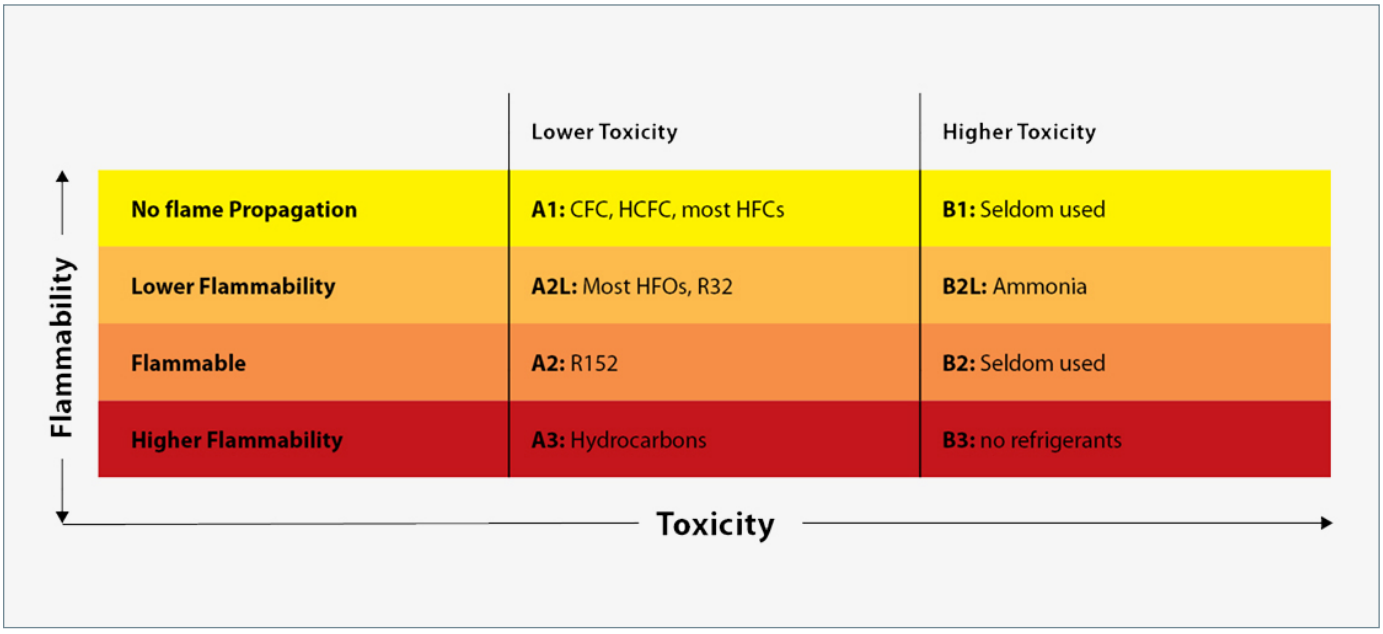
A growing number of installers are moving beyond medium Global Warming Potential (GWP) refrigerants like R448A and R449A in favor of ultra-low GWP alternatives. Mildly flammable refrigerants – with the ISO 817 classification A2L – offer a balance between ease-of-use, cost, and safety, along with a 90% reduction of greenhouse gas emissions.

By Gaël Renevier, Head of R&D System Solutions, Danfoss

Over the past decade, the cooling industry has succeeded in phasing down the use of high Global Warming Potential (GWP) refrigerants, limiting high-GWP HFCs in everyday applications.

The phase-down has paved the way for natural refrigerants with insignificant GWP levels, like R290 in smaller hermetic systems, and CO_2 for retail refrigeration. But despite their GWP benefits, both R290 and CO_2 require specific system architecture and more hardware than common HFCs to mitigate risks and meet mandatory EcoDesign efficiency thresholds.

A2L refrigerants – like R1234yf, R454C, and R455A – are mildly flammable alternatives that combine an ultra-low GWP with greater ease-of-use, delivering on both safety and environmental impact. For this reason, they're an increasingly viable option for installers who want to keep a conventional system design while minimizing GWP. They offer another green route to compliance.



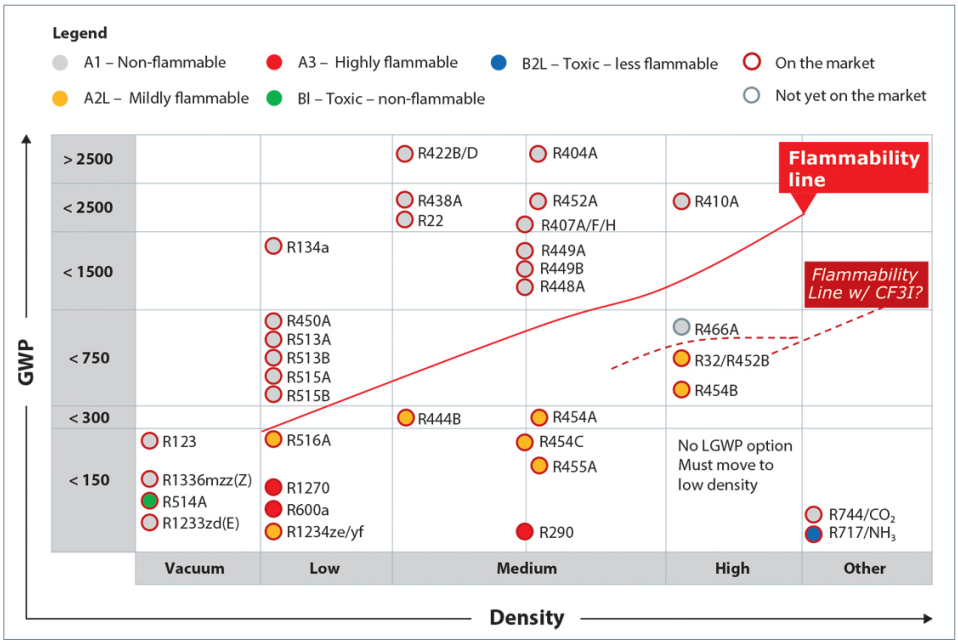
Refrigerant classes.

What are the benefits of A2L refrigerants?

The major benefit is on the GWP level. An A2L refrigerant like R454C or R455A offers 90% reduction in GWP over options like R448A or R449A—making it an attractive alternative as environmental regulations such as EU F-gas, currently under recast, continue to tighten.

Despite being rated as "mildly flammable", A2L refrigerants are relatively easy to use and can be worked on by most industry engineers without added system complexity or lengthy training. Due to their classification however, they do require some points of attention for a safe installation and installers must be prepared in handling these refrigerants as well as knowing the regulations and standards. With no toxicity – unlike refrigerants like ammonia – and lower flammability than hydrocarbons, A2L refrigerants are easier to manage once installed. This ease of use gives installers a simple way to reduce the carbon footprint of their installations.

While A2L refrigerants are subject to some additional standards requirements, they're a very safe option for most refrigeration, air conditioning, and heat pump applications when using a few basic precautions.



GWP vs density refrigerants chart.

The safety of A2L refrigerants

A2L refrigerants are only one step up from non-flammable A1 refrigerants, making them a practical alternative for commercial applications.

The "mildly" in the name is significant. In fact, A2L refrigerants require at least 1,000 times more energy to ignite than A3 refrigerants. Also, the concentration of an A2L refrigerant can be more than ten times greater than the A3 equivalent before it reaches its flammability limit.

An A2L refrigerant requires a concentration of approximately 300g/m³ or more to burn – and it's unlikely to be ignited by a cigarette or a space heater (source: Maryland University), although it is highly recommended to avoid any non-qualified source of ignition close by. And even in the event of ignition, A2Ls have limited risk because the "L" means they have a low burning velocity, as well as a low heat of combustion. In many cases, the flame will burn slowly and self-extinguish.

It's important to note that A2L refrigerants are still mildly flammable, so while the risk is low, some precautions are still needed. Properly qualified components are vital, and there are some necessary charge limitations. Depending on location or room size, users can apply A2L refrigerants up to 11kg for commercial refrigeration systems, with basic safety measures (source EN378-1).

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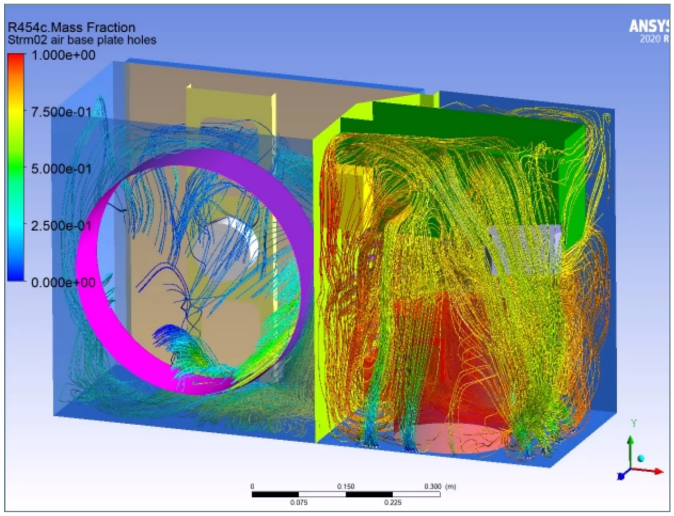
How we're preparing for A2L refrigerants

With the newest HFC phase down, a 55% reduction versus baseline, the trend towards ultra-low GWP refrigerants is gaining traction in commercial refrigeration. Many installers are switching to A2L-compatible systems to meet with the current F-Gas regulations. That's why we've made our Optyma™ **Plus** and Optyma™ **Slim Pack** multi-refrigerant condensing units compatible with A2L refrigerants.
We've also built in a whole range of safety measures to eliminate the possible risks of ignition for A2L refrigerants to ensure safe use, even in the case of leakage.

These include:

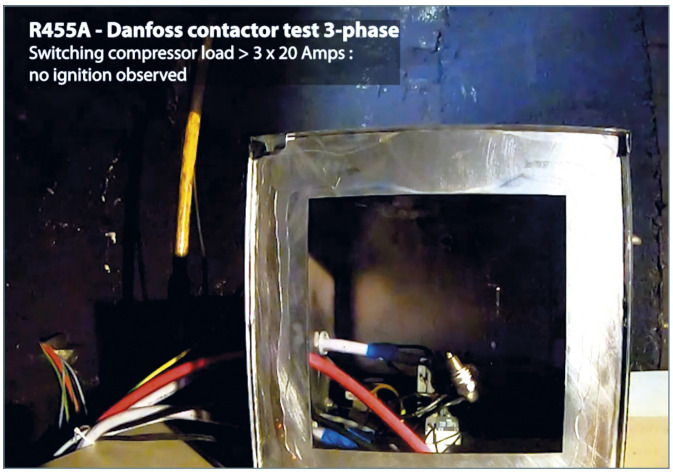
- **Finite Element Analysis (FEA):** A leak would need to be significant to reach an A2L refrigerant's lower flammability limit. To minimize the probability of any leakage, we're ensuring our components fit tightly by conducting thorough FEA simulations and tests

- **Computational flow dynamics (CFD):** We simulate leakages and apply safety factors to accommodate unpredictable circumstances and demonstrate that the concentration level is lower than the lower flammability limit in the vicinity of the electrical components



Computational flow dynamics of the Danfoss Optyma™ condensing unit.

- **Design risk mitigation precautions:** Sometimes condensing units can be affected by accidental damage, so we've equipped Optyma™ systems to handle worst-case scenarios. With a sealed electrical box, louvers to ensure the refrigerant's dilution, and pre-ventilation before energizing the compressor, there's no risk of ignition.



Ignition test in independent lab.

- **Application of IEC standard calculations:** These prove the inductive switching power of an Optyma™ A2L unit is lower than the energy needed to ignite an A2L refrigerant. Importantly, you can feel confident that all our safety measures have been rigorously tested in the broadest possible range of realistic operating conditions in an accredited independent fire safety laboratory.

- **Switching to A2L: we're ready when you are**
  There seems little doubt that the industry – and regulations – will continue to bear down on refrigerant GWP as the fight to tackle climate change intensifies. So, it's understandable that a growing number of installers – and OEMs – are seizing the initiative by exploring A2Ls today.

  At Danfoss, we're ready to help you make the switch whenever you like – and you'll be able to do it with the comfort of Optyma™ systems' known reliability and ease-of-use.

Learn more about our range of multi-refrigerant, A2L-ready condensing units at
https://www.danfoss.com/en/products/dcs/condensing-units/condensing-units/

If you'd like to discuss any of the forthcoming innovations – and see how Danfoss can help address your cooling design challenges – contact your Danfoss representative, or sign up to our newsletter.

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