NH3 and CO2 as natural working fluids

Petter Nekså
SINTEF Energy Research, Norway.
Refrigerants, what is important?

Energy efficiency
Differences in thermophysical properties gives the refrigerants unique characteristics
However, all refrigerants can in principle obtain the theoretical maximum energy efficiency (COP) for a given application
System and component development, together with an optimum system integration is the key tasks

Local safety
Proper engineering will reduce risk to acceptable levels, even for toxic and flammable refrigerants, but cost is an issue

Environmental issues
CFCs and HCFCs has failed due to ozone depletion (Montreal protocol)
HFCs has failed due to high global warming impact (Kyoto agreement)
Are we ready for a new range of synthetic refrigerants?
CO₂ and NH₃ are known not to be harmful for the environment

What to choose for the future?
Ammonia, NH₃, the old giant

Application status

Industrial refrigeration: since 1872
Preferred refrigerant in most of the world (80% in Europe, 90% in US est) Expected to become preferred option in developing world and Article 5

Marine refrigeration: increasing share

Heat pumps: medium to large, increasing

Lower capacity systems under development

Local safety developments

Combination with CO₂ in cascade
Charge minimisation
Scrubber systems eliminate emissions to the atmosphere for medium sized systems

Statement

NH₃, an old giant with a great
Carbon dioxide, CO\textsubscript{2}, coming back

Application, technology available
- Heat pump water heaters
- Mobile air conditioning systems
- Commercial refrigeration systems
- Beverage coolers

Under development
- Mobile heat pumps
- Transport refrigeration systems (containers, truck, marine)
- Residential heat pumps and air cond.
- Vending machines, combined hot-cold
- Heat pump dryers
- Water chillers
- Industrial refrigeration

Energy efficiency, an issue?
Superior energy efficiency is proven in many applications. Ongoing development will increase efficiency further and enable commercialisation in new applications.
Conclusion on $\text{CO}_2$ and $\text{NH}_3$

$\text{CO}_2$ and $\text{NH}_3$ (and HCs) are complimentary refrigerants which may cover most applications, alone or together.

$\text{NH}_3$ has a dominant role in industrial refrigeration and new applications are coming.

Safety risk of $\text{NH}_3$ can be reduced by combining with $\text{CO}_2$ in cascade systems, charge minimisation and by using scrubbers.

$\text{CO}_2$ systems has been commercialised in some applications and more are coming.

$\text{CO}_2$ systems will contribute to reduction in GHG emissions both by eliminating direct emissions and through reduced indirect emissions due to better energy efficiency.

$\text{CO}_2$ and $\text{NH}_3$ are natural substances known not to be harmful to the environment, thus long term alternatives.

Is there any reason to start using a new generation of artificial substances which have unknown and known negative effects to the local and global environment?