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Danfoss

Ultra-low Charge Ammonia Glycol Chiller
Cutting Down Operating Costs
Engineering Industrial Refrigeration of Tomorrow

Inderpal Saund, Danfoss Food Retail Business Development Manager, APA & India

Speaker's Profile

Expertise

- Ammonia & CO_2 Refrigeration Technologies
- Large Industrial Refrigeration System Application Technologies

Title

- FRL Business Development Manager APA & India, Danfoss

Content

Application

- End User
- Process
- Pain Points

Solution

- System Description
- Energy Efficiency
- Ammonia Charge
- Operational Experience

Application

End User’s Profile

- SYLVAN Pty Ltd is the Australian subsidiary of SYLVAN Inc., the worlds largest producer and distributor of mushroom spawns

- The Australian operation is located in Windsor, New South Wales

- Producer of high quality mushroom spawn/nutrient mix for the Australian mushroom industry

Sylvan
CULTIVATING EXCELLENCE

Process

- Nutrients (grain based) are homogeneously mixed
- The mix is then sterilized at high temperature
- After sterilization, the mix is cooled in rotating drums, which are jacket cooled
- The jacket cooling is **provided by Glycol**, which in turn is cooled by a chiller
- Due to production expansion **additional chiller capacity** was required

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Pain Points

- **First Cost** was a budgetary constraint
- Efficiency as part of **Total Cost of Ownership** was to be optimized
- **Environmental footprint** (CO_2 equivalent was to be minimized)
- **Reliability of equipment** was paramount due to high value of the product
- Mick Daley, General Manager of Sylvan (Australia) Pty Ltd chose **Strathbrook Industrial Services** to provide a solution

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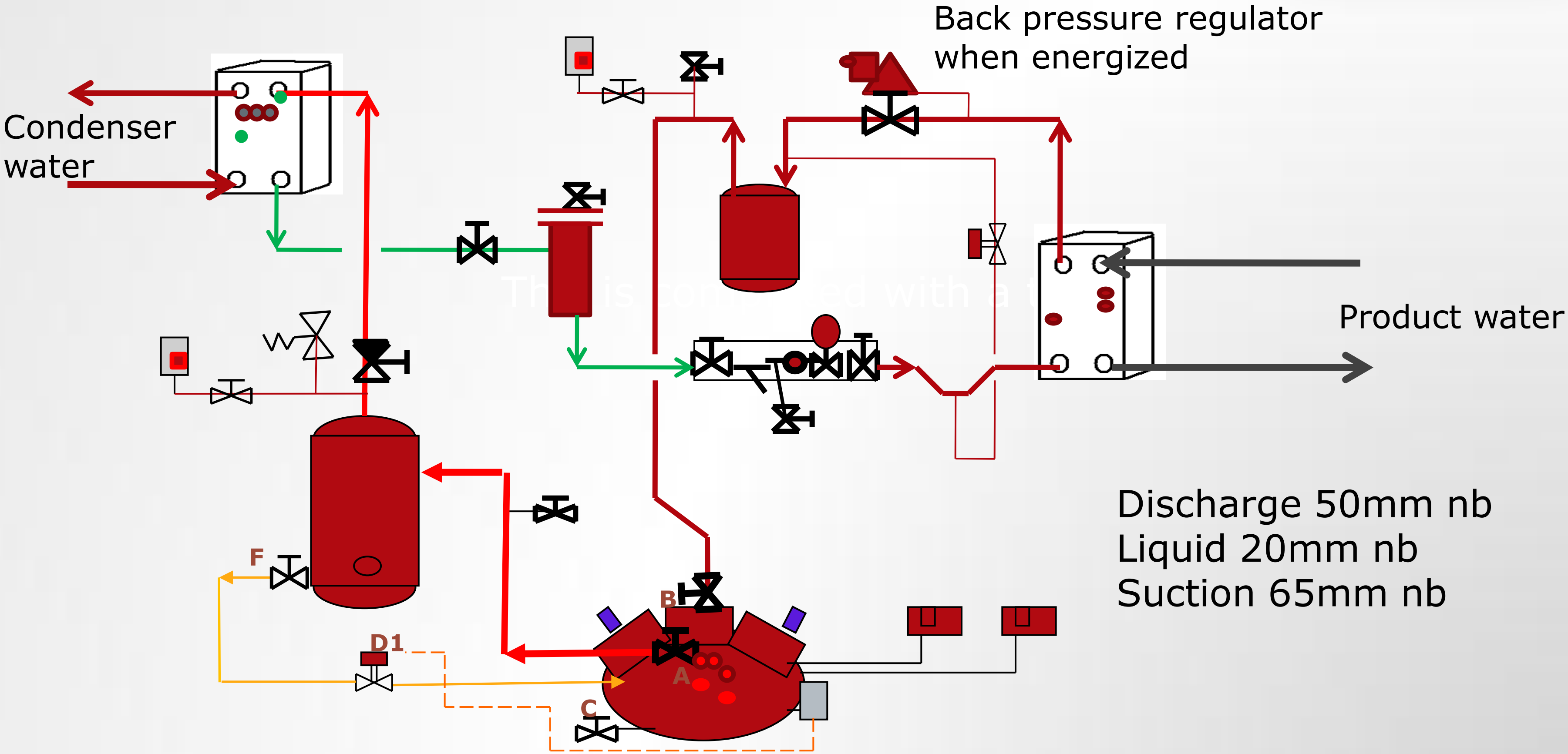
Solution

System Description

- **Ammonia (NH3)** was chosen due to the low GWP and high efficiency
- A DX system was designed to minimize the refrigerant charge and therefore the potential risk
- The chiller was pre-manufactures at the contractor’s facility and matched up to a **dry cooler** on site to provide the heat rejection
- The dry cooler principle was chosen to enable a packaged, self contained ammonia system without any necessity to connect ammonia pipes on site

Ammonia Water Chiller Package

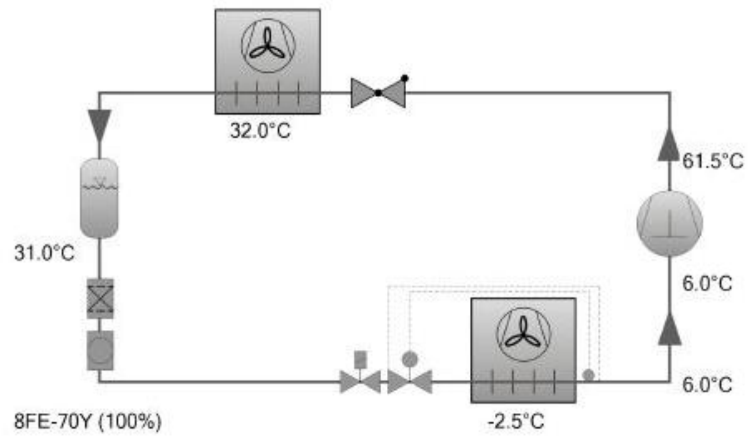


Bitzer W6GA.2K 10 SST / 35 SCT 145 kW Q 22 KW Motor

Energy Efficiency – R134a

Input Values

Compressor model	8FE-70Y
Mode	Refrigeration and Air conditioning
Refrigerant	R134a
Reference temperature	Dew point temp.
Evaporating SST	-2.50 °C
Condensing SDT	32.0 °C
Liq. subc. (in condenser)	1.00 K
Suction gas temperature	6.00 °C
Operating mode	Auto
Power supply	400V-3-50Hz
Capacity Control	100%
Useful superheat	100%



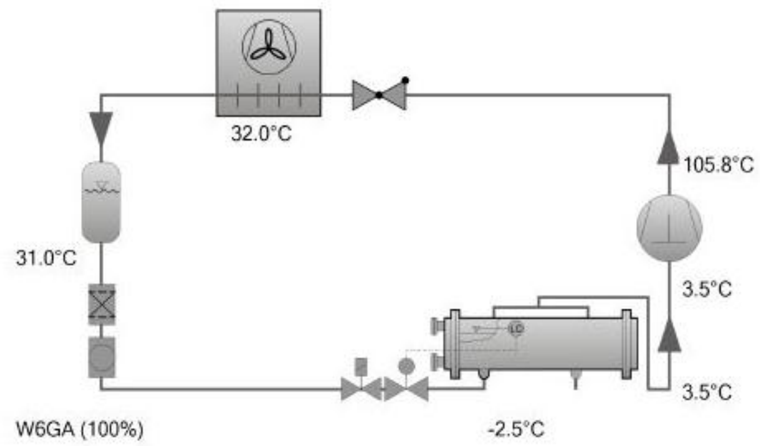
Result

Compressor	8FE-70Y-40P
Capacity steps	100%
Cooling capacity	104.9 kW
Cooling capacity *	105.1 kW
Evaporator capacity	104.9 kW
Power input	27.8 kW
Current (400V)	68.7 A
Voltage range	380-420V
Condenser Capacity	132.6 kW
COP/EER	3.78
COP/EER *	3.78
Mass flow	2347 kg/h
Operating mode	Standard
Discharge gas temp. w/o cooling	61.5 °C

Energy Efficiency – NH3

Input Values

Compressor model	W6GA-K
Refrigerant	R717
Reference temperature	Dew point temp.
Evaporating SST	-2.50 °C
Condensing SDT	32.0 °C
Liq. subc. (in condenser)	1.00 K
Suct. gas superheat	6.00 K
Useful superheat	100%
Motor speed	1450 /min
Drive	Coupling (1:1)
Capacity Control	100%



Result

Compressor	W6GA
Capacity steps	100%
Cooling capacity	105.8 kW
Cooling capacity *	105.6 kW
Evaporator capacity	105.8 kW
Shaft power	20.2 kW
Condenser Capacity	12[illegible] kW
COP/EER	5.25
COP/EER *	5.24
Mass flow	[illegible] kg/h
Operating mode	Coupling (1:1)
Compr. speed	1450 /min
Recommended driving motor	30.0 kW
Discharge gas temp. w/o cooling	105.8 °C

Operation – COP Comparison & Savings

Efficiency Gain

$$P_{NH3} = \frac{Q}{COP_{NH3}} \; ; \; P_{R134a} = \frac{Q}{COP_{R134a}}$$

$$\frac{P_{R134a}}{P_{NH3}} = \frac{Q}{COP_{R134a}} \times \frac{COP_{NH3}}{Q} = \frac{COP_{NH3}}{COP_{R134a}} = \frac{5.25}{3.78} = 1.39$$

I.e. for the same refrigeration capacity in kW, **39 percent** more power is necessary when using R134a.

This is compared with a test

- At approximately 2,500 full load hours, the total electricity used is:

$$P = \frac{Q}{COP} * t = \frac{160\ kW}{5.25} * 4,500\ h = 137,140\ kWh$$

- In Australia, the electricity tariff is approx. 0.20 AUD/kWh.

- With the above, by using NH3 instead of R134a, an annual saving of **AUD 10,670** is achieved.

Refrigerant Charge

- By using PHE's for condenser and evaporator, internal volumes were **kept to a minimum**
- Using a **remote dry cooler** further reduced the ammonia volume
- Care was taken to design the chiller as compact as possible
- By using **Danfoss ICF compact valve stations**, the ammonia charge was further reduced
- The result was a total charge of **4.9kg** of **ammonia**
- This represents 30g NH3/kW
- Compare to 1-2,000g R404A for some commercial applications

SYLVAN Ammonia Chiller Installation

Outdoor Chiller installation

- Note the packaged NH_3 unit

SYLVAN Ammonia Chiller Installation

Integrated control panel

h a test

SYLVAN Ammonia Chiller Installation

Chiller and remote dry cooler

h a test

SYLVAN Ammonia Chiller Installation

Danfoss regulating valve

h a test

SYLVAN Ammonia Chiller Installation

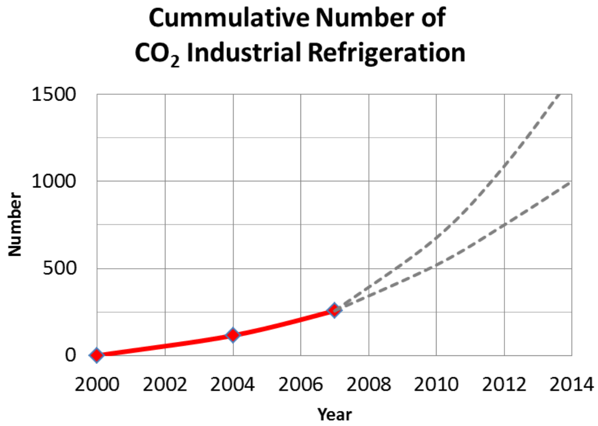
Ultra compact Danfoss ICF valve station

h a test

Lessons Learned

- Ammonia DX represents a **cost effective**, l**ow carbon footprint**, energy efficient solution compared to Freon chillers in certain applications
- Careful design with proprietary oil return ensured **successful, low maintenance operation**
- Operating cost well down on alternative system solutions
- **System reliability** for critical process first in its class
- Future expansions will follow similar footprint

CO_2 in Industrial Refrigeration - History



The Past:

1992 The CO_2 was re-invented (Gustav Lorentzen)

2004 **115** CO_2 / ammonia installations operating in Europe. 35% of these installations in The Netherland. (Holm Gebhardt, Nestle)

Today:

Industrial CO_2 installations is today build with "standard" components, and therefore it is difficult to trace the number of installations.

More than **500** installations operating in Europe, dominated by Nederland, France and Spain.

It is estimated that **10-15 %** of all new industrial installations in Europe is build with CO_2.

Co2 in Commercial Refrigeration

Since 1992 when CO_2 was re-invented (Gustav Lorentzen) Danfoss have played a very active role in ensuring we have the mechanical and Electronic components to support the Co2 movement.

Today there are over 10,000 Co2 systems around the world which are using Danfoss controls.

Q & A

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