



9th Working Group Meeting on Stage II HCFC Phase-out in Brazil

Phase-out Technologies for RAC manufacturing sectors

Ole Reinholdt Nielsen
Sao Paulo, 20 March 2014



Outline

- Political framework;
- Technical options for RAC; and
- MLF trends.



Political Framework - Objective

- ODS Phase-out;
- Maximize climate benefit through:
 - Direct emissions (low GWP);
 - Indirect emissions (EE).



Political Framework

- TEAP Progress Report 2010

<i>GWP < ~30</i>	<i>“very low-GWP” (“ultra-low”¹)</i>
<i>GWP < ~100</i>	<i>“very low-GWP”</i>
<i>GWP < ~300</i>	<i>“low-GWP”</i>
<i>GWP < ~1000</i>	<i>“moderate-GWP”</i>
<i>GWP < ~3,000</i>	<i>“high-GWP”</i>
<i>GWP < ~10,000</i>	<i>“very high GWP”</i>
<i>GWP > ~10,000</i>	<i>“ultra-high GWP”</i>



Political Framework - New EU F-Gas

- Bans on placing in the market:
- Domestic refrigerators and freezers with HFCs, GWP ≥ 150 (from 2015);
- Refrigerators and freezers for commercial use (hermetically sealed systems) with HFCs : GWP $\geq 2,500$: from 2020 , GWP ≥ 150 : from 2022 onwards;
- Single split air-conditioning systems, less than 3kg charge size, F-gases with GWP ≥ 750 from 2025



Political Framework – HFC Phase-down

- North American Proposal to phase-down HFC;
- Handle HFC within Montreal Protocol;



Political Framework: Montreal Protocol intervention

Technology	Comments	Safety group
HFC-404A, 410, 407C	GWP	A1
HFC/HFO blends (drop-in)	GWP around 1000, no ICC	A1
HFC-32	GWP = 675	A2L
HFC/HFO blends – several in prep. Two types: HCFC-22 replacements and HFC-410 replacements	GWP in range of 150-300	A2L
CO2 – R-744	Excess pressure	A1
Ammonia – R-717		B2
R-290, 1270 and HC blends		A3

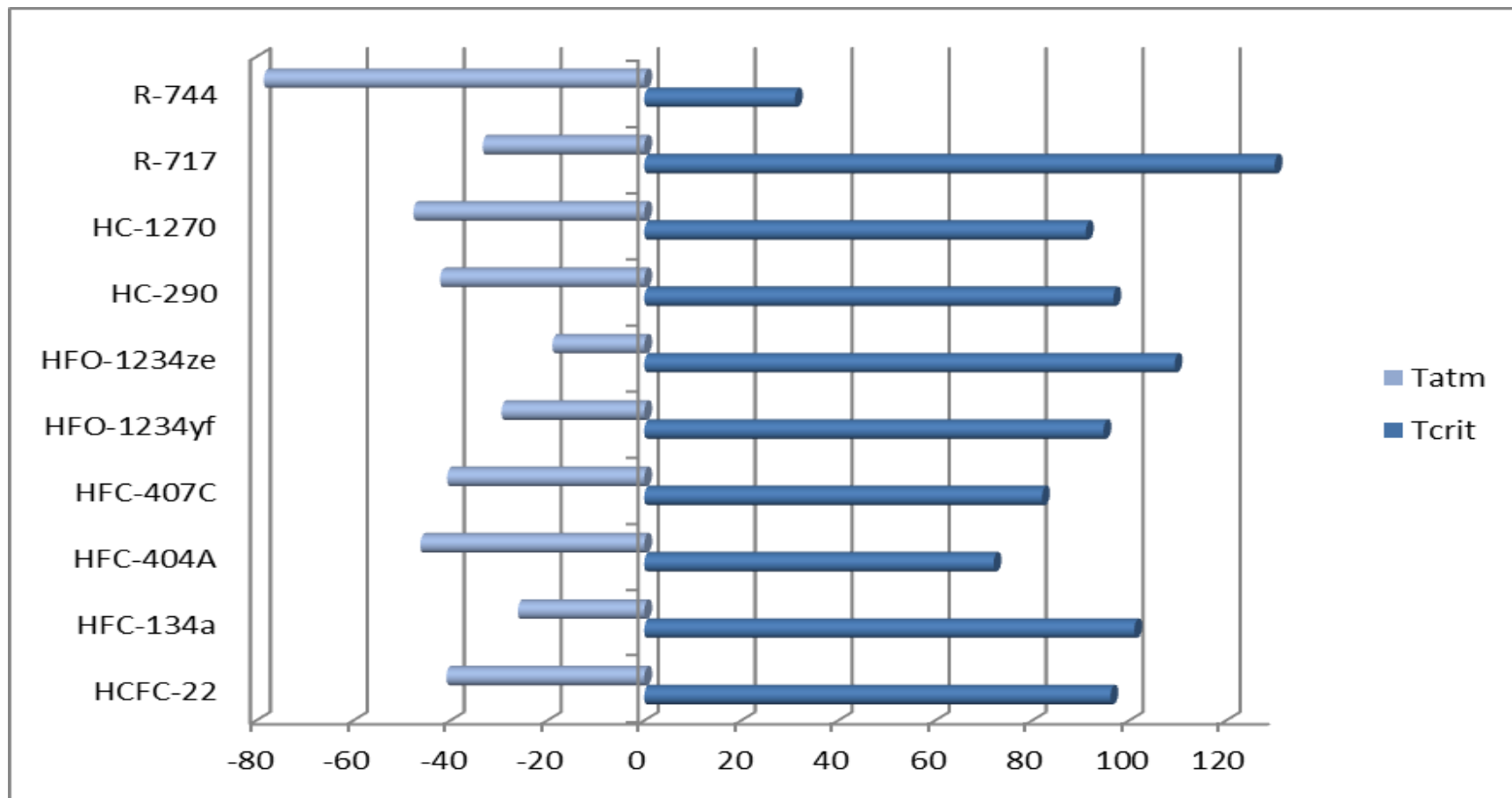


Some parameters to consider when selecting HCFC-22 alternatives

- Operating pressure;
- Volumetric capacity;
- Temperature glide;
- Energy efficiency;
- Global and local environment; and
- Price/availability.

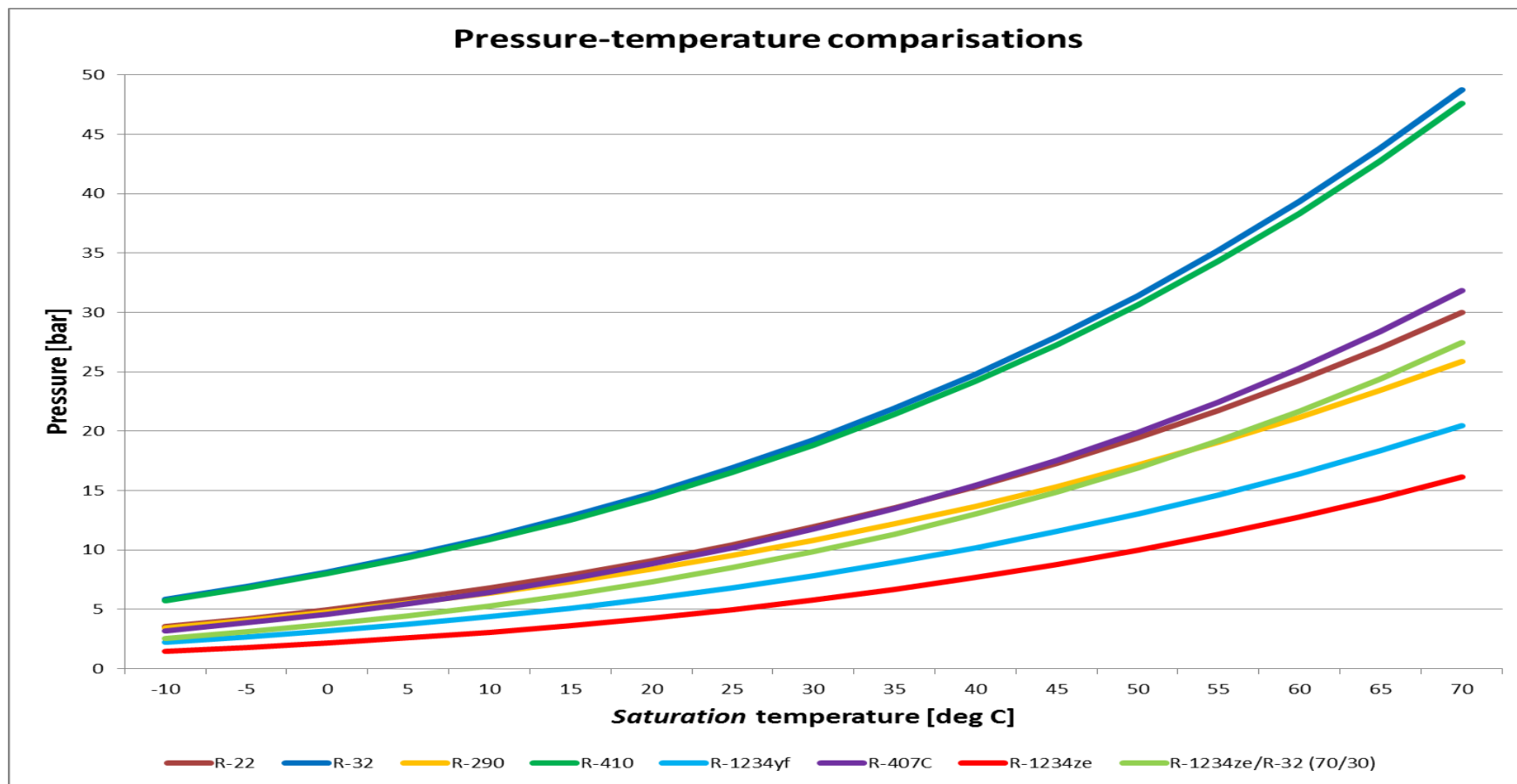


Refrigerants properties – temp's



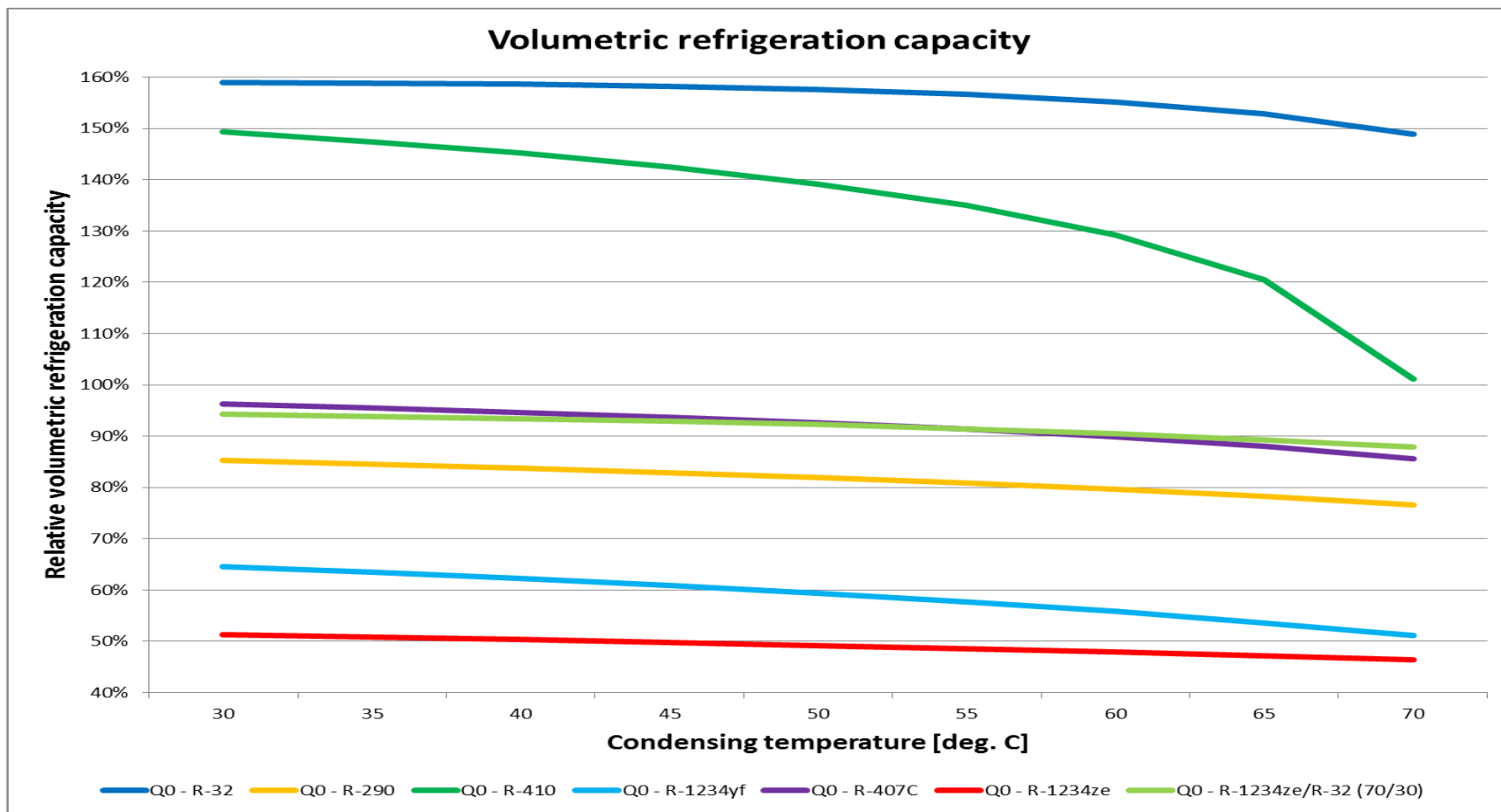


Refrigerants properties – temp's



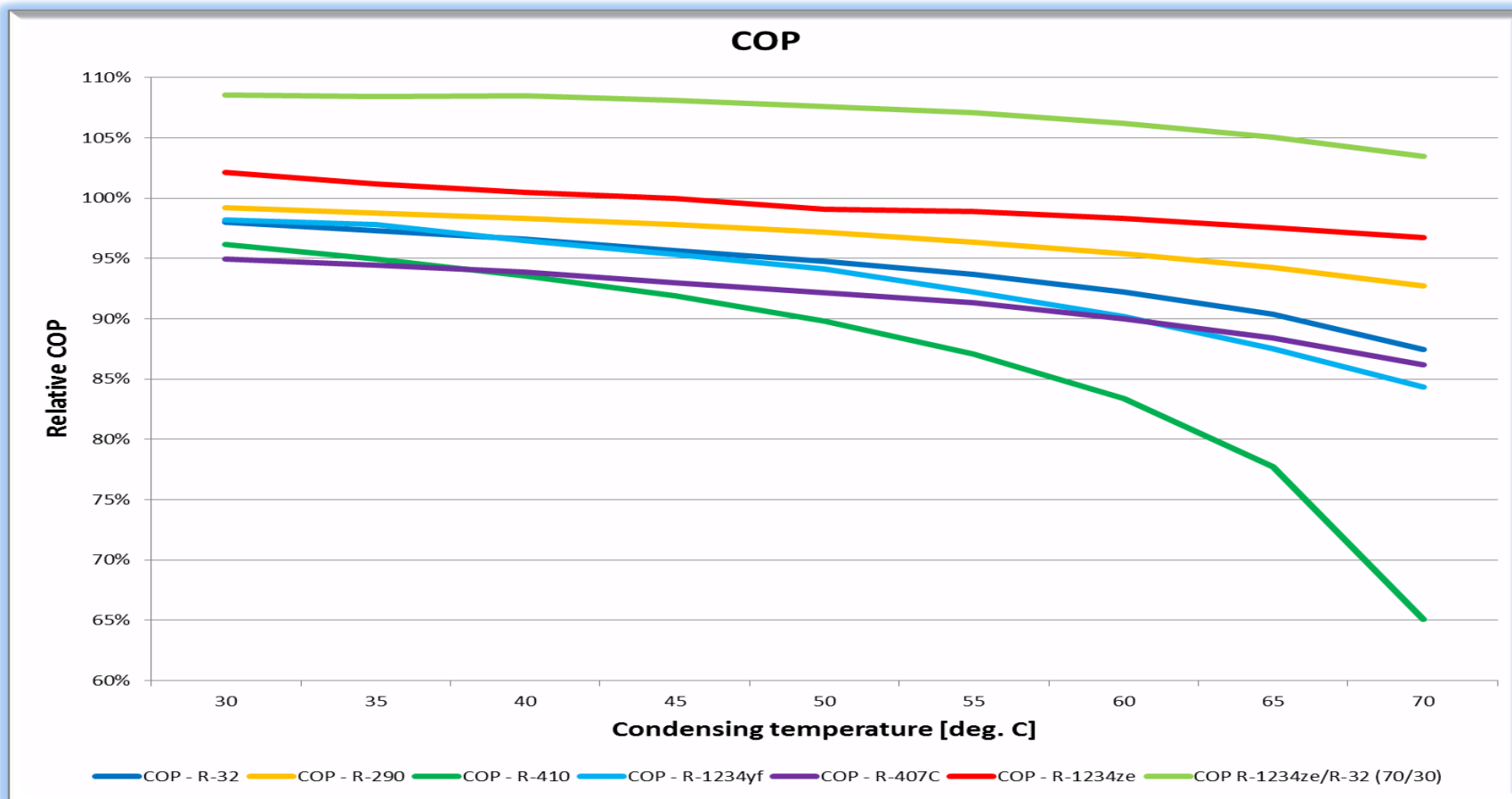


Refrigerants properties – volumetric capacity





Refrigerants properties – COP





Safety classification

Classification			Toxicity	
			Class A	Class B
			Lower chronic toxicity	Higher chronic toxicity
Flammability	Class 1	No flame propagation	A1	B1
	Class 2L	Lower flammable with low burning velocity	A2L	B2L
	Class 2	Lower flammability with higher burning velocity	A2	B2
	Class 3	Higher flammability	A3	B3



Alternatives – HFC/O

Refrigerant	GWP	Atmospheric boiling temp.	Safety class
HCFC-22	1810	-41 deg. C	A1
HFC-134a	1340	-26 deg. C	A1
HFC-152a	124	-24 deg. C	A2
HFC-32	675	-52 deg. C	A2(L)
HFO-1234yf	4	-30 deg. C	A2(L)
HFO-1234ze	6	-18 deg. C	A2(L)
HFO/HFC blends	300-500	???	A2(L)



Potential HC alternatives to HCFC-22

- R-290 (propane);
- R-1270 (propylene);
- R-433b (propane/propylene – 5%/95%)
- R-443a – HCR188C2 (propane/propylene/isobutane)

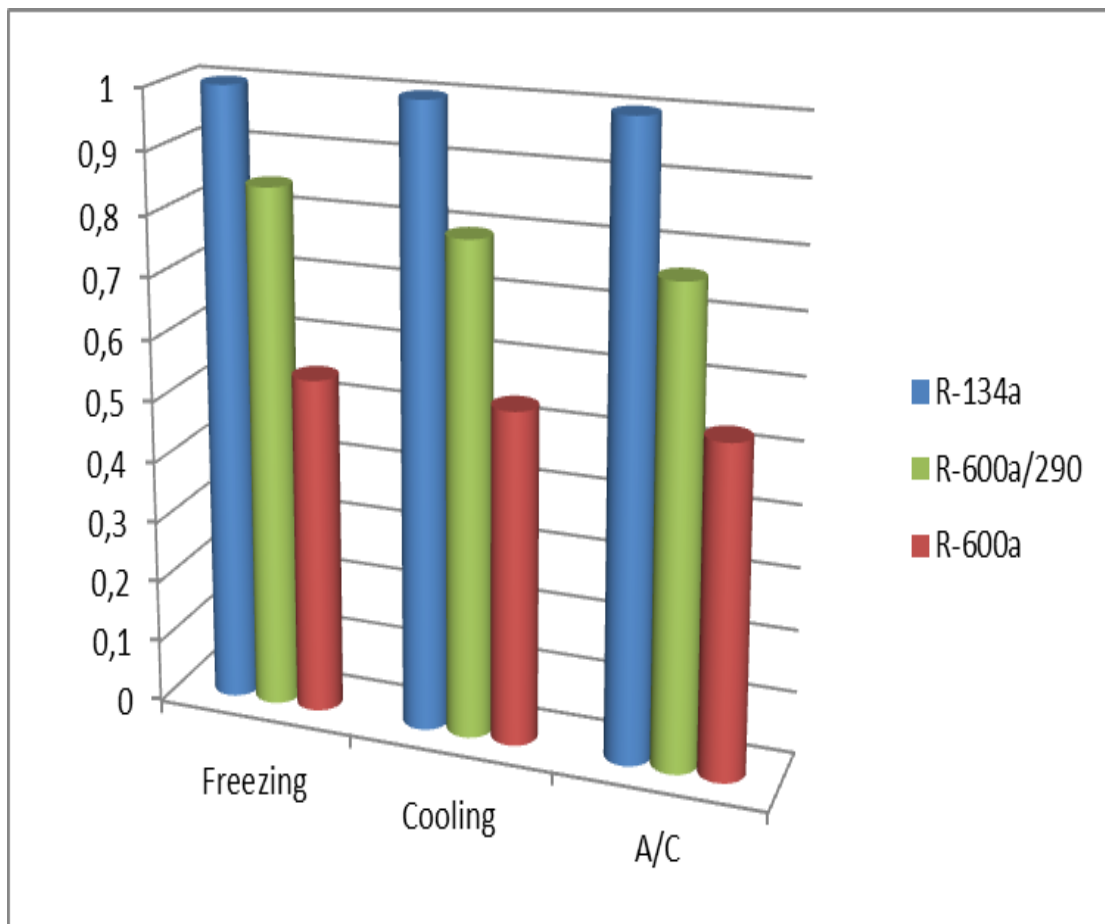




Potential HC alternatives to HCFC-22

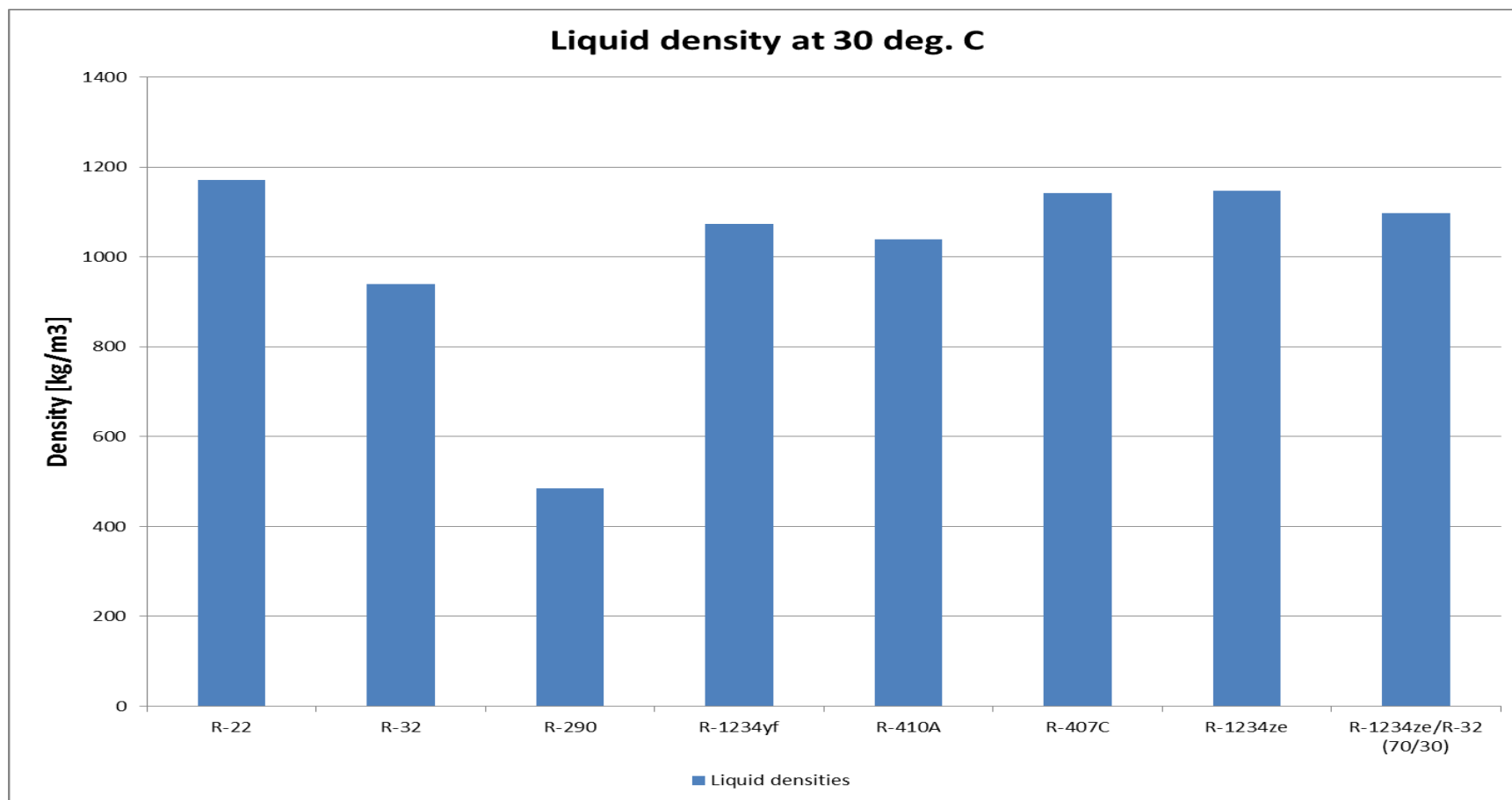
Example (DR):

- Initially the mixture of butane/propane (50/50) was selected;
- Later industry opted for pure isobutane.





Refrigerants properties – charge





Montreal Protocol intervention

- ICC and IOC;
- Any processes/operations directly affected by Montreal Protocol (i.e. Phase-out of HCFC-22) can be supported;
 - Limited support to HX modifications;
- Incremental operating costs (typically for 6 months) can be supported;
- Overall support should be cost effective (xx US\$/kg HCFC-22 phased-out).



Findings from China HPMP (RAC Sector)

- Pre HPMP demo projects at Gree (GIZ); Midea and GMCC (UNIDO);
- HPMP Stage I (UNIDO) scope (until 2015):
 - 18 A/C lines converted to R-290 (> 6 million A/C's per year);
 - 5 compressor lines converted to R-290

A/C manufacturer:

- Funds allocation based on standard setup (eligible items) and adjusted with cycle time;
- HX modifications supported (condenser coil from $\varnothing 7$ to $\varnothing 5$);



PRAHA Categories and Prototypes

	60 Hz		50 Hz	
	Window (18 MBH)	Decorative (24 MBH)	Ducted (36 MBH)	Packaged (90 MBH)
R32	Red	Green	Green	Red
HFO1	Green	Green	Green	Green
HFO2	Green	Green	Green	Green
HC	Red	Green	Red	Red



Concluding remarks

- No universal solution exist;
- Low-GWP alternatives exist:
 - Commercial refrigeration several options;
 - A/C slightly more complicated;
- Flammable refrigerants are here to stay – learn to work with them;
- Highly flammable vs mildly flammable:
 - In production setting no difference;
 - Difference in application.



Thank you for your attention

Contact

Ole Reinholdt Nielsen

Unit Chief, Refrigeration and Aerosols Unit
United Nations Industrial Development Organization,
UNIDO

Montreal Protocol Branch

P.O. Box 300, 1400 Vienna, Austria

Tel: +43 1 26026 3036 (direct)

Fax: +43 1 26026 6804

E-mail: O.Nielsen@unido.org

URL: www.unido.org