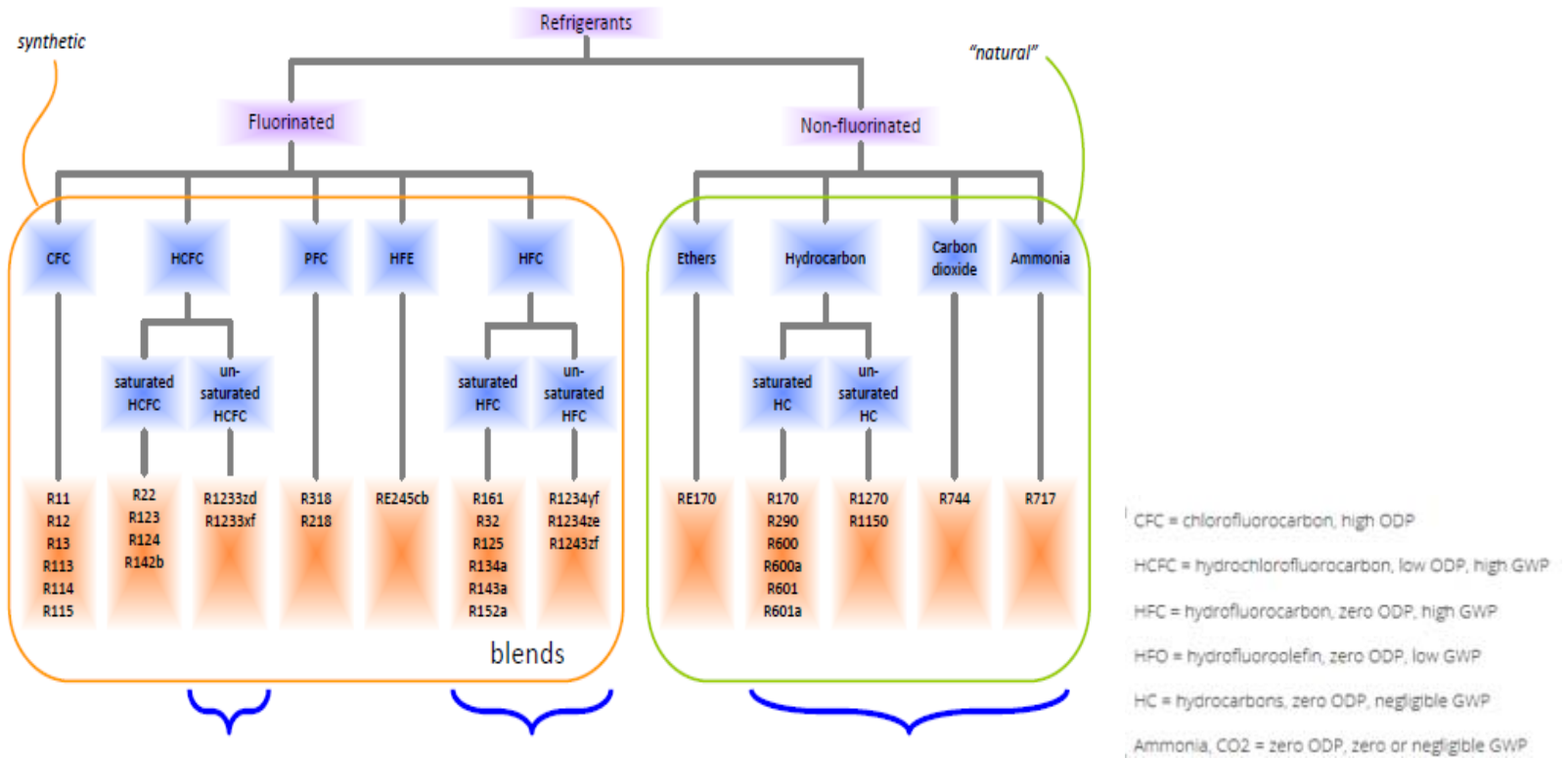

Ervaringen van ENGIE Axima Refrigeration

Met milieuvriendelijke koelmiddelen

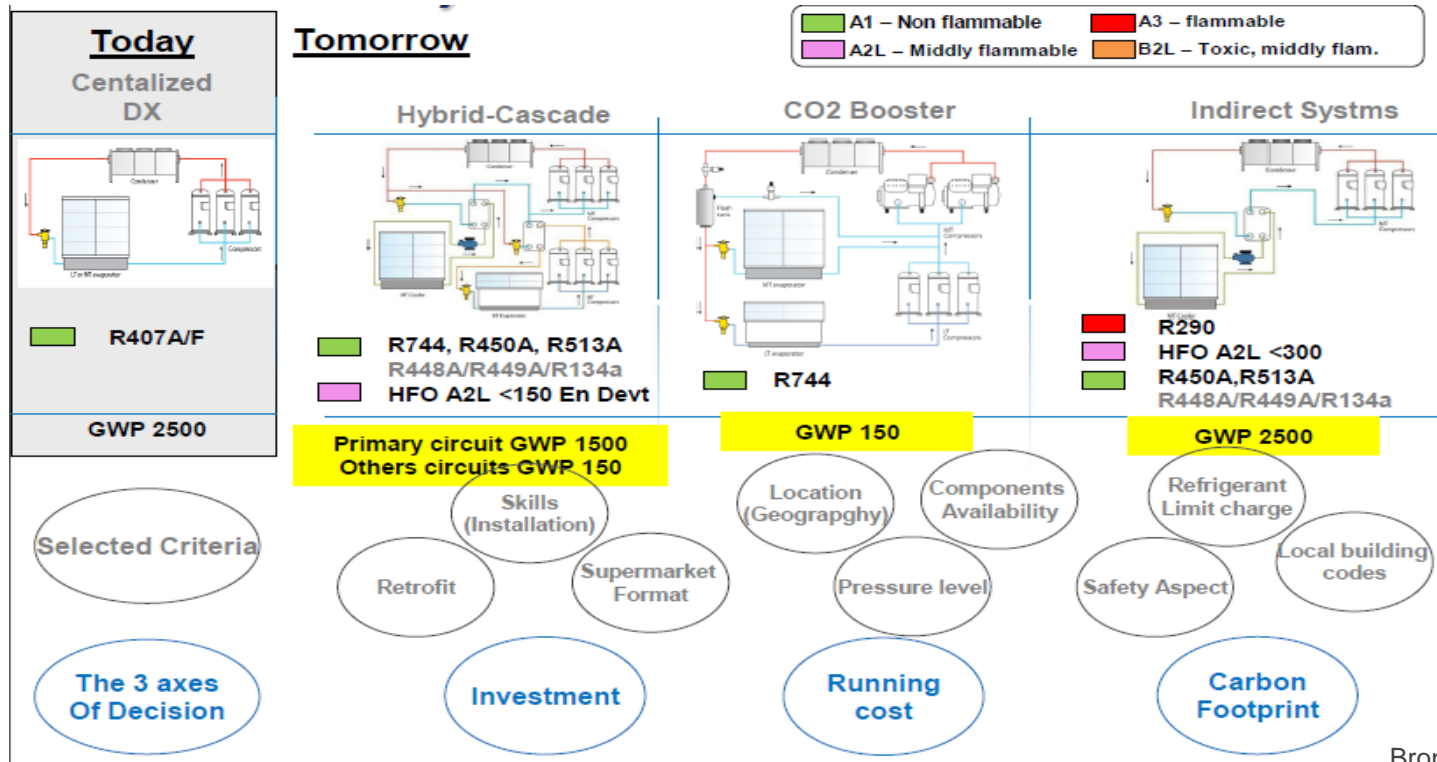


Koelmiddelen met een lage tot gemiddelde GWP waarde



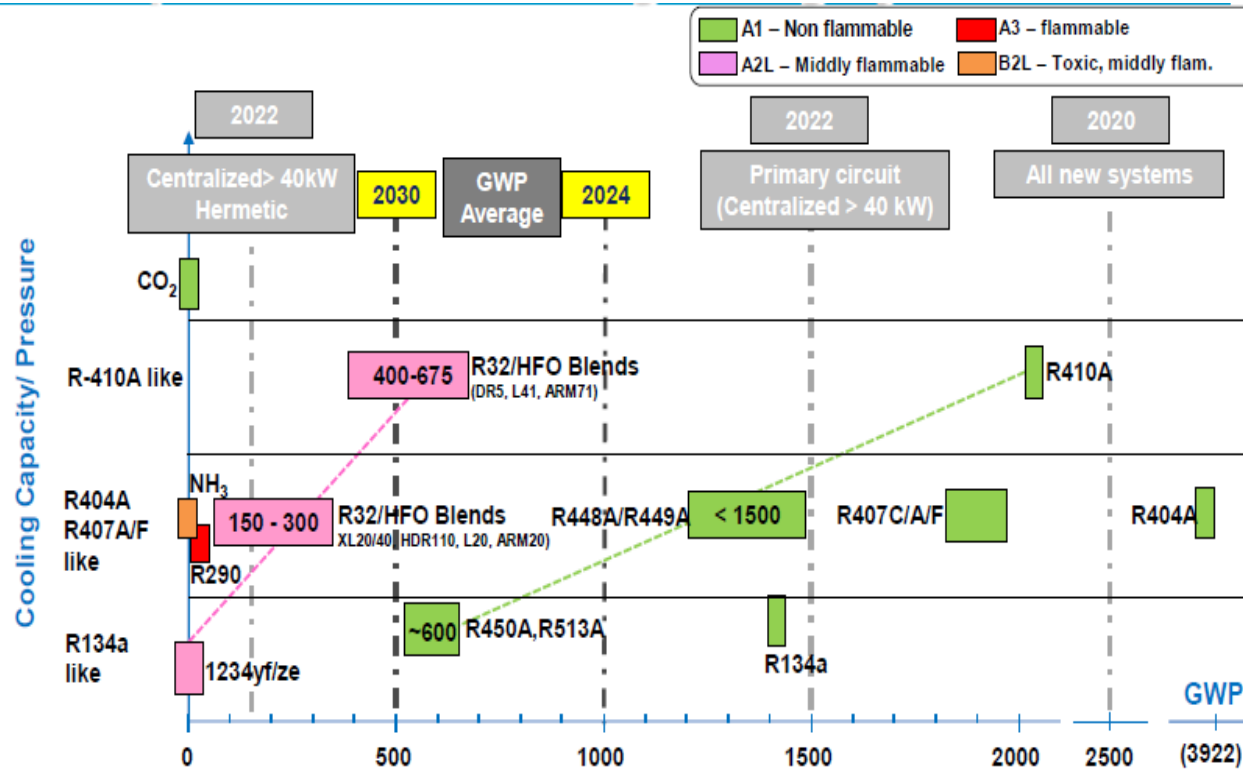
Bron: Markus Wypior

Meerdere opties mogelijk voor centrale systemen



Bron: Emerson

De keuze van het koelmiddel is bepalend voor je ontwerp



Bron: Emerson

Belangrijkste eigenschappen koelmiddelen

| | lage toxiciteit | hoge toxiciteit |
|----------------------|-----------------|-----------------|
| niet brandbaar | A1 | B1 |
| lage brandbaarheid * | A2L | B2L |
| brandbaar | A2 | B2 |
| hoge brandbaarheid | A3 | B3 |

* De brandpropagatie snelheid (<10cm/s) is te laag om een horizontale vlamverspreiding of een explosie te weeg te brengen volgens ASHRAE. Deze klasse is reeds opgenomen in ISO 817 en de pr h EN 374

| koelmiddel | natuurlijke koelmiddelen | | | syntetische koelmiddelen | |
|-----------------|--------------------------|-----|-----|--------------------------|-----------------------------|
| | HC | NH3 | CO2 | gesatureerde HFC | niet gesatureerde HFC (HFO) |
| GWP | ++ | ++ | ++ | -- | ++ |
| Brandbaarheid | -- | - | ++ | ++ | - |
| Toxiciteit | ++ | -- | + | ++ | ++ |
| Druk | + | + | -- | + | + |
| Beschikbaarheid | + | + | + | ++ | - |
| Kennis | + | + | - | ++ | - |

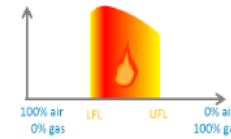
Karakteristieken van een brandbaar gas

- Volgens ISO817 & ASHRAE34

| | Class 1 | Class 2L | Class 2 | Class 3 |
|-------------------------------|-----------------------|--|--|---|
| | Not flammable | Lower flammable = Class 2 AND burning velocity ≤10 cm/s | Flammable LFL > 3,5% and Heat of Combustion < 19000 kJ/kg | Higher flammable LFL ≤3,5% or Heat of Combustion ≥ 19000 kJ/kg |
| Class A lower toxicity | R-744 (CO2) R-410A | R-1234yf / ze R-32 | R-152a | R-290 (Propane) |
| Class B higher toxicity | | R-717 (Ammonia) | | |

LFL = lower flammable limit in% by volume
For R-32, the LFL is 0,306kg/m³
For R-290, the LFL is 0,038 kg/m³

Omdat de brandbaarheid van R32 zeer laag is, kan het veilig bij praktisch iedere toepassing van warmtepomp worden toegepast.
Bij bepaalde omstandigheden zijn er beperkingen (zie wetgevingen zoals ISO5149, IEC/EN60335-2-40, EN378 ... bij gebouwen

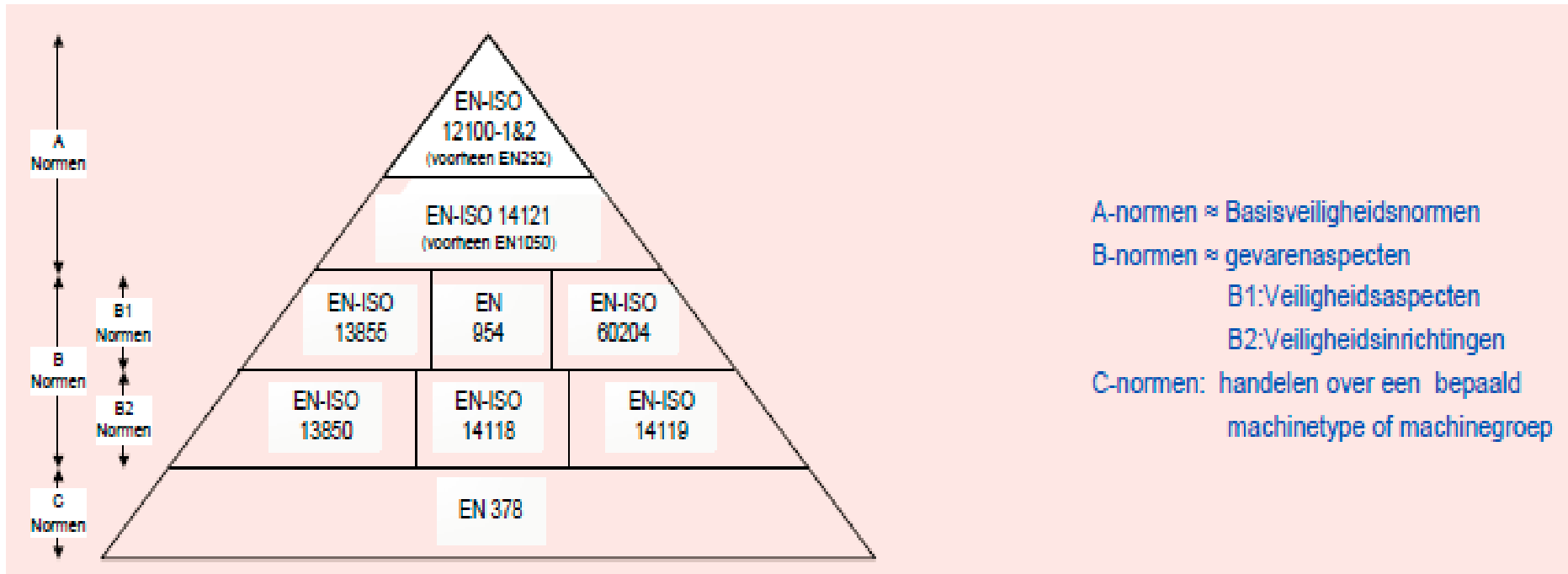


| GAS | LFL-UFL |
|-------------|---------|
| R-32 | 14-31 |
| Iso-butane | 1,8-8,4 |
| Natural gas | 5-15,8 |
| Ammonia | 15-30 |
| R410A | / |
| Acetylene | 2,3->80 |



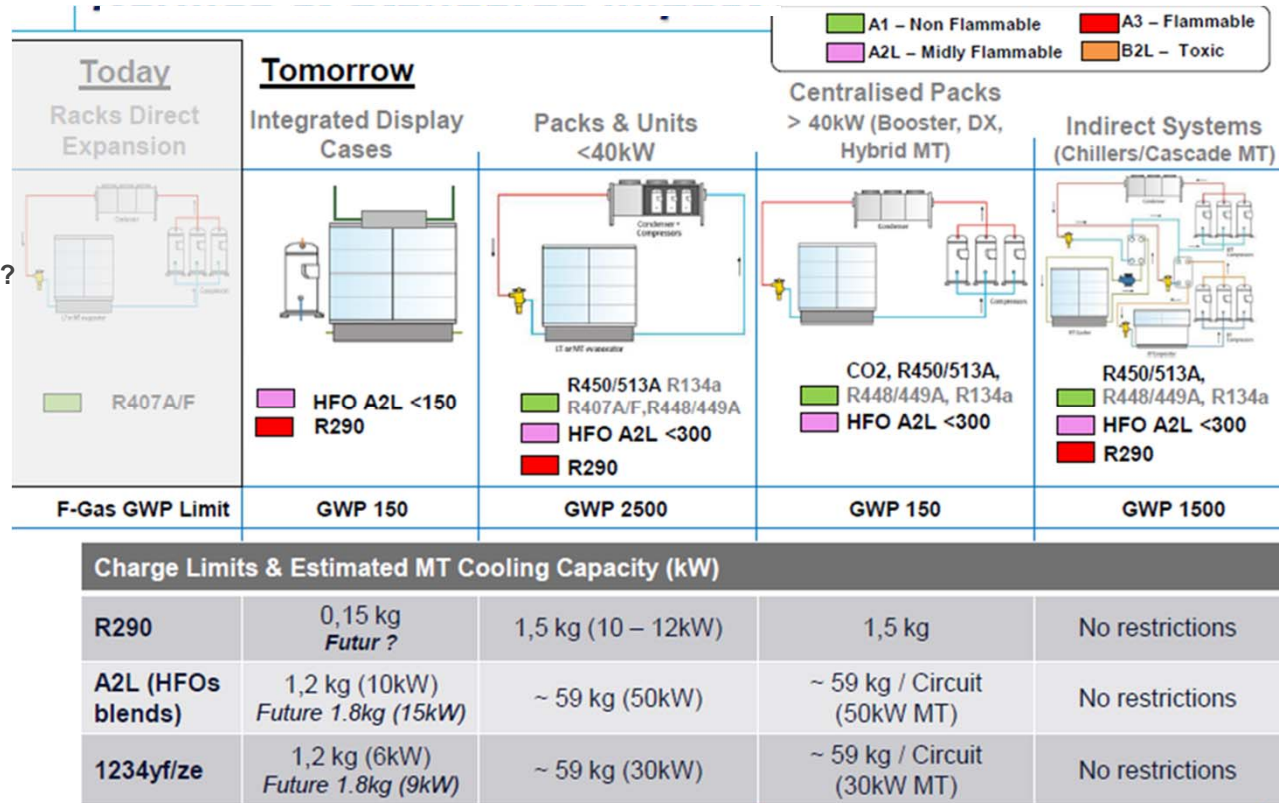
Bron: Daikin

Installatiebedrijf = eindverantwoordelijke



Impact van de normen op het ontwerp

1. Veiligheidsgroep KM ?
2. Verblijfsruimte ?
3. Systemecategorie?
4. Opstelling systeem?



Bron: Emerson

Impact van alternatieve koudemiddelen op prestaties

| Screw Chiller Alternatives for Commercial Applications | | | | |
|--|-------------------------------------|-------------------------------------|-------------------------------------|---|
| | R-134a | R-513A | R-450A | R-1234ze |
| Type | HFC | HFC/HFO blend | HFC/HFO blend | HFO |
| Drop-in capacity vs. R-134a | Baseline | 2% | -12% | -25% |
| Optimized efficiency vs. R-134a | Baseline | -4% | -4% | -7% |
| Global Warming Potential (GWP) | 1430 | 631 | 604 | 7 |
| Ozone Depleting Potential (ODP) | None | None | None | None |
| Glide (°C) | None | None | 0.5 | None |
| Safety Classification (ASHRAE 34) | A1 Low toxicity Non-flammable | A1 Low toxicity Non-flammable | A1 Low toxicity Non-flammable | A2L Low toxicity Mildly flammable |

Results of tests carried out by Johnson Controls with the potential alternatives

Based on its test results, Johnson Controls maintains that R134a continues to give the best balance of cost/kg, efficiency, GWP, toxicity and flammability.

“However, to alleviate any uncertainty and concerns with regards the price and availability of R134 over time, we recognise the need to “future proof” our chillers,” said Scott Willocks.

Technologische innovatie met CO2 koelinstallaties

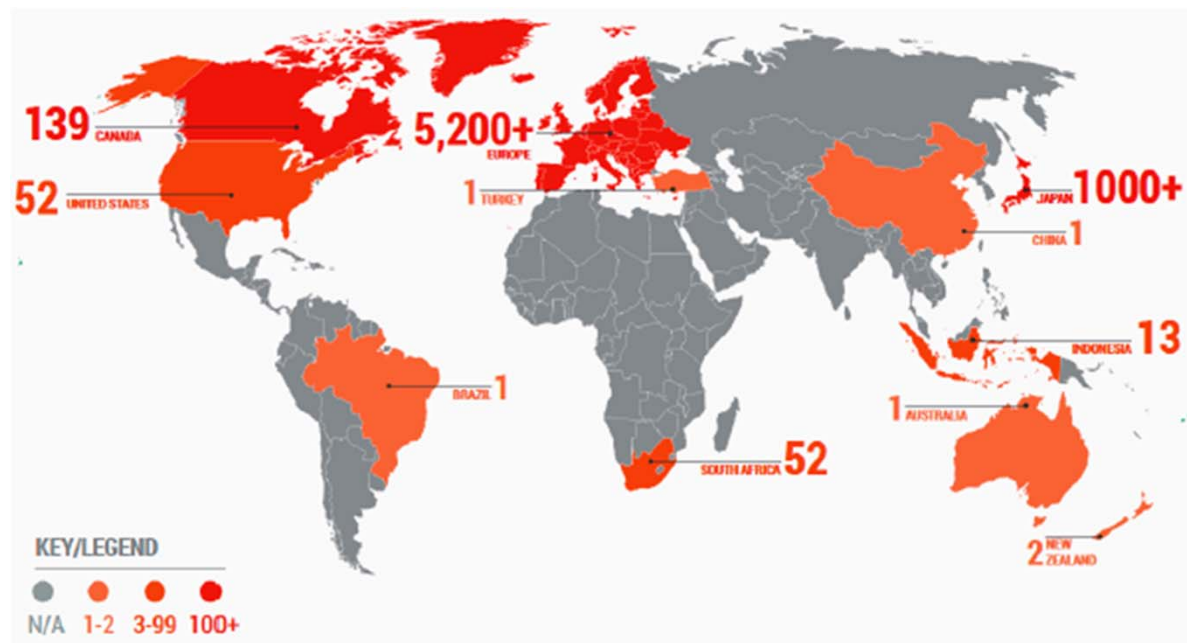
| System | Energy saving VS. R404a | Compressor saving VS. Booster |
|----------------------|----------------------------|----------------------------------|
| Booster | -11% | 0% |
| Parallel compression | 7% | 15% |
| Gas ejector | 10% | 18% |
| Liquid & gas ejector | 22% | 27% |

Comparison made @ 90 ° F

- Parallel compression is not a possibility on small systems (<100kW)
- Large energy saving potential in warm ambient with ejector technology
- Possible to build smaller (more compact) and cheaper systems using ejectors
- Liquid ejector solution is not ready for the large market yet.
- Multi ejector fits very well in stores with a capacity of 100 – 300 kW where we are strong today

Bron: Danfoss 2016

Spreiding CO2 koelinstallaties over de wereld



Bron: Danfoss 2016

Impact van Veiligheid, gezondheid & Milieu



Figure 4 - Recovery machines for use with flammable refrigerants (respectively on the left for HCs and on the right for A2L refrigerants)

REFRIGERANT RECOVERY

A2L-flammable refrigerant must be recovered using a suitable recovery machine (a standard recovery machine for halocarbon-type refrigerants must not be used).

Evacuate the recovery cylinder to remove air before filling it with flammable refrigerant.

Do not mix flammable refrigerants with other types of refrigerant in a recovery cylinder.

When recovering hydrocarbon refrigerants, do not fill the recovery cylinders with more than 45% of the HFC safe fill weight.

Label the recovery cylinder to show it contains a flammable substance.

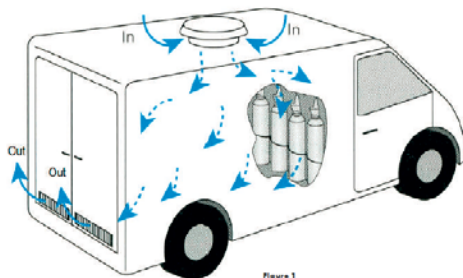


Figure 1

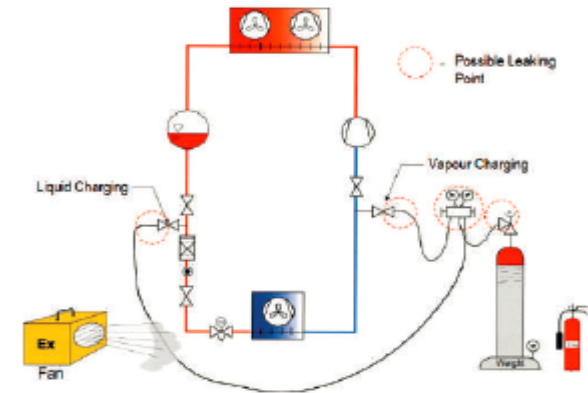


Figure 2 - Possible sources for leakage and safety equipment used when filling flammable refrigerant

EVACUATION

If a vacuum pump approved for A2L-refrigerants is not available, check that the on/off switch is the only source of ignition in the pump. If this is the case, the vacuum pump can be safely used with flammable A2L-refrigerant if the on/off switch is not used.

Move the switch to the on position and plug the pump into a socket outside the 3 m zone and control it from this socket

Locate the vacuum pump in a well-ventilated area or outside.

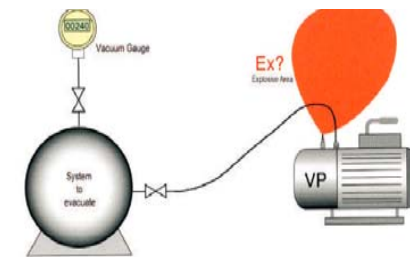
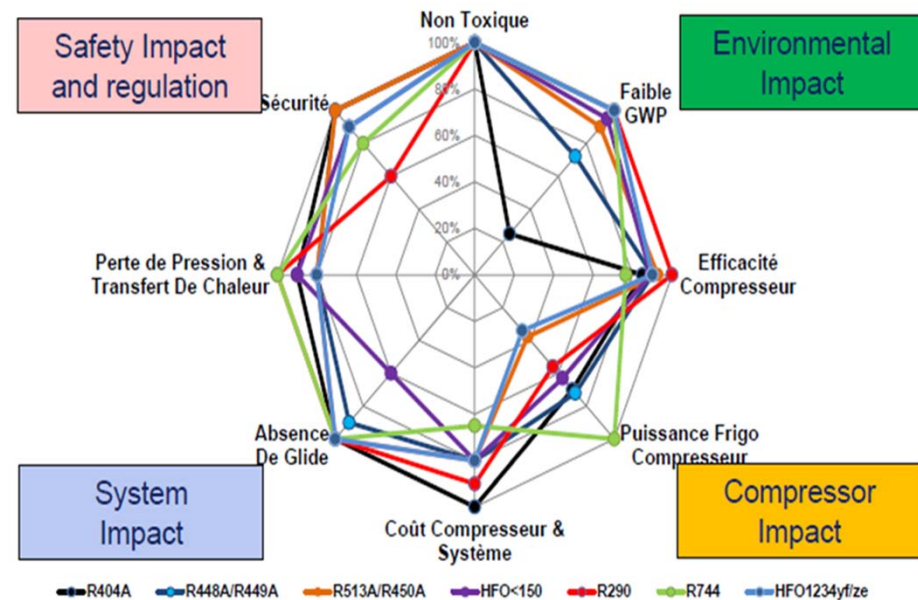


Figure 5

Bron: AREA

Samenvatting: Er is niet één alles makend alternatief koelmiddel

- Er is een enorme uitdaging bij de keuze van koelmiddelen om conform te zijn met de wetgevingen en tevens een performant systeem aan te bieden
- Er moet een compromis gemaakt worden tussen de economische en de ecologische doelstellingen. Koelmiddelen van de klasse A2L gaan een groot deel van de markt inpalmen
- CO2 koelmiddel zal een belangrijke rol spelen bij de koeling van supermarkten
- Voor grotere koelvermogens, is NH3 nog steeds de meest economische oplossing, rekening houdend met alle wetelijke eisen



Bron: Bitzer



QUANTUM olievrije koelgroep



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