As seen in rac

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What's the Big Deal about Hydrocarbon Charge Sizes?

As the HVACR industry takes on the responsibility of designing equipment with a lower overall impact on the environment, the use of highly flammable hydrocarbons (Class 3) in refrigerating appliances is one of the solutions being considered.

Often, when this topic is raised it leads to a discussion about the "fairness" of the allowable charge sizes for hydrocarbon use in refrigerating appliances. A frequent response is "What's the big deal?" as homeowners have propane or natural gas running throughout the house already for heating and cooking.

Why is it that highly flammable (Class 3) hydrocarbons in refrigeration appliances are restricted to less than 150 g or less than 500 g per appliance, depending on the standard and part of the world you live in, while a domestic boiler can consume up to 4.5 litres of propane per hour?

The answer lies with the significant system design, assembly, operation, and service considerations that come into play in a refrigeration cycle, which are simply not a factor in the use of a boiler, gas stove, or other gas heating device in the home.

Let's take a closer look:

- **Pressure** In the refrigeration cycle, pressures at the compressor and condenser reach about 200-400 psi (13.7 bar to 27.6 bar) for typical refrigerants used, which is in stark contrast to the typical operating pressure of a propane heating appliance that operates around 0.2-0.4 psi (0.01 bar to 0.03 bar).
- **System Design** HVACR systems are fundamentally designed with thinner-walled heat exchangers, in order to help with heat transfer, whereas the thickness of household piping used in propane systems is not limited by heat transfer concerns.

These differences between refrigeration system operating conditions and design and that of a propane boiler lead back to one inescapable fact: refrigerating appliances have a higher probability of leaking than the liquid propane tank feeding the domestic boiler.

A higher probability of a leak of a highly flammable Class 3 hydrocarbon necessitates keeping charge size restrictions to a lower, safer limit. A lower charge size is a critical safeguard to ensure that even if a highly flammable Class 3 hydrocarbon is released, the chances of forming an ignitable flammable concentration in the air are minimized.

The next question often raised is: "Why not use an odorant in refrigerating appliances – like we do in liquid propane and natural gas – so you can smell a leak and take precautions?" Unfortunately, using odorants isn't an easily viable option.

It's important to consider that hydrocarbons in refrigerating appliances need to be designed to circulate for more than a decade, while hydrocarbons in furnaces are quickly burned and consumed. The typical life expectancy of a refrigerating appliance is 10-15 years, and the same refrigerant circulates repeatedly in that system, undergoing temperature and pressure cycling numerous times a day. In contrast, propane furnaces are designed to feed propane into the furnace to be immediately burned.

Odorants are typically organic materials, and when organic materials are placed in an operating environment with temperature and pressure cycling, they have a high probability of degrading over time. Degradation is not a concern in the boiler as it immediately burns the propane, but it can impact the system performance and reliability of a refrigerating appliance. Moreover, the degradation byproducts may be more toxic than the odorants used and therefore a careful evaluation should be performed.

While industry bodies such as ASHRAE continue to study the use of odorants and other detection devices for a full range of refrigerant classifications, the search is certainly not a trivial task.

The search for an odorant that could work does ignore one simple fact: even if there was an available material, the use of the human nose as leak detector is highly discouraged. As a result, industry must continue to limit charge sizes. There is a very good reason charge limits are restricted and should remain so: safety.

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