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ATMOsphere EU

Solutions for Europe

natural refrigerants

5 – 7 November 2012 in Brussels

Presented by Jan Boone, MAYEKAWA

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NATURAL 5 LINE-UP

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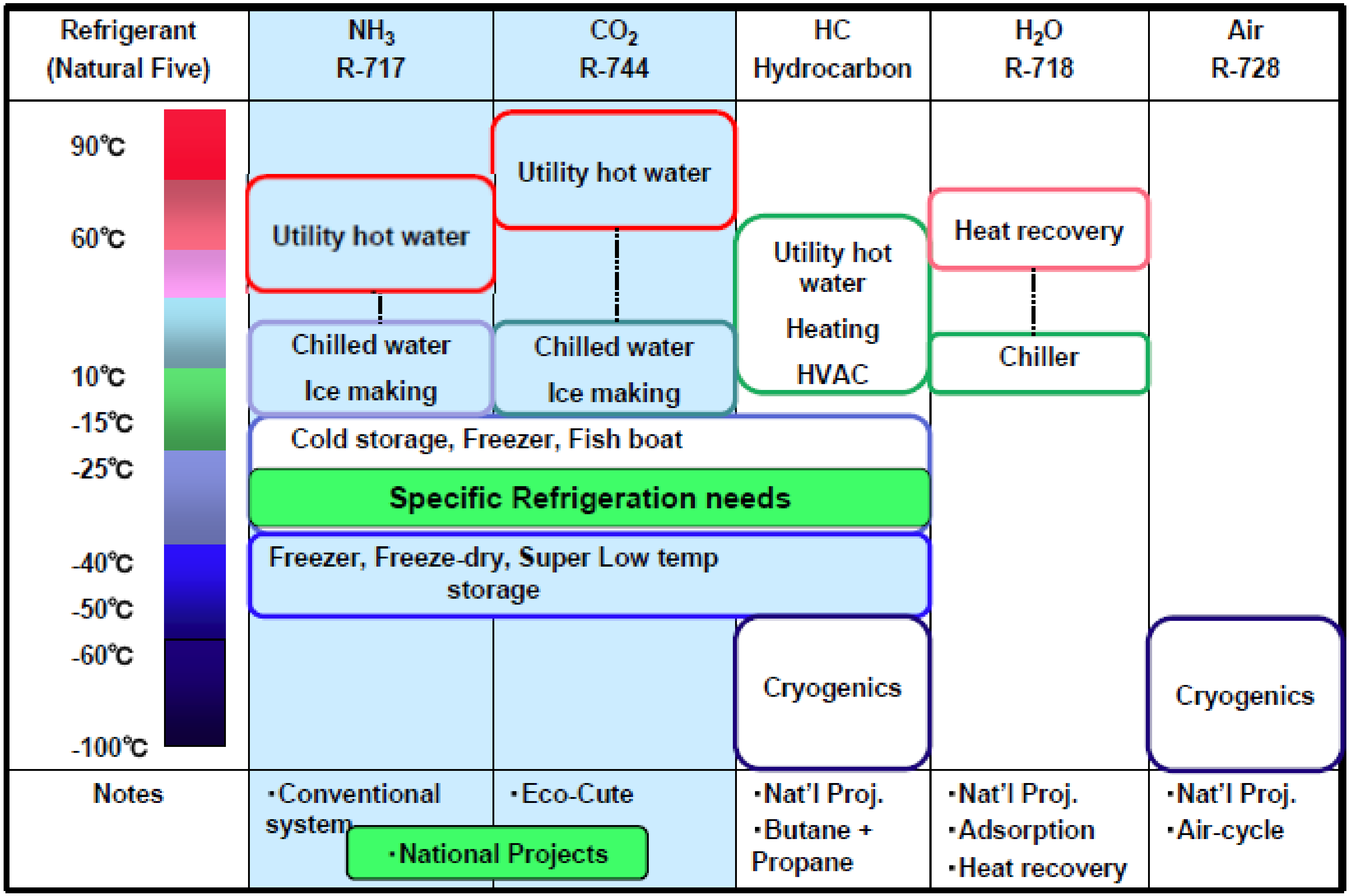
"Natural Five" Refrigerants and Product Solutions



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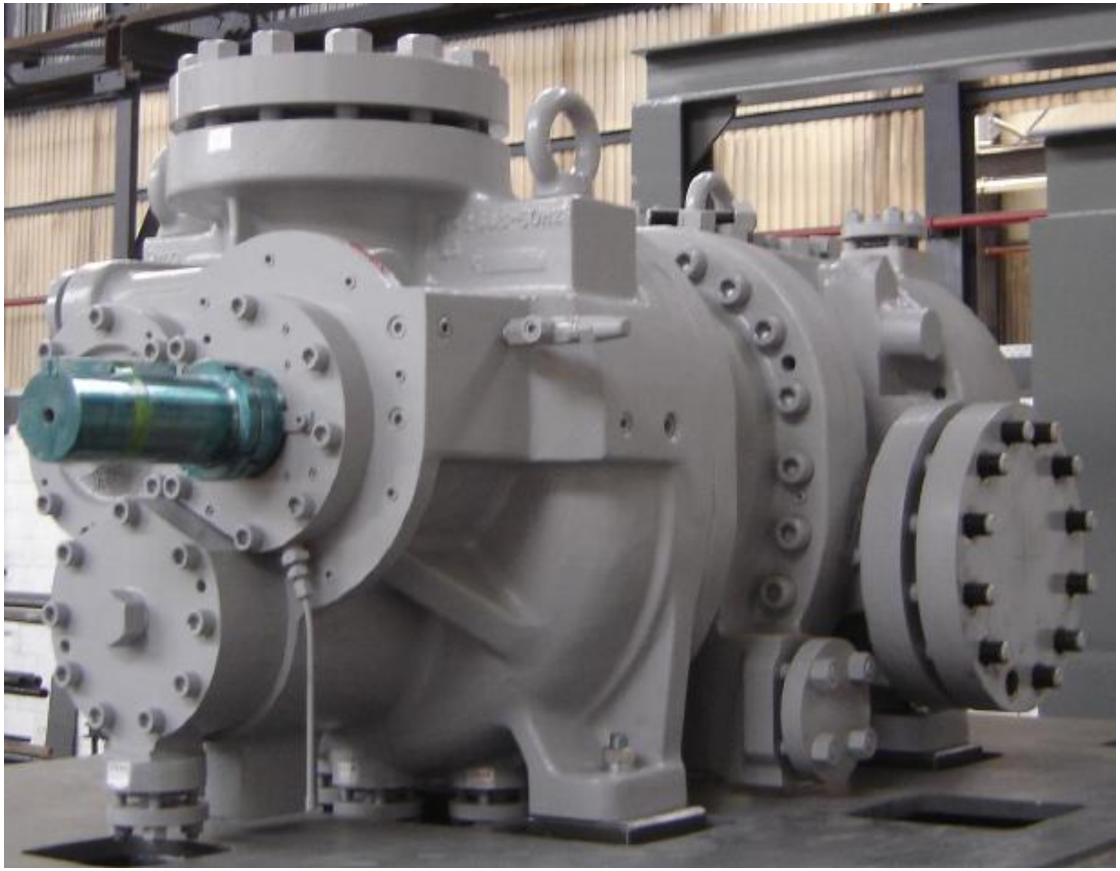
FIELD CASES :

NATURAL REFRIGERANTS
In Different Industrial
HEAT PUMP plants in Norway

NH3 COMPRESSION HEAT PUMPS



FIELD CASE

SLAUGHTERHOUSE – HOT WATER PRODUCTION

INTRODUCTION

Starting point, need?	The plant is a Norvegian slaughterhouse existing since 1950, with about 30 plants in operation. In 1987 a centralisation and modernisation of the sites took place with NH3 as preferred refrigerant. Since 1989 NH_3 compression heat pumps are used for production of 50° C water for 1200kW. In 2007 a hybrid heat pump was installed for 500kW.
Requirements 2009? 2400kW 52° C	As there was an important need for more hot water because of production modernisation & extension, it was decided to increase the hot water production with an additional 2400 kW. The contractor THERMA INDUSTRI received the request to install 2 sets MYCOM NH_3 overcompression heat pump screw compressors.

->INTRODUCTION

Why natural refrigerants +52° C	
Which choice & why	NH_3 (TC=+57° C & PD=23 barg) as natural refrigerant to obtain 52° C hot water. Heat source : rejected condensor heat from refrigeration plant 'VERY EFFICIENT' 'CHEAP' 'EXPERIENCE SINCE 1950' NH_3 is standard application for THERMA INDUSTRI.
Timeframe 2009 idea Re-built & Extend? 2011 ∑ 9 wks	The project started in 2009. Followed by some budgetting time. Installation done in 2011 - building out old equipment : 1 week - building in completed after 8 weeks ! Start-up OCTOBER 2011.

FUNDING

Funding, partner : **other organisation**	**YES** **NORWEGIAN ENERGY ORGANISATION** **ENOVA** **900.000 NOK**
	This new heat pumps save 1,6 GW fuel per year (approx. 210.000 liter). 'The funding is only valid on condition that savings were realised ! After 7 months of operation it was already visible that the 1,6 GW was going to be realised easily !'

EQUIPMENT

COMPRESSORS	**NH3 SCREW COMPRESSOR PACKAGES COMPLETE WITH OIL SYSTEM AND CONTROLS.** **Producing NH_3 at 57° C (saturated condensing temp.) from NH_3 heat source at 20° C (saturated evaporating temp.) to make hot water of 52° C.** **This hot water is than further heated by other equipment to 84° C and buffered in a 200.000 liter tank.**
MODULATING CONTROL VALVE	The suction pressure of the heat pumps is controlled at 7,5 barg (20° C), Representing an important saving of energy on the refrigeration plant : COPc 50% better at least -10/+35° C RT/BKW/COPc=353kW/105kW/3.36 -10/+20° C RT/BKW/COPc=381kW/ 73 kW/5.21. (256MW power saving on 8000hrs) Priority is given to the heat pumps, normally the external condensor is not active.
FREQUENCY CONTROL	The screw compressors are equipped with frequency convertors which result in no reactive power, Saving 8.000 NOK monthly (or x12 = 96.000 NOK per year) The FC drive engines are more expensive but quickly paid back. ‘this was a bonus’

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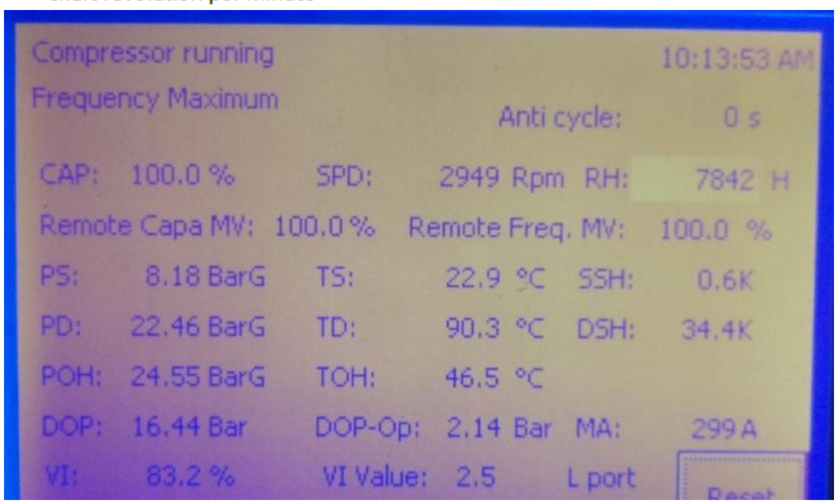
IDENTIFICATION		
COMPRESSOR MODEL	SERIAL NUMBER	UNIT
N170JM-L	1731020	VP1
N170JM-L	1731010	VP2
MAIN DRIVE MOTOR	250kW	
QUANTITY	2	

PER MACHINE		HEAT INPUT	POWER INPUT	HEAT OUTPUT	
T	°C	20		52	
	kW	RT	BKW	QC	COP-h
RPM	3400	**971**	**186**	**1157**	**6,2**
	2950	**835**	**162**	**997**	**6,2**
	1500	**403**	**85**	**488**	**5,7**

T	°C	temperature (heat input : NH3, heat output : hot water)
RT	kW	heat source capacity
BKW	kW	absorbed motor power at shaft
QC	kW	heat output capcity
COP-h		coefficient of heating performance
RPM	rpm	shaft revolution per minute



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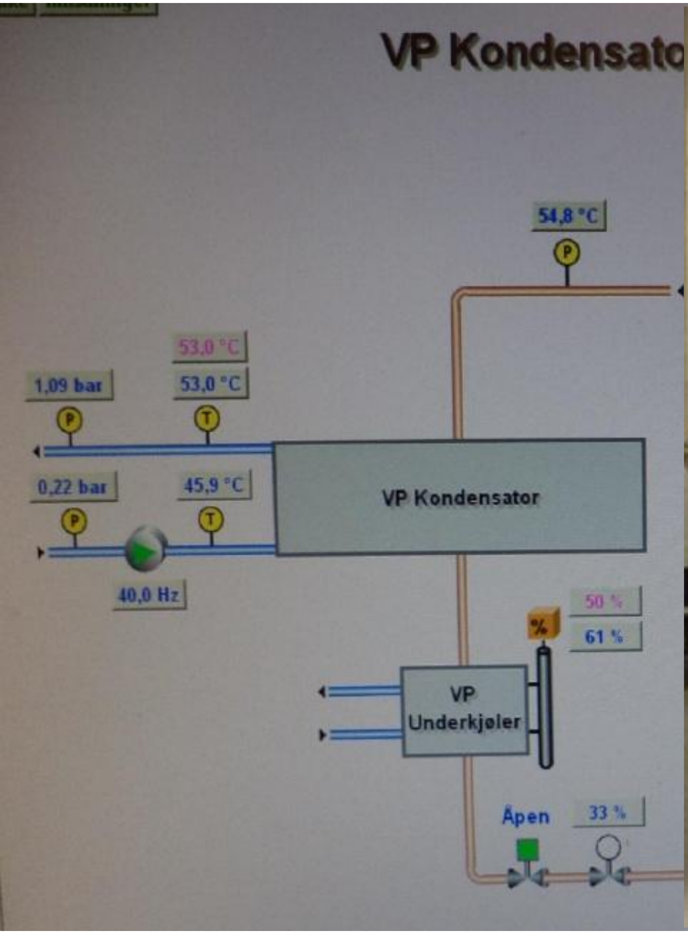

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EFFICIENCY ANALYSIS

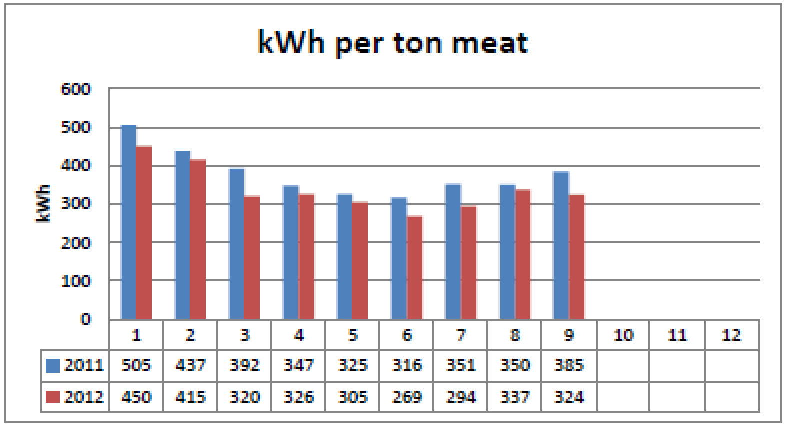
Difference planned & actual results if occured?	
If yes, why were there differences?	The design COP-h is in the range of 5.7 to 6.2 depending on the plant load. The average COP-h was at 5,5 for the first 11 months of operation. (Compared to classic boiler: saving of 85% input energy!)

DESIGN WEEKLY mWh				
HRS		276		12997 hrs in 11 months (47 wks)
RPM	BKW	QC	COP-h	
3400	51	319	6,2	
2950	45	275	6,2	
1500	23	135	5,7	

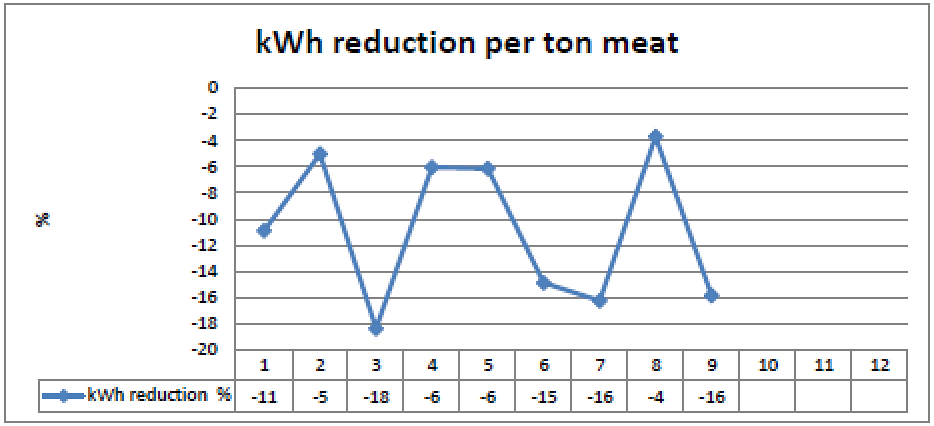
MEASURED REAL OUTPUT/INPUT mWh					
	BKW	QC	COP-h		
MAY	35	190	5,4		
JAN	41,55	232	5,6		

EFFICIENCY ANALYSIS

Difference planned & actual results if occured?	
How is the process of measuring efficiency?	Total power input and heat pump output are checked weekly And taken up in the monthly energy cost per ton of meat which is the basic indicator for the process.



	1	2	3	4	5	6	7	8	9	10	11	12
2011	505	437	392	347	325	316	351	350	385			
2012	450	415	320	326	305	269	294	337	324			



	1	2	3	4	5	6	7	8	9	10	11	12
kWh reduction %	-11	-5	-18	-6	-6	-15	-16	-4	-16			

COST ANALYSIS

COSTS INVOLVED	**This installation represents a value of 3.500.000 NOK.** **Includes :** **NH_3 Heat pump installation** **Condensor** **Subcooler** **Waterpumps etc.**	**3.500.000 NOK**	
FUNDING	ENOVA 900.000 NOK	-900.000 NOK	2.600.000 NOK
COST SAVING	1,6 GW fuel (210.000 liter equivalent 1.260.000 NOK) TC=20° C (up to 256 MW/yr or 201.000 NOK) FC drivers (96.000 NOK/yr)	1.260.000 NOK/yr 201.000 NOK/8000 hrs 96.000 NOK/yr	1.557.000 NOK/yr ROI =1,7 yr

->COST ANALYSIS

Savings or potential savings because of existing or pending regulation	-heat recovery overcompression heat pump uses refrigeration plant heat rejected to the condensor, incl.oil cooler heat rejection -high efficiency electrical motors IE2 motors are applied -frequency controllers compressors and waterpumps -energy-saving condensors

->COST ANALYSIS

Potential savings in the future	Improvement is possible by increasing the ammonia condensing temperature from 57°C to 62°C, requiring a 30 bar safety valve setting on the heat pump unit. With the old heat exchangers drain water heat is recovered in the 45°C buffer. In the future this heat exchanger can be replaced with a more efficient execution .
Did forecast succeed/expectations were met?	The customer is absolutely happy with the plant 

BARRIERS & SOLUTIONS

WHAT BARRIERS WERE WE FACING WITH THIS PROJECT & HOW SOLVED ?	
Technical problems or availability of systems, components, engineers?	Thanks to the customer who gave full confidence and made strong investment in this new technology to Therma Industri it was possible to succeed and realise this plant with success !
Psychological barriers from customer:management?	Not as customer prefered NH_3 as natural refrigerant since long time and fully relied on the capability Therma Industri for the heat pump technology.
Safety problems, legilative barriers?	The plant/system was build fully in compliance with CE-PED.

LESSONS LEARNED

WHAT HAS BEEN LEARNED FROM THE PROJECT & HOW CAN THIS BE APPLIED TO OTHER PROJECTS USING NR.	
What will you do different in the future?	For the refrigeration/heating plant, the customer will go for the same solution as demonstrated by this field case !
What can you apply to the next project?	Higher safety valve set pressure to allow operation with higher water output temperatures.

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ACTION PLAN

IDEAS OF CONCRETE ACTIONS TO GET NATURAL REFRIGERANTS SOLUTIONS FOR EUROPE :	
1.1. What are the concrete actions already done ?	Mayekawa only promotes natural refrigerants since the beginning of this century.
1.2. Or/and planning to do ?	
2.1. what kind of actions needed to expand NR systems, for : Technology, Training, Safety, Policy, Standards, Regulation, Market, Costs, End-users.	Unlimited development ongoing. With each new product/system neccessary trainings are also made available. Suppliers of refrigeration accessories (EN378 qualified) should make more products available for high pressure/big size duty. Mayekawa still have too often to rely on expensive accessories designed for oil and gas industry.

CONCLUSION

NATURAL REFRIGERANTS SOLUTIONS FOR EUROPE :

THIS PROVEN FIELD EXAMPLE SHOWS THAT THE SUCCESS OF THE NEW TECHNOLOGY IS MUCH DEPENDING ON THE QUALITY OF THE PREPARATIONS DONE ON BEFOREHAND FOLLOWED BY THE INSTALLATION AND COMMISIONING WITH OPTIMAL FINE TUNING, FROM COOPERATION BETWEEN ALL PARTIES INVOLVED :

MANUFACTURER : MAYEKAWA JAPAN/ MAYEKAWA EUROPE
CONTRACTOR : THERMA INDUSTRI
PLANT RESPONSABLE/OPERATORS.

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THANKS FOR YOUR ATTENTION !

& much appreciated thanks to the Contractor of the fieldcases :

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