MAYEKAWA

Natural is what we design for

AMMONIA HIGH TEMPERATURE HOT WATER HEAT PUMP

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Mayekawa Australia Pty Ltd

ATMOsphere ASIA solutions for asia natural refrigerants

3-5 February 2015 in Tokyo

New Zealand Export Markets:

Beef : 3.6 million

Sheep : 30 million

Dairy : 6.4 million (Exceeds 7% of GDP)

Wine : 34,562 hectares

Timber : 2.6 million m^3
(timber harvested per annum)

NZ Population: 4.4 million
Land Area: 268,021 km^2

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Energy Sources For Industry :

Electricity :
- Hydro
- Gas Turbine
- Coal Fired
- Wind
- Geothermal

Natural Gas :
- Reticulated Natural Gas – North Island
- LPG – Non Reticulated – South Island

Industrial Refrigeration Installations:

(Mayekawa Compressors)

- **NH3 :** In excess of 600 compressors operational
- **CO2 :** Three NH3 / CO2 Cascade Systems
- **NH3 Heat Pumps** : Two 570kW-h Hot Water Heat Pumps

Ammonia Heat Pumps

- A significant number of Industrial NH3 Refrigeration Plants are in operation around New Zealand. Most users of such systems have a large requirement for hot water and often use expensive energy sources for hot water generation.
- The Total Heat of Rejection from many plants can often exceed 2MW.
Therefore a large quantity of useful rejected heat is available for hot water generation.
- In the future, Ammonia heat pumps are expected to replace or complement conventional boilers because of their high efficiencies when providing hot water by utilising refrigeration plant rejected heat. They not only reduce CO2 emissions, but they also offer lower operation costs when compared to conventional gas or oil fired boilers.

Why Ammonia?

NH3

- Ammonia has no ozone depletion potential (ODP = 0)
- Ammonia has no global warming potential (GWP=0)
- Considered a natural refrigerant
- Used widely and safely around the world in large-scale industrial cooling systems. Applications include food processing, petro chemical, process cooling and air conditioning.
- Excellent Thermodynamic Properties - High COP

NATURAL FIVE
HC
CO_2
NH_3
H_2O
Air
5
Natural Refrigerant

Why Recover Useful Heat?

- Energy Costs & Demand Increasing
- Limited Natural Resources (Oil & Gas)
- Climate Change
- Our Children's Future

Canon 40D F18 iso100 20mm hdr

Raym's Fotosite Industrie Antwerpen

Features of the Ammonia Heat Pump

- Continuous Hot Water Supply
- Efficiency
- Relatively Easy Installation
- Environmentally Friendly Water Heating
- Variable Supply Hot Water Temperatures

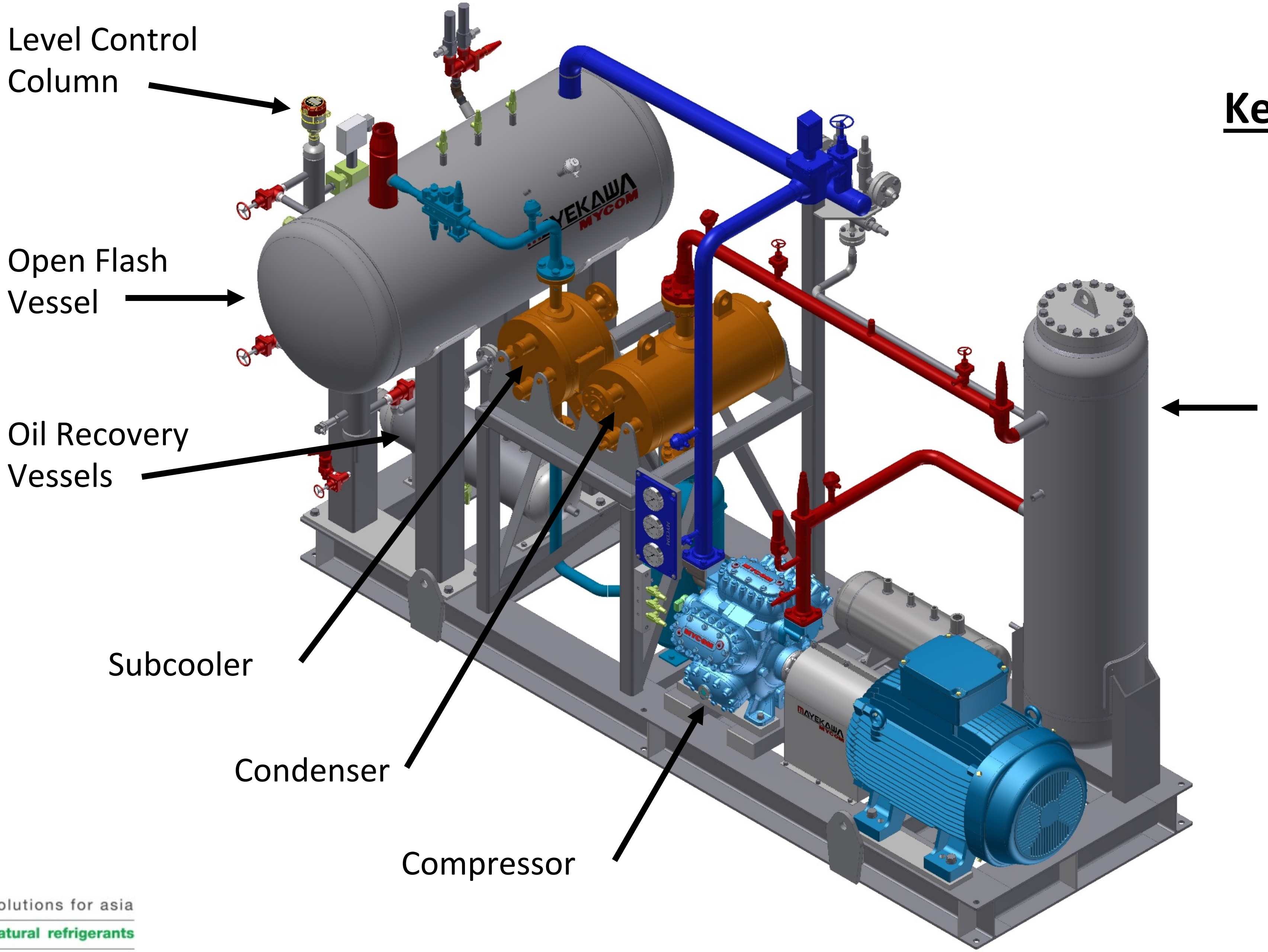
Hot Water Requirements

Meat Processing :

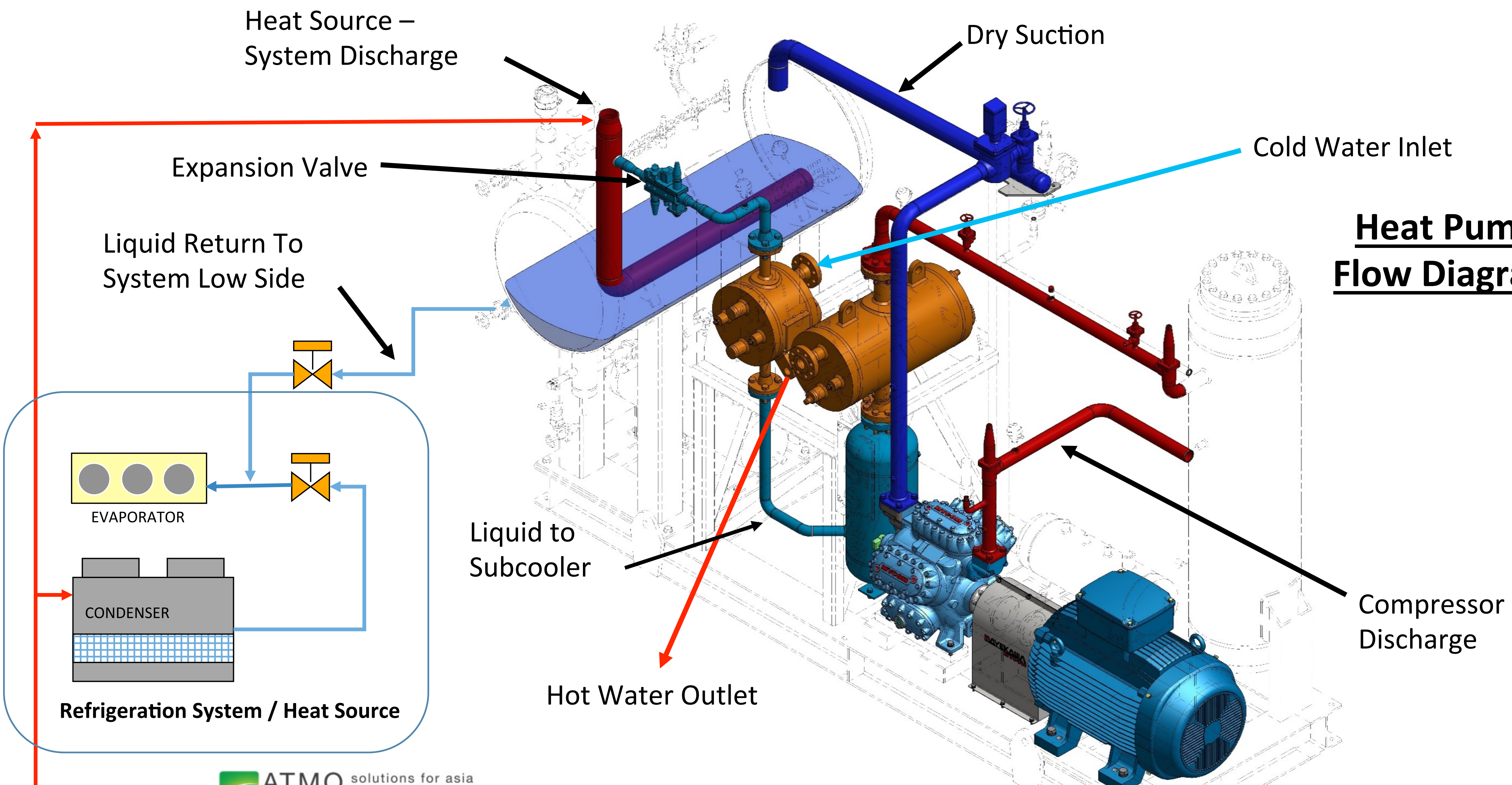
- C.I.P Functions
- Sterilisation
- Wash Down

Large Requirement for 65°C Hot Water

Key Components



Heat Pump Flow Diagram

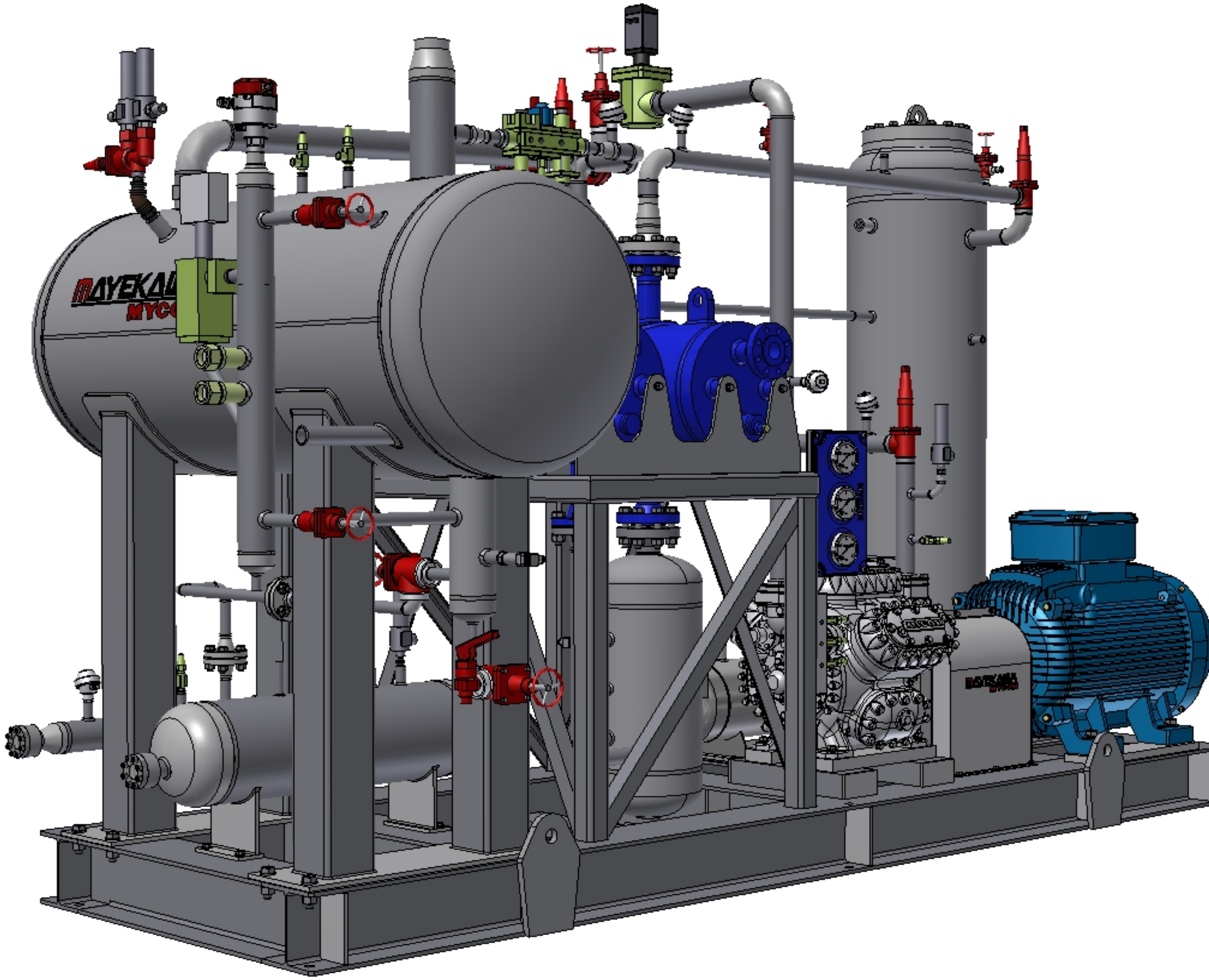


Heat Pump Operating Parameters (Actual)

- Suction Pressure : 8.25 Bar G
- Discharge Pressure : 31.8 Bar G
- Oil Pressure (dP) : 2.8 Bar G
  Suction Temperature : 28.2 °C
- Discharge Temperature: 115.3 °C
- Water Inlet Temperature- SC : 27.7 °C
- Subcooler Water Outlet Temp : 33.6 °C
- Condenser Outlet Temperature: 64.6 °C

- Compressor Speed : 1450 RPM
- Compressor Load: 100%
- Heating Capacity : 458.5 kW
- COP-h : 6.28
- COP-h (Average) : 6.5

- Water Flow Rate : 221 l/min



Performance Data Sheet

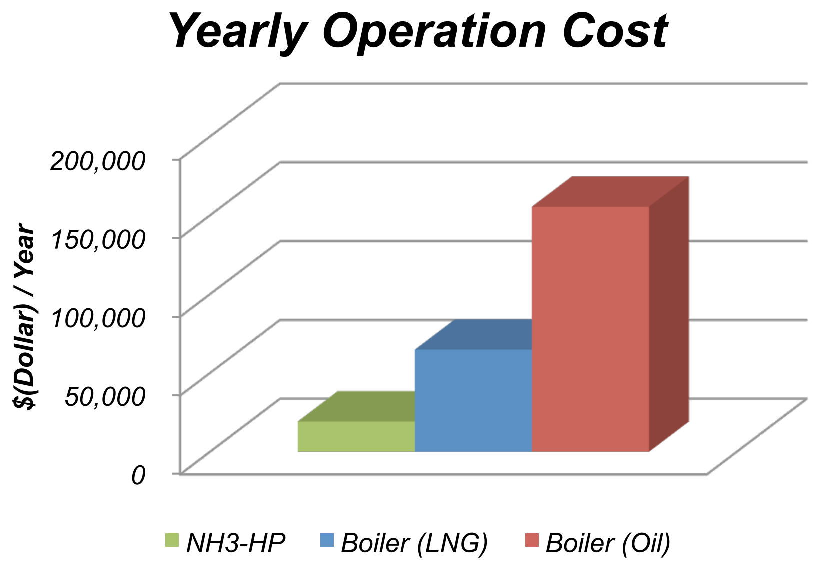
N6HK Reciprocating Compressor @ 1450 rpm

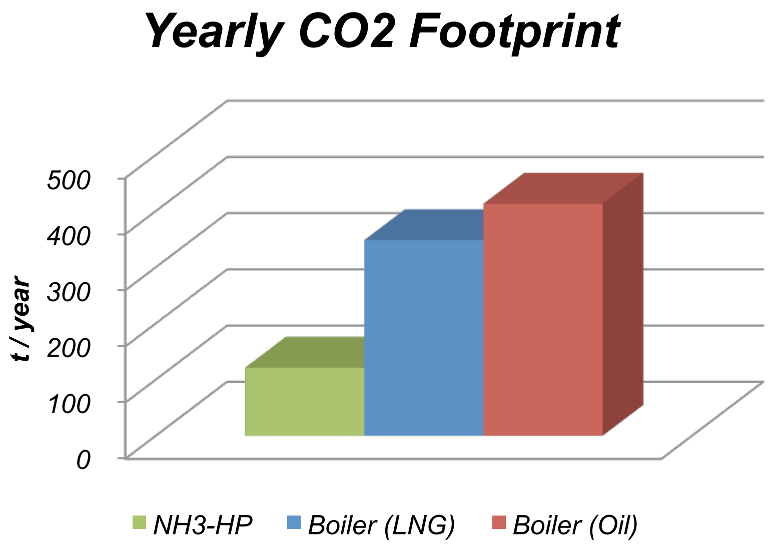
Hot water temperature	Te(1)	5℃	10℃	15℃	20℃	25℃	30℃	35℃	40℃	45℃
	Heat source temperature (2)	15℃	20℃	25℃	30℃	35℃	40℃	45℃	50℃	55℃
65℃	Heat capacity(kW)		207.1	252.3	302.6	357.8	418.5	484.5	556.2	633.3
	Power consumption(kW)		61.9	66.1	69.6	72.2	73.8	74.1	73.1	70.4
	COP		3.35	3.82	4.35	4.96	5.68	6.54	7.61	9.00
70℃	Heat capacity(kW)			241.2	290.8	345.4	405.2	470.2	540.7	616.5
	Power consumption(kW)			69.6	74.1	77.7	80.4	81.8	81.9	80.4
	COP			3.47	3.93	4.45	5.04	5.75	6.61	7.67

Evaporative Temp	**[°C]**	**25.0**	**26.0**	**27.0**	**28.0**	**29.0**	**30.0**
Heating Capacity	**[kW]**	**437.6**	**451.8**	**466.2**	**480.9**	**495.9**	**511.1**
COPh	**[-]**	**6.62**	**6.81**	**7.01**	**7.22**	**7.44**	**7.67**

- **Prior to** the installation of the NH_3 Heat Pump, the bi monthly LPG cost was between $8,000.00 and $10,000.00
- Payback period for the Heat Pump Unit < 3 years

Operation Cost & CO2 Footprint
NH3 Heat Pump vs. Boilers





Payback :

vs. LPG Boiler : $45,500 per year
vs. Oil Boiler : $136,200 per year

CO2 Footprint :

vs. LPG Boiler : 227 Ton/Year
vs. Oil Boiler : 292 Ton/Year

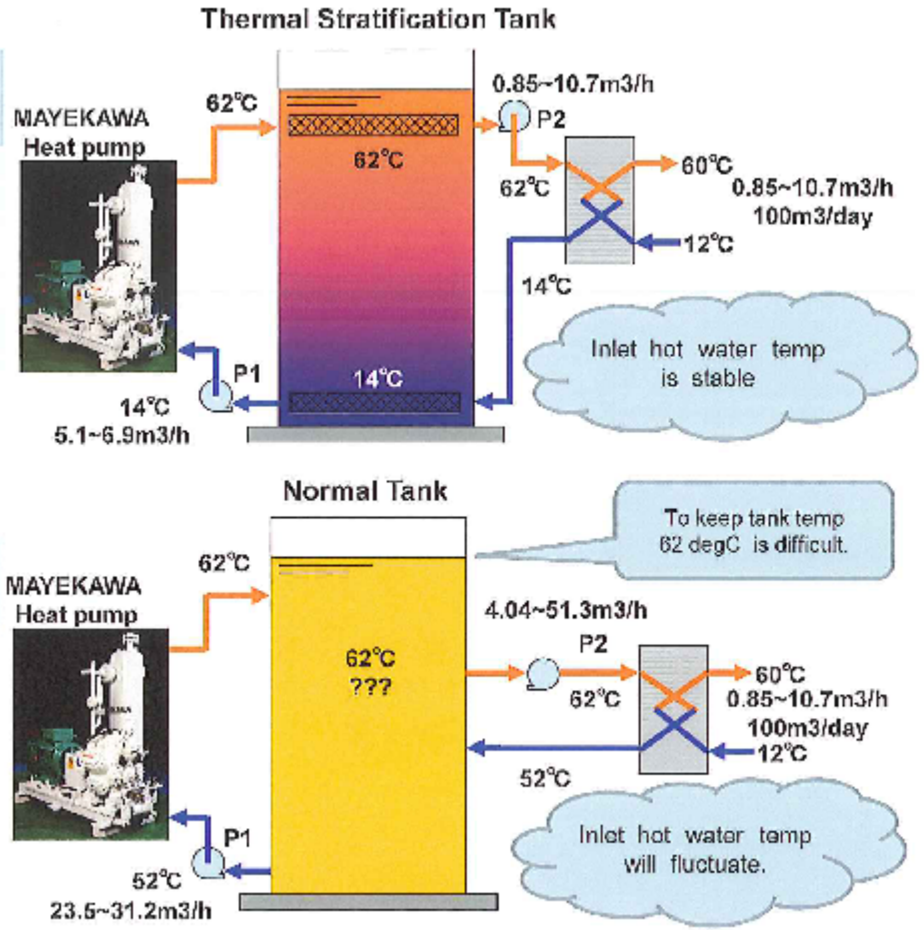
- 10 hour/day, 300days/year
- Hot Water supply 80°C
- 0.12 $/kWh(Electricity), 0.5 $/m3(LNG), 1.0 $/L(Oil), 0.86 $/L(Propane)
- Boiler Efficiency 85%

Water Reticulation

- Adequate Storage
- Thermal Stratification
- Demand vs. Supply

COP	8.79 (Te=35℃) 6.54 (Te=25℃)
Merit	70.975€/yr
P1	5.1~6.9 m3/h
P2	0.85~10.7 m3/h

Pump flow rate is lower than below system !!



COP	7.90 (Te=35℃) 5.90 (Te=25℃)
Merit	68.814€/yr
P1	22.0~29.8 m3/h
P2	4.04~51.3 m3/h

Mayekawa recommend upper drawing system !!

Conclusion

- With the use of Ammonia Heat Pumps, we can significantly reduce the combustion & usage of water heating fuel sources such as natural gas and coal to further assist in the creation of a low carbon society.

- Depending on system operating conditions and applications, Ammonia Heat Pumps can achieve COP's in excess of 8.0

- Application examples have shown that Ammonia Heat Pumps are effective in reducing annual energy consumption and CO_2 emissions.

- By encouraging and promoting the use of the "Natural Five Refrigerants" we as an industry can be proud of our contribution to a sustainable and low carbon environment.

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Thank you.

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