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CO₂ refrigeration in Scandinavia – Exploring sub- and transcritical technologies in the most demanding environmental and legal market in the world

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RSA, London, 27.10.2005

Sub- and transcritical CO₂ refrigeration

- Differences between subcritical and transcritical
- Transcritical applications and properties
- Benefits over conventional DX HFC systems
- Supermarket expectations in Scandinavia – why technology is being developed to meet increasingly stringent requirements
- How transcritical CO₂ refrigeration systems are being implemented in Scandinavia





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Introducing Knudsen Køling A/S

- **Danish company manufacturing and installing commercial refrigeration systems used in supermarket applications**
- **Products**
 - Sales islands for frozen food and meat products
 - Multidecks
 - Various delicatessen counters
 - Compressor packs
 - Electrical control system
- **100 in employment**

Kvickly Næstved KM/FM 193



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Metro Århus



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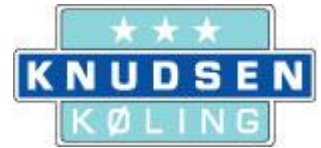
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KR 103 /150



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Nærum Stormarked



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Bilka / Fields



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Superbest Rødovre



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Refrigerants



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- Conventional systems HFC used
 - R134a and R404A
- High GWP
 - R134a 1300
 - R404A 3780
- In Denmark HFC's are taxed
 - R134a dkr. 130,- / kg = 17 euro / kg
 - R404A dkr. 378,- / kg = 50 euro / kg
- New national Danish law
 - After 01-01-2007 maximum HFC charge in system is 10 kg

Natural refrigerants

1. Ammonia

1. Toxic
2. Flammable

3. HC

Flammable

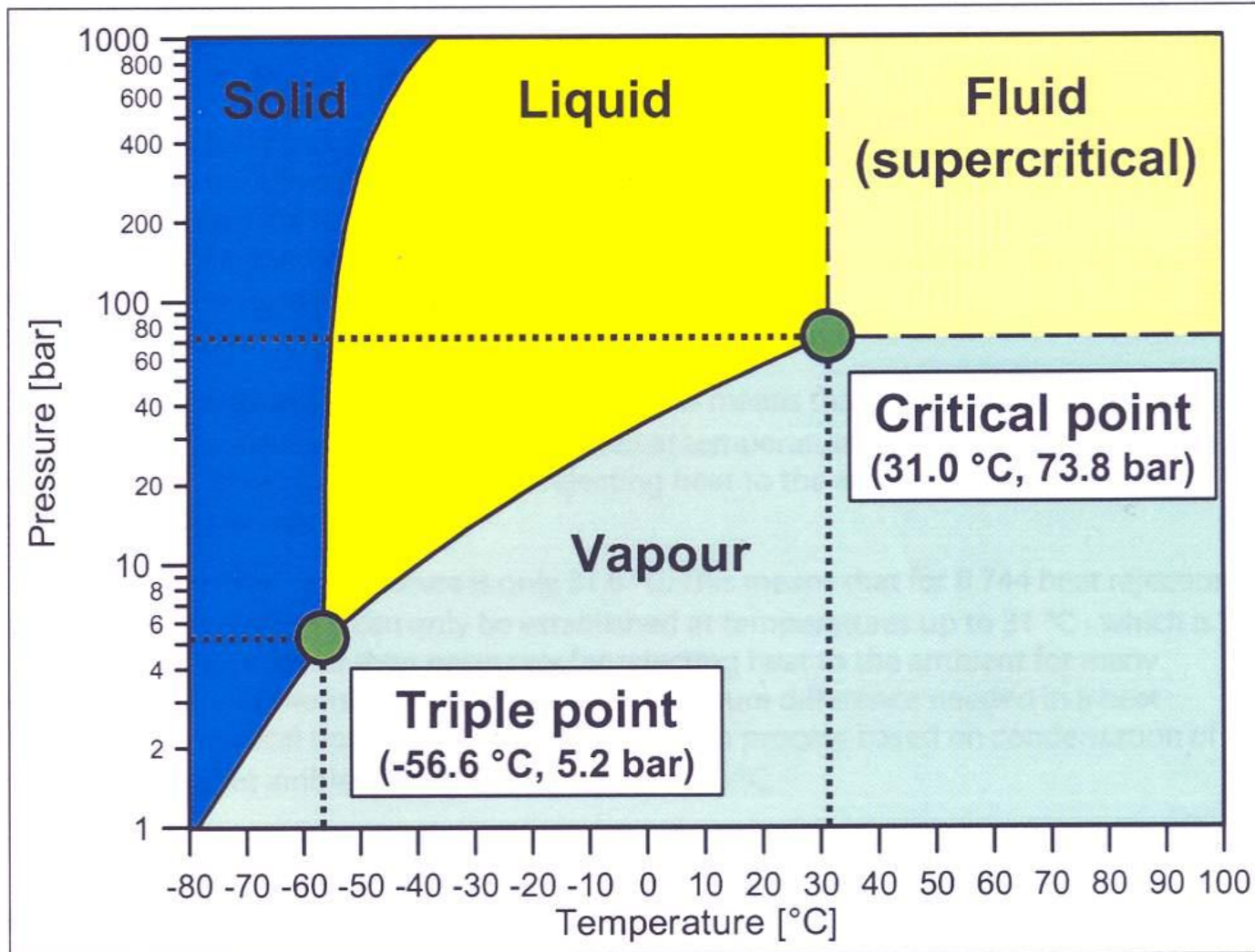
5. CO₂

Properties CO₂



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- ODP = 0 GWP = 1
- Odourless
- Non-flammable
- Non-toxic
 - High concentration increases breathing rate in humans
- Excellent heat transfer properties
- High volumetric capacity results in smaller tubes
- CO₂ operates at high pressure
- Critical point
 - 31.0° C, 73,8 bar
- Triple point
 - -56,6° C, 5,2 bar

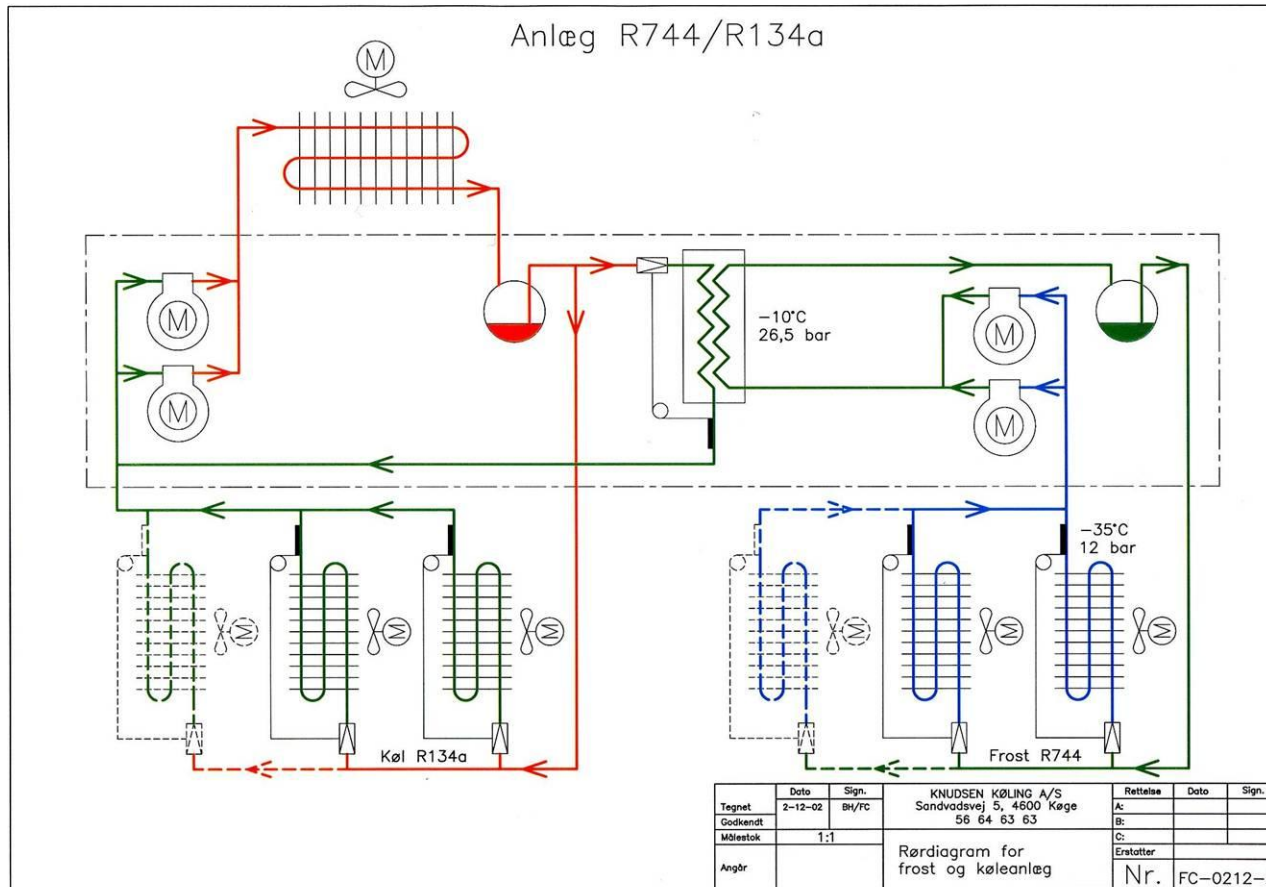


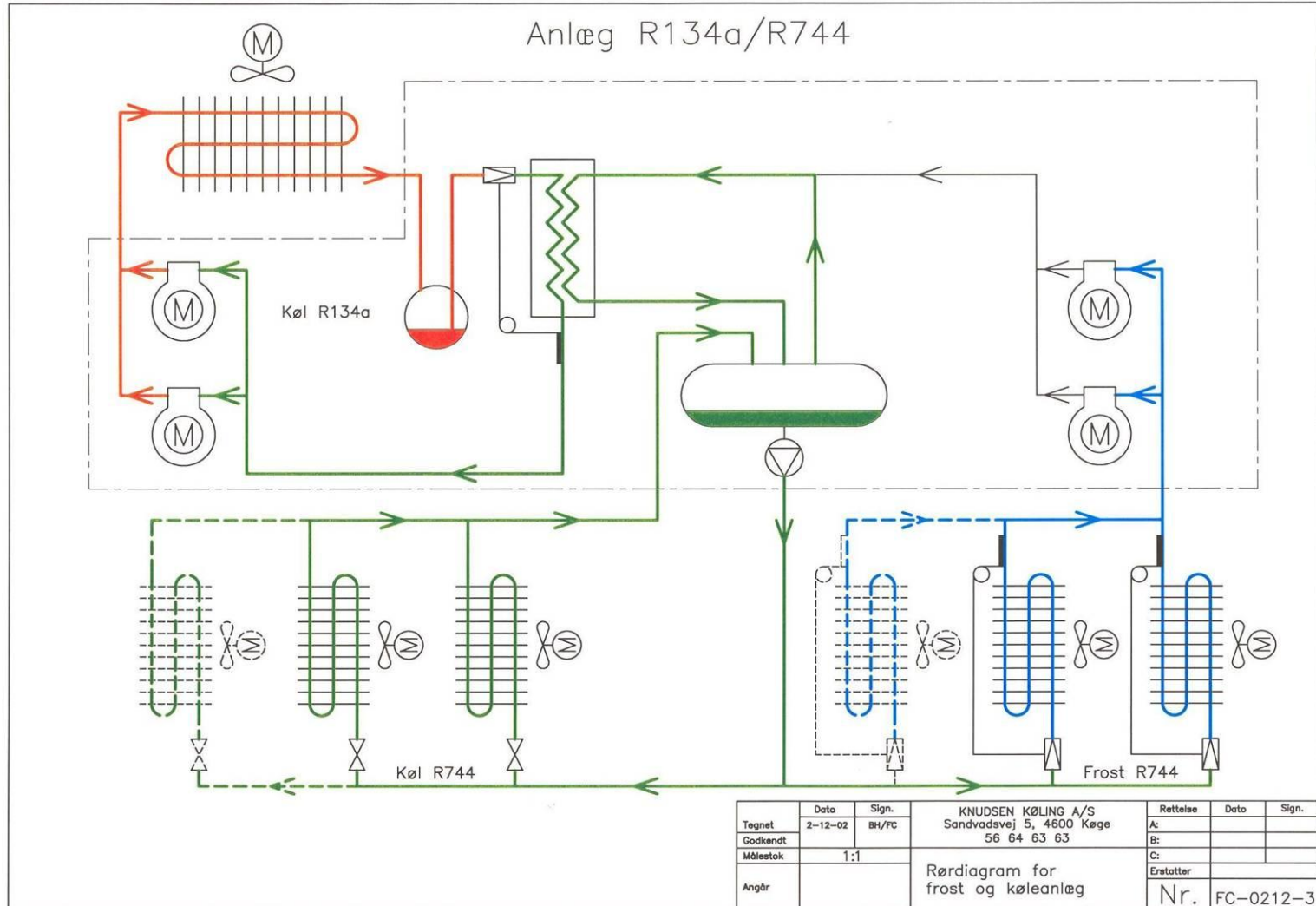
Subcritical CO₂ system



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- CO₂ under the critical point
- Max pressure 35 bar
- CO₂ only in low temperature cabinets (freezers)
- CO₂ in both low and normal temperature





Superbest Viby CO₂ system



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Superbest Viby CO₂ system



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Subcritical CO₂ systems

- Electronic expansion valves on DX Danfoss Adap Kool
- Special evaporators
- 2 refrigerants
 - CO₂ and normal on high temperature HFC
- All CO₂ piping must be insulated – temperatures lower than 10°C
- Cascade cooler
- CO₂ pump

Transcritical CO₂ system

- Only CO₂ as refrigerant
- High pressure 110 bar
- Special components
- Compressor (Bock)
- Gas cooler
- Extra valve before receiver (Danfoss)
- Liquid receiver
- Piping system
- Expansion valve (Danfoss)

