



Business Case for Natural Refrigerants

04/09/2018 – Singapore

- LOW NH₃ CHARGE
 - LOW ENERGY CONSUMPTION
 - LOW OCCUPATIONAL RISK
 - LOW DIRECT EMISSIONS
 - **HIGH EXPECTATIONS**



LARGE SCALE, CENTRAL TYPE, LOW CHARGE NH₃ REFRIGERATION PLANT

Stefan S. Jensen, Scantec Refrigeration Technologies Pty. Ltd.

Lower ceiling = no sprinklers

Evaporator air supply

NH₃ inventory 850 kg

HOW DOES LOW CHARGE NH₃ LOOK?



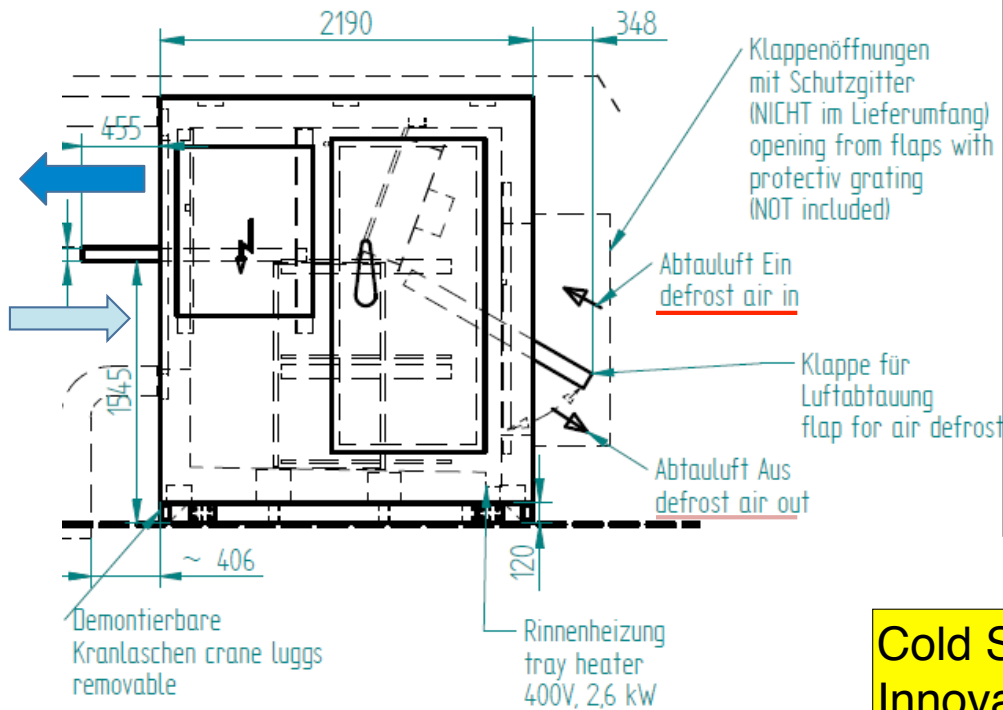


Total NH₃ operating charge 5 kg

Unit capacity 155 kW

HOW DOES LOW CHARGE NH₃ WORK?

Valve stations and pipelines outside building



Cold Storage Design Innovations Award Winner



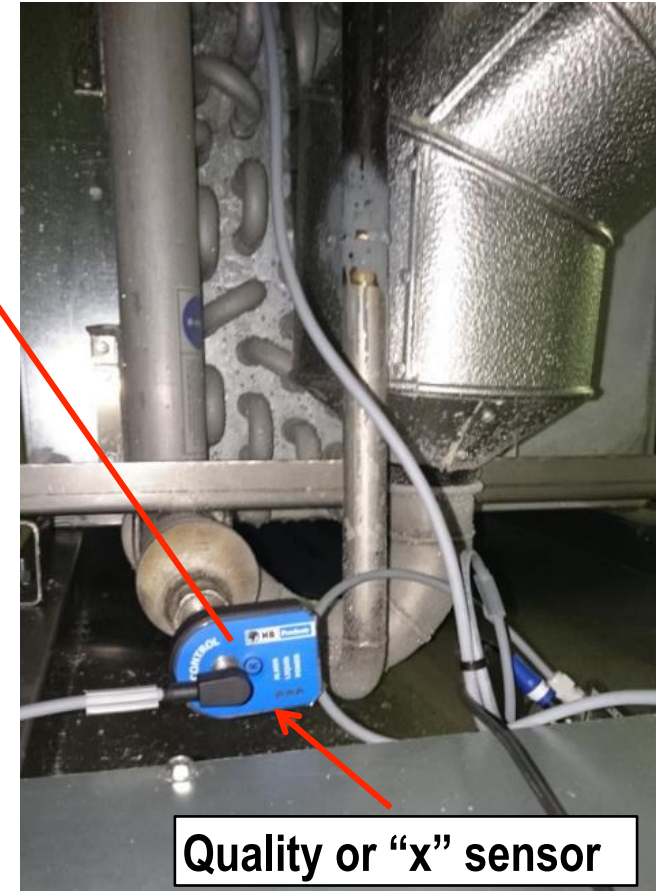
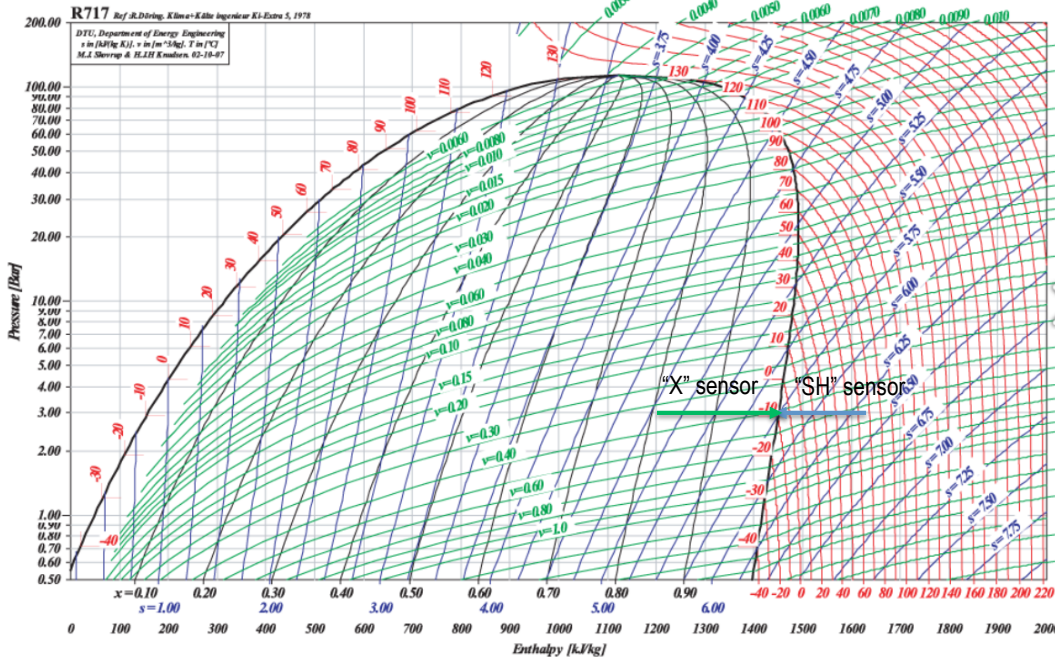
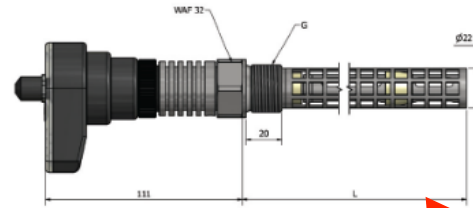
CLIMATE SUITABLE FOR AUTOMATIC AMBIENT AIR DEFROST?

- Ambient air defrost has been used in all parts of Australia
- Applied in minimum warehouse temperature of -30°C
- Melbourne latitude $37^{\circ}, 47'\text{S}$ – penthouses; 2°C winter
- Perth latitude $31^{\circ}, 57'\text{S}$ – alcoves; night temp. 9°C



Singapore coordinates 1.3521° N ,
 $103.8198^{\circ}\text{ E}$

HOW DOES LOW CHARGE NH₃ WORK?



Quality or "x" sensor

The dielectric spectroscopy (capacitance) measurement method uses the difference in dielectric properties of gases and liquid

Electronically controlled R717 injection based on refrigerant quality at evaporator exit



HOW LARGE CAN A LOW CHARGE NH₃ PLANT BE?

No technical limits



Refrigerated volume 114,000 m³

50/50% freezer/chiller

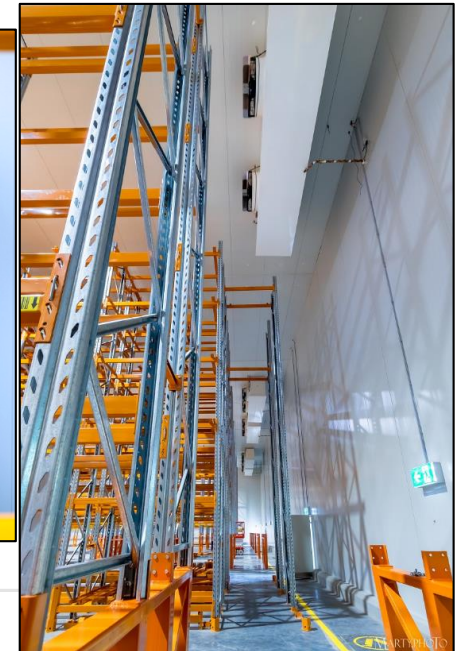
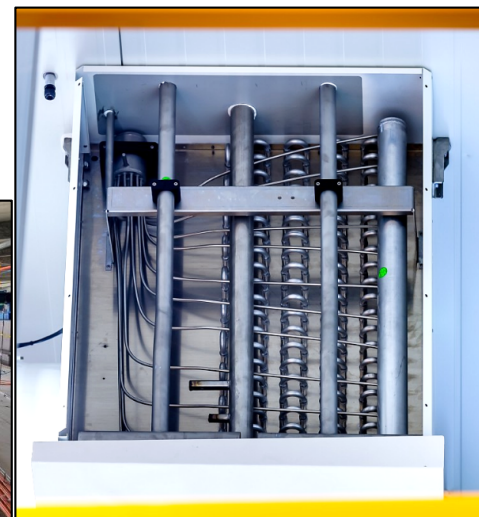
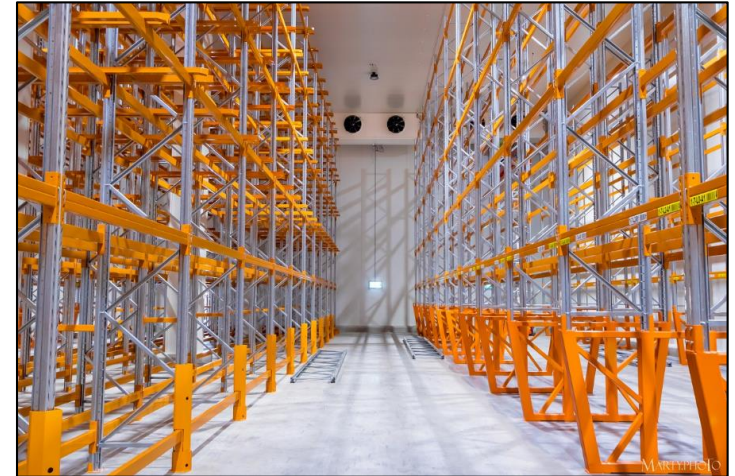
13,000 m² refrigerated area

500/600 kW LT/HT

750 kg NH₃ (0.7 kg/kW)

10 kWh/m³*a (storage)

17 kWh/m³*a (50 t/day)





HOW SMALL?

Refrigerated volume 5,250 m³



46/54% freezer/chiller
1,264 m² refrigerated area
45/49 kW LT/HT
Replaces ten year
old HFC plant

Projected
electricity cost
saving \$8,000/
month



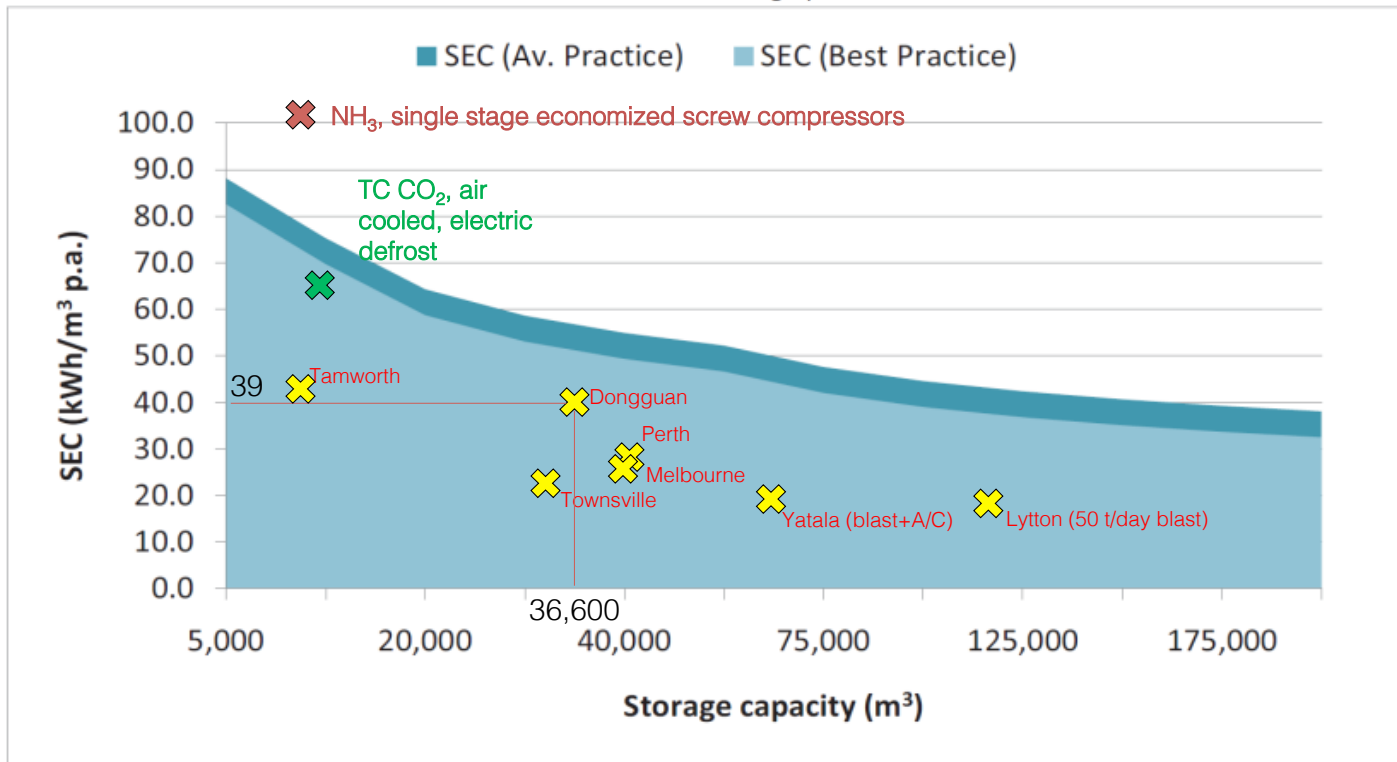
ATMOsphere Asia/ Singapore / 4 September, 2018



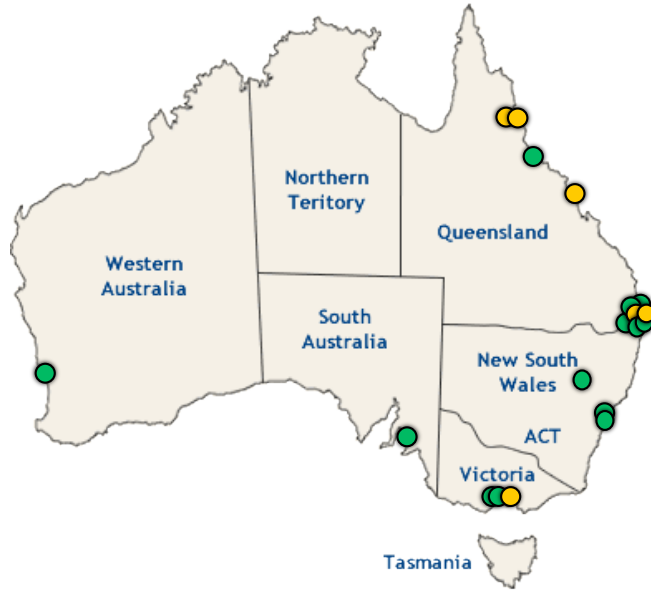
HOW ENERGY EFFICIENT?

Recorded energy performances for various plants

$$\text{SEC (kWh/ft}^3\text{)} \text{ average practice} = 38.978 \times \text{storage volume}^{-0.2275}$$



HOW IS THE MARKET ACCEPTANCE?



- Completed
- Under construction



Factory Packaging for Mobility and Safety

HOW IS THE FUTURE LIKELY TO BE?

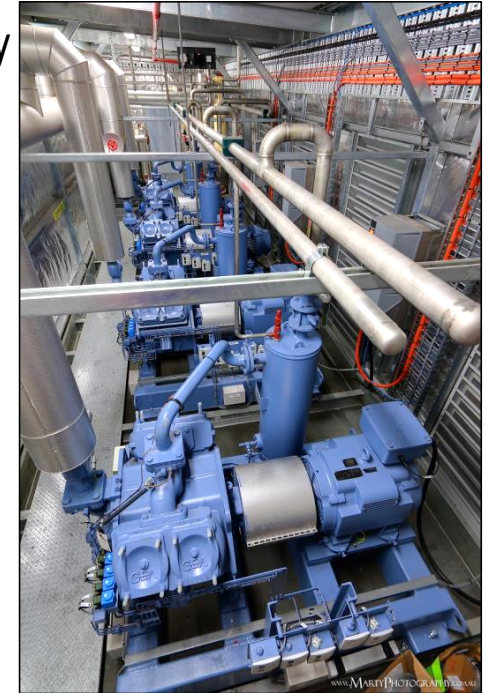


Smaller tubes for lower NH₃ inventories

304SS piping for low friction, high corrosion resistance, low leakage probability

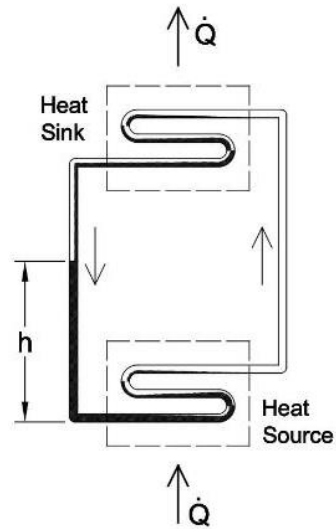
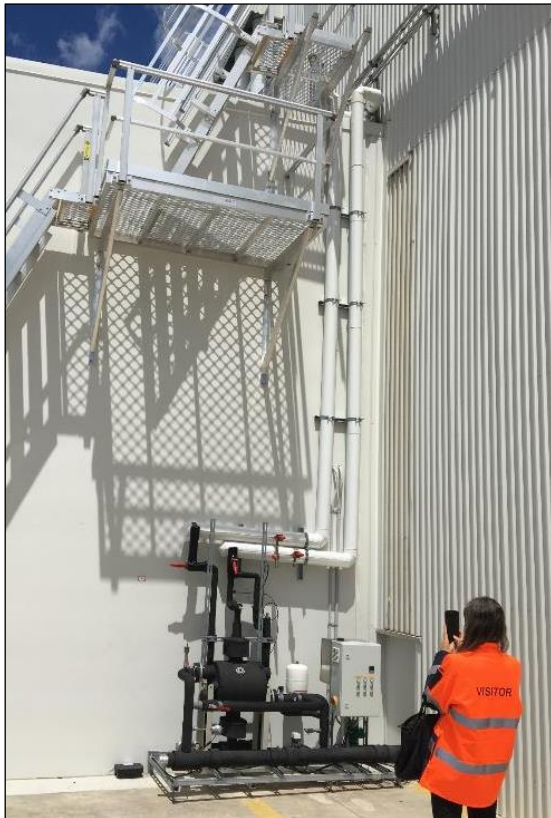


NH₃ DX S&T's



NH₃ DX PHE's

HOW IS THE FUTURE LIKELY TO BE?



Secondary loop defrost for further NH₃ inventory minimization, prevention of liquid hammer, energy efficiency and better defrost efficiency

Low Charge Plate Freezers

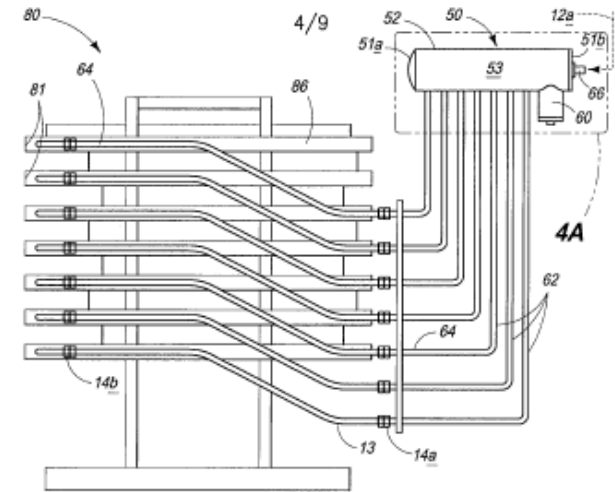


FIG. 4

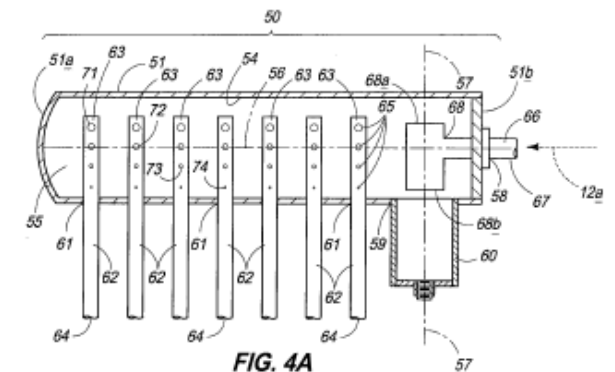


FIG. 4A



ONCE YOU GO AMMONIA YOU NEVER GO BACK



Thank you for listening!



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