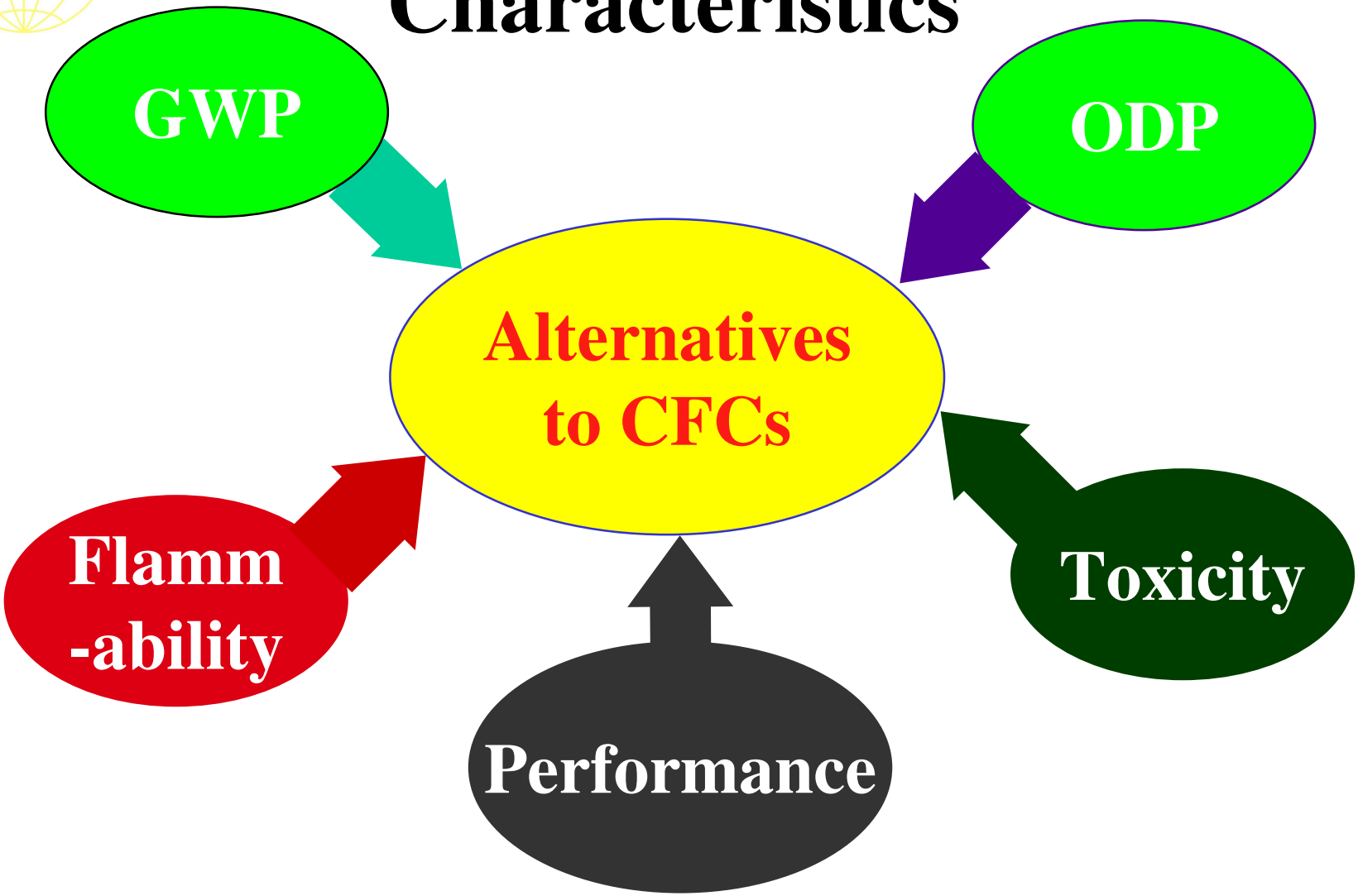
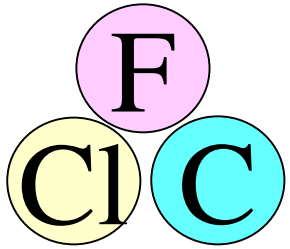
Alternatives to CFCs and their Characteristics

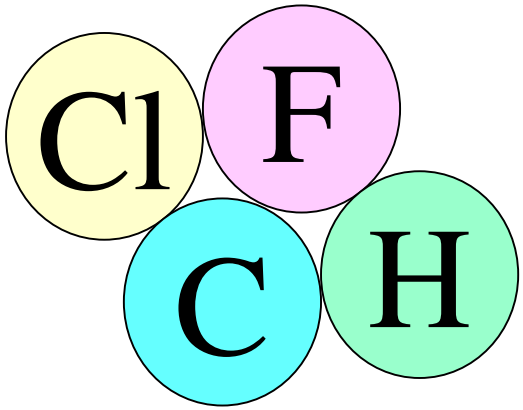
Alternative Refrigerants: Characteristics



Alternatives to CFCs

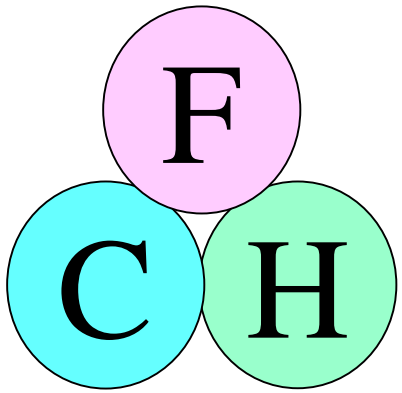


HCFC



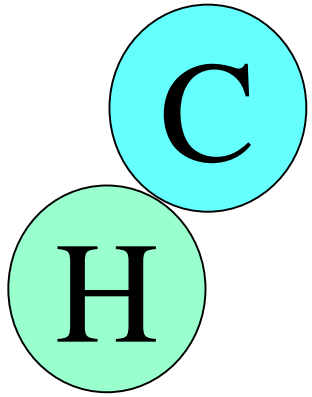
e.g. HCFC22

HFC



e.g. HFC134a

HC



e.g. HC600a

Environmental Characteristics

Refrigerant	Atmospheric Lifetime (Years)	ODP	GWP (100 Year)
CFCs			
CFC-11 (Baseline for ODP)	50	1.0	4000
CFC-12	102	1.0	8500
HCFCs			
HCFC-22	13.3	0.055	1700
HCFC-123	1.4	0.02	93
HCFC-141b	9.4	0.11	630
HFCs			
HFC-134a	14.6	0	1300
HFC-245fa	7.3	0	820
HCs			
HC-290 (Propane)	-	0	3
HC-600a (Isobutane)	-	0	3
Cyclo-Pentane	-	0	3
Blends			
R-404A	-	0	3260
R-407A	-	0	1770
R-407C	-	0	1530
R-410A	-	0	1730

HFCs and HFC Blends

e.g. HFC134a, R404a, R407c, R410a, R507

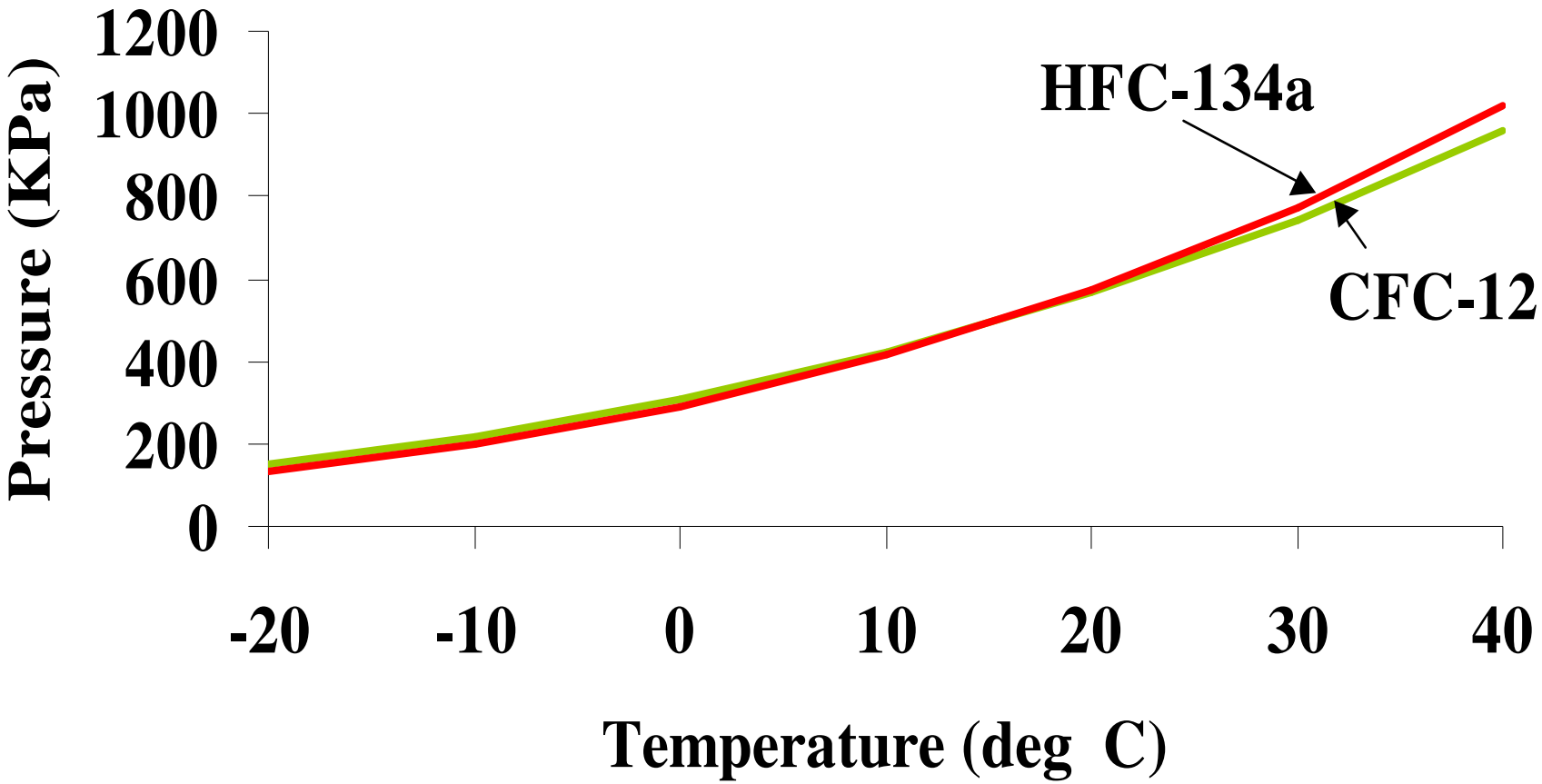
☑ Advantages

- **Zero ODP**
- **Non-flammable**
- **Capacity close to CFCs**

☒ Disadvantages

- **High GWP**
- **Do not work with Mineral Oil**
- **Reliability/Compatibility issues**
- **Major system changes necessary**

HFC-134a
Operating Conditions



HFC134a: Characteristics

- **Single fluid**
- **Boiling point: -26°C**
- **Capacity similar to CFC12 at high evaporation temperature**
- **Capacity lower than CFC12 at low evaporation temperature (-10 °C)**
- **Sensitive to contamination**
- **Costly & difficult to retrofit CFC12 appliances with HFC134a**

Other HFCs

- **R404a *as a substitute to* R502**
  - **Retrofit possible**
- **R407c *as a substitute to* HCFC22**
  - **Retrofit possible**
- **R410a *as a substitute to* HCFC22 & R502**
  - **for new systems**
  - **It has slightly high pressures**

Polyol Ester Oil Issues

- **Very hygroscopic**
  - → **reliability problems**
  - → **service issues**

Hydrocarbons (HCs)

e.g. HC600a(Isobutane), HC290 (Propane), HC Blend

☑ **Advantages**

- **Zero ODP**
- **Negligible GWP**
- **Long term solution**
- **Work with Mineral Oil and can be used in existing and new systems**
- **Few refrigeration circuit changes & capacity close to CFCs**

(applicable for HC Blends)

☒ **Disadvantages**

- **Flammable**
- **Changes needed to some electrical components**

<u>Being safely used in Europe and other countries</u>

HC Issues

- **Electrical devices attached to/ close to system must be non-sparking**
- **HC charge is lower**
- **Safe manufacturing/ servicing essential**
  - **training needed**

Blend Issues

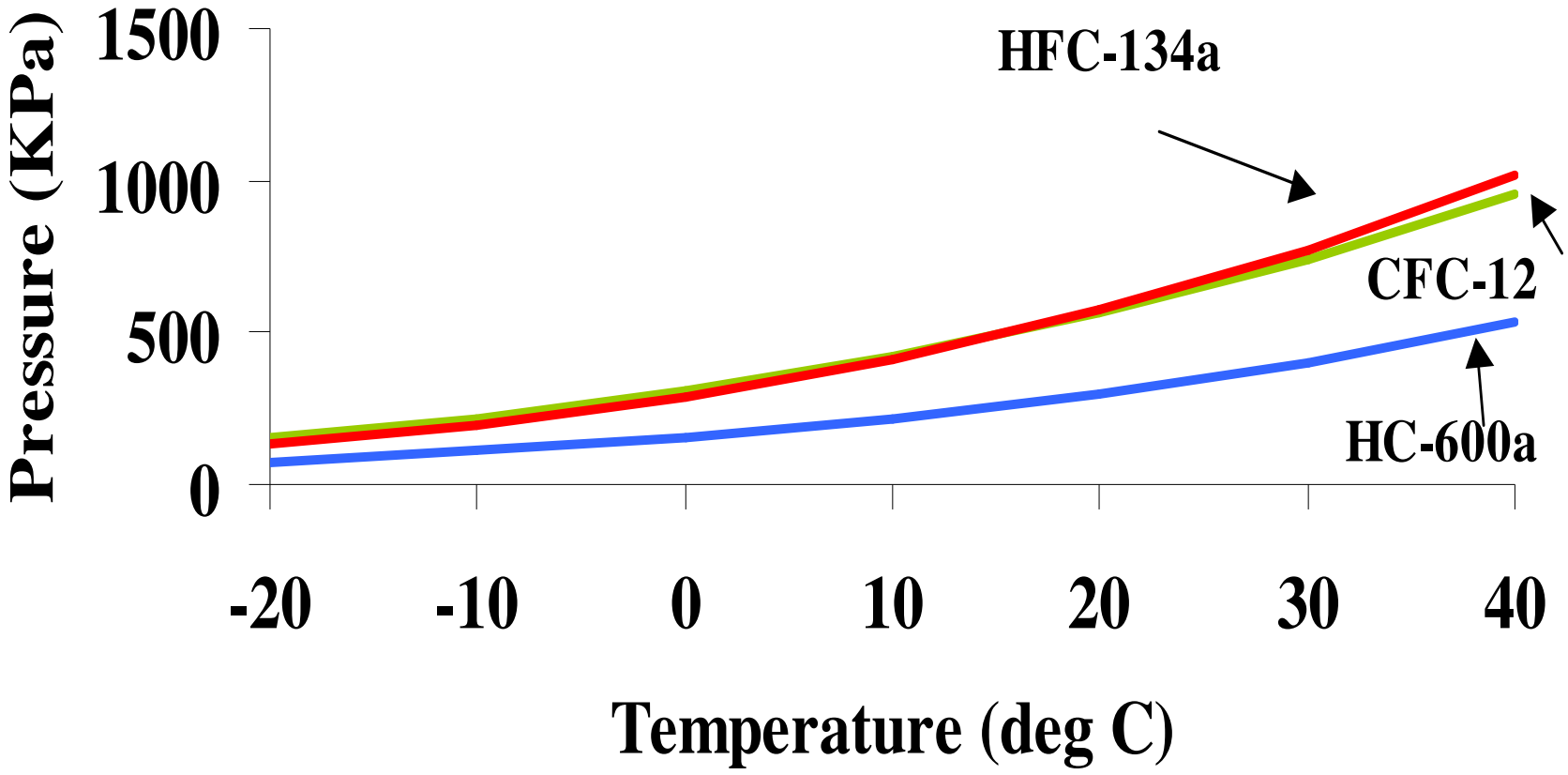
e.g. HC Blend

- **Many alternatives are zeotropic blends**
- **Do not behave as single substance**
  - **have temperature glide**
  - **different behaviour in system**
  - **different charging procedure**
  - **leakages are more problematic**

HC600a

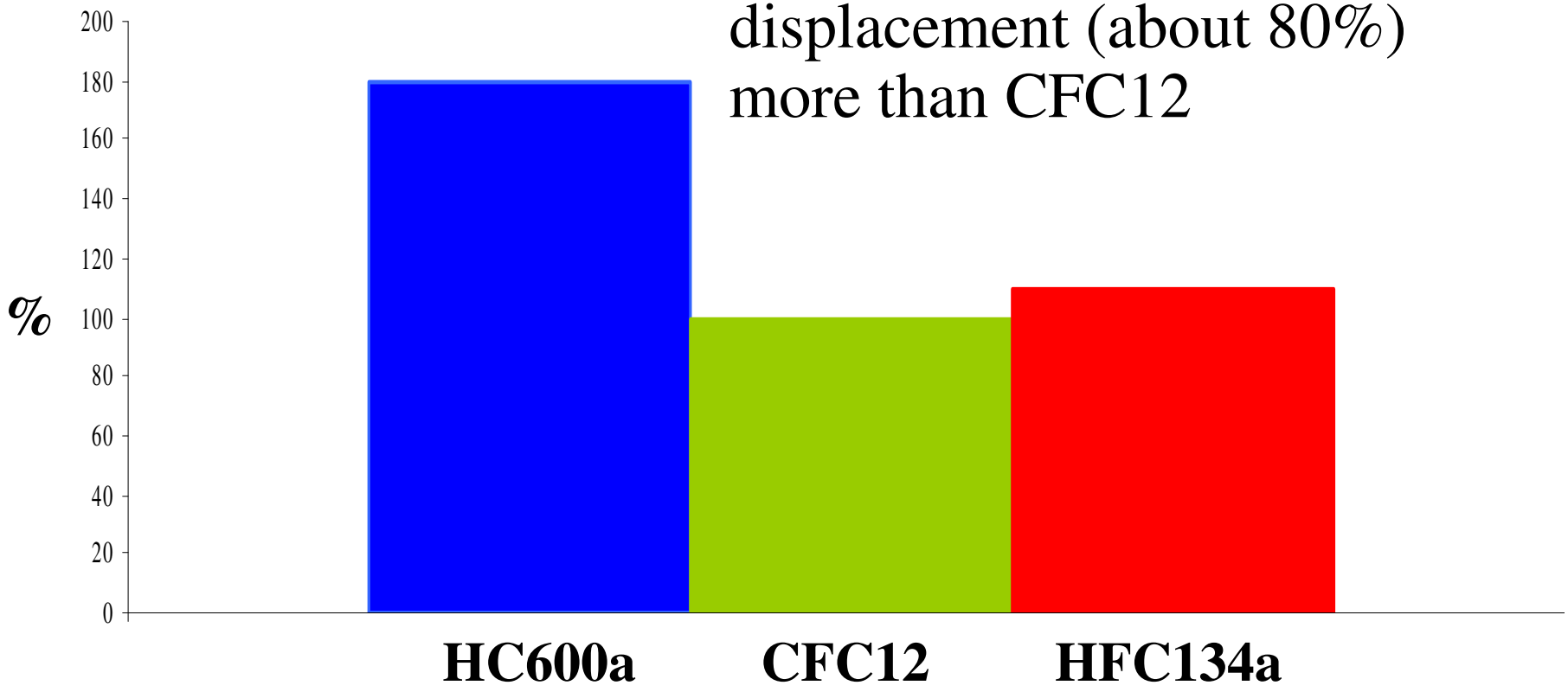
- **Isobutane**
- **Single substance**
- **Boiling Point: -12°C**
- **Much lower vapour pressures**
- **Miscible with Mineral Oil**
- **HC600a/Mineral Oil is compatible with compressor materials**
- **Widely used in domestic and commercial refrigerators**

HC600a: Operating Conditions



HC600a Compressor Size

Bigger Compressor displacement (about 80%) more than CFC12



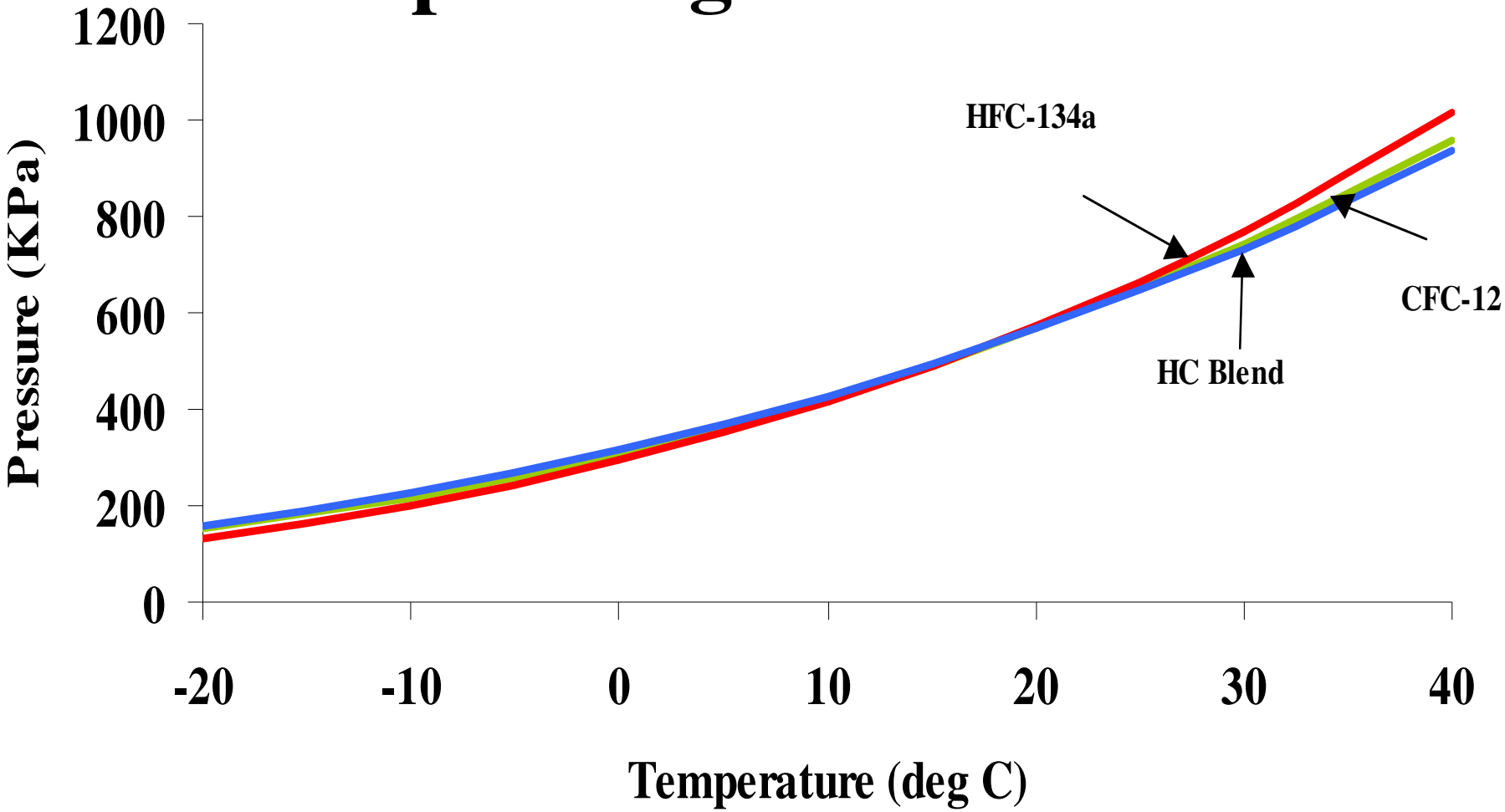
HC600a: Characteristics

- ☹ **Different compressor design**
- ☹ **Retrofit not possible**
- ☺ **Quieter**
- ☺ **Different capillary tube**
- ☺ **Lower condensing pressures**
- ☺ **Lower evaporating pressures**
  - *– under vacuum*
- ☺ **Only used in domestic and commercial systems**

HC Blends

- **HC290 (propane) / HC600a (iso-butane)**
- **50/50% by weight (most common)**
- **Zeotropic blend**
- **Fully miscible with Mineral Oil**
- **Compatible with compressor materials**

HC Blend: Operating Conditions



HC Blend Performance

Compared to CFC12

- ☺ Capacity similar
- ☺ Retrofit possible
- ☺ Same size compressor
- ☺ COP may be up to 20% higher, commonly 5 to 10% higher

HC Blend Performance (Contd.)

- ☺ Can be used to convert CFC12 or HFC134a systems
- ☺ Can be used with CFC12 or HFC134a compressor
- ☺ Can also be used in new systems
- ☺ Lower running costs

Other HCs: Alternatives to HCFC22 & R502

- **HC290:**
  - **propane**
  - **lower capacity**
- **HC Blends**
  - **Propane / ethane blends**
  - **Propane / propylene blends**

Issues with Alternative Refrigerants

HFC-134a

POE lubricants

Better manufacturing & servicing practices

Training required

Hydrocarbons

Require safer design

Better manufacturing & service practices

Training required

Should avoid HCs like commercial LPG