REPLACEMENT OF HCFC-22 REFRIGERANTS WITH AMMONIA: A CHALLENGE FOR HOCKEY ARENAS IN QUEBEC

Jean-Paul Lacoursière, P.E.
University of Sherbrooke
jpla@sympatico.ca

Claude Dumas, P.E.
Ville de Montréal
cdumas@ville.montreal.qc.ca
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Introduction

Montreal Protocol on Ozone Depleting Substances

• Adopted in 1987
• Canadian Legislations to phase out Ozone Depleting Substances
  – starting 2010, forbidden construction or import of products or equipments using these substances
Introduction

Refrigeration systems in hockey arena

- 500 hockey arenas (operated by municipalities)
  - 400 arenas use HCFC22 as Refrigerant
    - 35 operated by Montreal
    - Very close to populated areas (meters)
Introduction

Refrigeration systems in hockey arena

- In the 70’s HCFC22 was judged to be safer
- All these facilities have to be upgraded with an ozone friendlier refrigerant
- Ammonia is the refrigerant of choice
Conventional Design

Ammonia Inventory 2258 kg
Class T Machinery Room
External Ice Rink
HP Receiver sight glass leak

NH₃ ERPG3 750 ppm 45 m

NH₃ ERPG2 150 ppm 135 m
Ammonia Impact on Condominiums
Intrinsically Safer Design

Ammonia Inventory 333 kg

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Intrinsically Safer Design

Critically Charged System

- Entire charge is located in the evaporator (s)
  - A plates and frames heat exchanger and surge drum are used instead of a shell and tubes to minimize ammonia inventory
  - Existing High Pressure receiver is modified for use as a Service Tank
Intrinsically Safer Design

Two modes of operation are planned:

• Refrigeration mode – all liquid ammonia is in the plates and frames heat exchanger evaporator and surge drum (winter)

• Standby mode – All liquid ammonia is in the service tank (summer)
Intrinsically Safer Design

- This design allows a reduction of ammonia inventory to 333 kg.
- This represents a safer alternative than the base case with 2,268 kg.
Intrinsically Safer Design

Additional Mitigation Measures

• Ammonia scrubber on the emergency ventilation system with a vertical stack
• Closed circuit oil drainage
• Water tank to scrub ammonia relief valve discharges
• Ammonia detectors in evaporative condenser shelter and evaporative condenser with interlocks to equipment shutdown system
Intrinsically Safer Design

Population exposure

• Ammonia exposure reduced below 25 ppm
Conclusion

- Ammonia inventory reduced from 2,268 kg to 333 kg with Critically Charged System (85%)

- Additional simple measures reduce impact of accidental release
  - Water tank for relief valve discharges

- Ammonia refrigeration can be used with minimal risk and nuisance to nearby residents.