NATURAL REFRIGERANTS

HEAT PUMPS

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LINE-UP OF 'NATURAL 5'.

Mayekawa was founded in 1924 and is to-day one of the world's largest industrial refrigeration companies. It actively promotes the 'NATURAL 5' refrigerants, including ammonia, CO2, hydrocarbon gasses, air and water. Mayekawa is active in ammonia compressors for more than 85 years, for hydrocarbons and CO2 for more than 40 years.

The 'NATURAL 5' refrigerants cover the full application range -100°C/+100°C from cryogenics, freezing, cooling, air conditioning up to heating.

HOT WATER PRODUCTION NH3 HEAT PUMP

REQUIREMENT

The meat company located in Storkow-Germany needs a heat pump to produce hot water up to 60°C for a hot water consumption of 160m3/day for 18 to 20hrs/day during 5 days/week.

The hot water buffer tank has a capacity of 60m3 and the energy-boiler vessel has a capacity of 20m3.

The heat capacity should be maximum 750 kW.

As refrigerant NH3 was selected as natural refrigerant with an ODP and GWP of 0.

To obtain 60°C a condensing temperature for NH3 of 65°C is selected corresponding with a pressure of 28,5 barg.

Between the NH3 and the process water the secondary medium is selected by using glycol-water.

As heat source the condensor circuit of the central refrigeration plant will be used.

This means that the heat pump NH3 evaporating temperature will be 25°C, corresponding with a pressure of 9.0 barg.

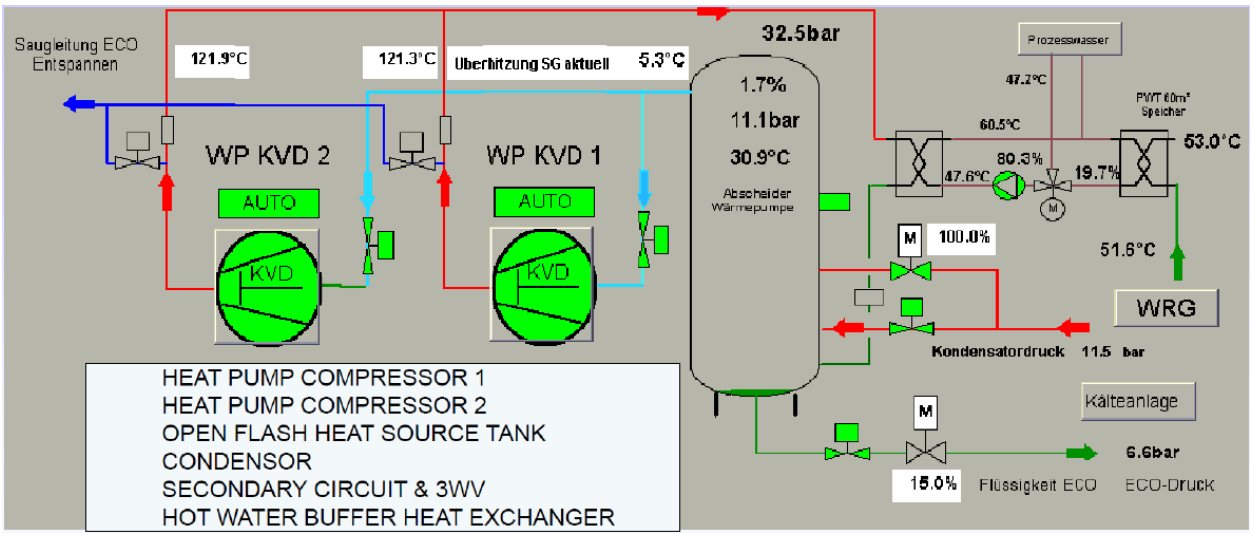
PRINCIPLE SCHEME

The principle scheme shows the heat pumps compressor KVD1 and KVD2 which are connected on the low pressure side to the open flash heat source tank,

and to the condenser on the high pressure side.

The hot water buffer heat exchanger is visible on the right hand side of the scheme.

Between the hot water buffer heat exchanger and the condenser the secondary glycol-water circuit with 3-wayvalve can be seen.



EQUIPMENT

2 piston type compressors model N6HK are used for the heat pump units, equipped with frequency convertor to allow speed control from 1450 to 970 rpm.

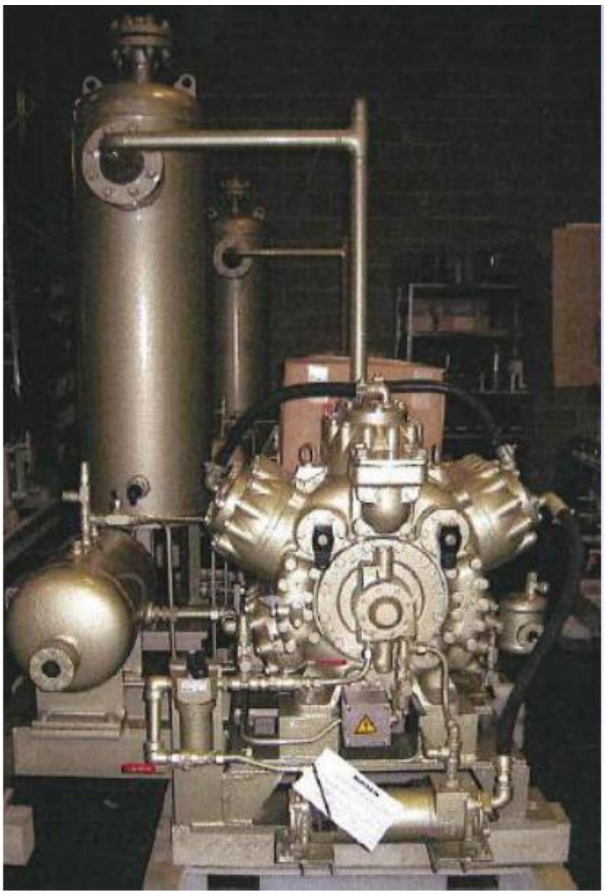
Each compressor has mechanical cylinder banks which can be unloaded in steps of 33%. For the design conditions evaporating-/condensing temperature of +25°C/+65°C

The compressor performance varies between 393kW to 262 kW based on respectively 1450 to 970 rpm for each machine with an absorbed shaft power of resp. 69 to 44kW.

The final design coefficient of heating performance corresponds with 5.7 to 5.9

The actual operating hours on 25/4/2013 amount to 9900 and 9562 hrs for KVD1 resp. KVD2.

MODEL		N6HK	
QTY		2	
SITE LOCATION COUNTRY TOWN		GERMANY STORKOW	
REFRIGERANT		NH3	
TE	°C	25	
TC	°C	65	
PS	barg	9	
PD	barg	28,5	
RPM	rpm	970	1450
QC	kW	262	393
BKW	kW	44	69
COP-H		**5.9**	**5.7**
OPERATING HOURS		25/04/2013	
KVD1	hrs	9900	
KVD2	hrs	9562	



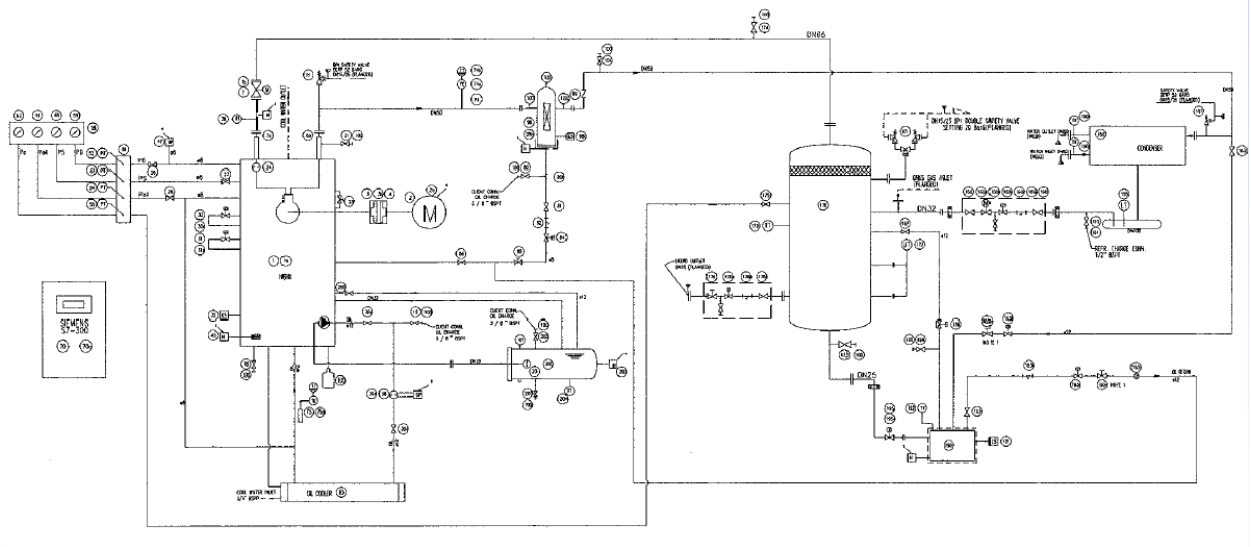
UNIT PID

The scheme shows the compressor with complete oil system on the left part;

The oil system contains an oil pump(integrated in compressor), oil filter, external oil tank, a watercooled oil cooler and a fine oil separator on the gas outlet of the compressor.

On the right hand side the condenser is shown with receiver and the expansion control devices to the heat source flash tank shown in the middle.

On the flash tank the gas inlet from the refrigeration plant is visible and the oil recovery vessel.



UNIT LAYOUT

The photo shows the compressors with main drive motor make SEVA 280M 90kW installed in the machine room. The yellow painted line is the suction line with automatic closing valve mounted on the top to be closed at compressor standstill.

On the discharge side of the compressor the insulated oil separator is visible.

The installation was done in October 2010 and operation is approx.. 10.600 hrs on yearbasis.

The efficiency of the power drive is in the range of 97 to 98%.

The main drive motor efficieny varies around 93.7 to 93.2 at resp.100%,50% load.

OPERATION STATUS.

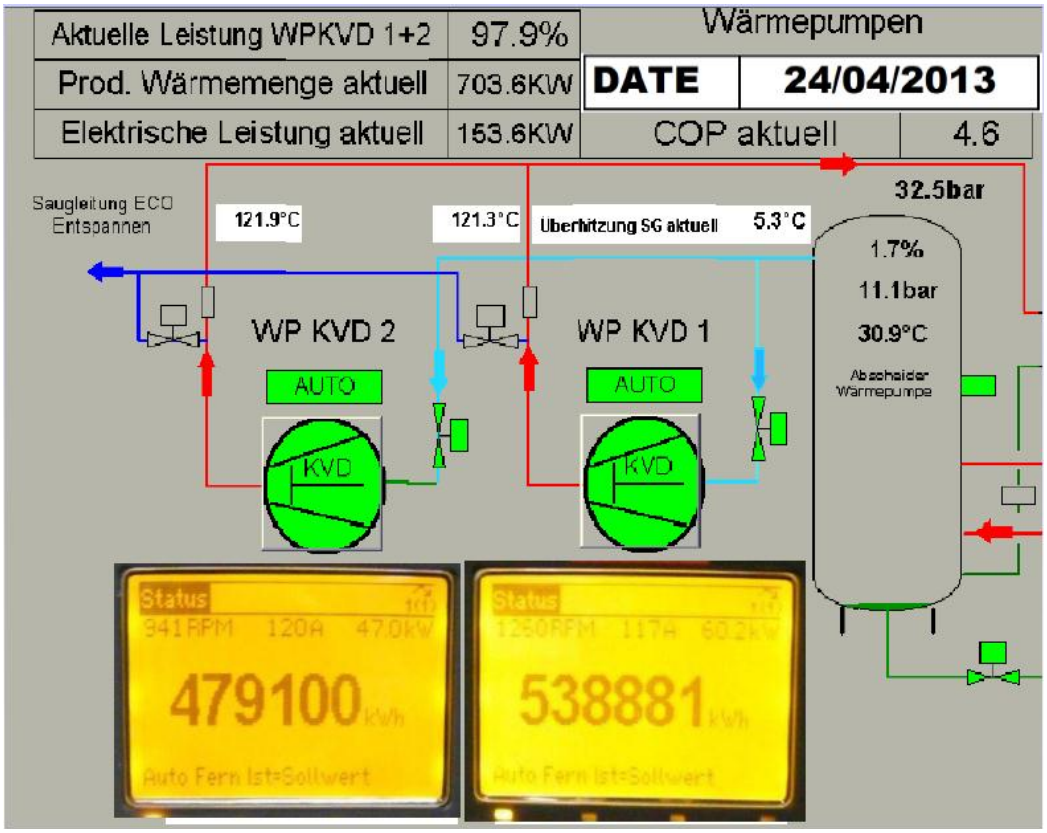
The operation status is shown on the visualized scheme from the control panel.

On 24/4/2013 the total energy input is 479100 resp.538881 kWh for resp. KVD1 and KVD2.

The total number of operating hours is 9900, resp.9562hrs for resp.KVD1, KVD2.

The total heating energy output is 4.928.342 kWh, which corresponds with a net COP-H of 4.8

The scheme shows the actual electrical power input of 153.6kW and actual heat energy output of 703.6kW corresponding with an actual COP-h of 4.6



OPERATION SAVINGS.

For a total heating energy output of 4.928.342 kWh the comparison is made between conventional heating with gas and the heat pump.

Based on a load ratio of 75% and an efficiency of 85% the boiler system energy input will be 7.730.732 kWh, what means a COP-H of 0.64;

This gas boiler has an energy cost of 309.229 € based on a gas price of 0.04 €/kWh.

For the heat pump the electrical energy input amounts to 1017981 kWh, what means a COP-H of 4.8.

The energy cost for the heat pump amounts to 152.697 € based on an electricity price of 0.15 €/kWh, representing a saving of 156.532 € or 50% of the energy cost.

For a heat pump installation cost of 300000€ and 10.600 hours of operation per year this represents a return of investment of 3,5 years.

CONCLUSION.

This field case shows that the annual savings can be listed as follows :

On operation 85.381 €,

On condenser water 2.244 Mw (2,5m3 water + treatment) + lower condensing pressure in the refrigeration plant brings important savings on rerfrigeration power consumption.

Natural waste heat and condenser. (with condenser operation approx.. 10 kW is needed per hour for fans and waterpumps)

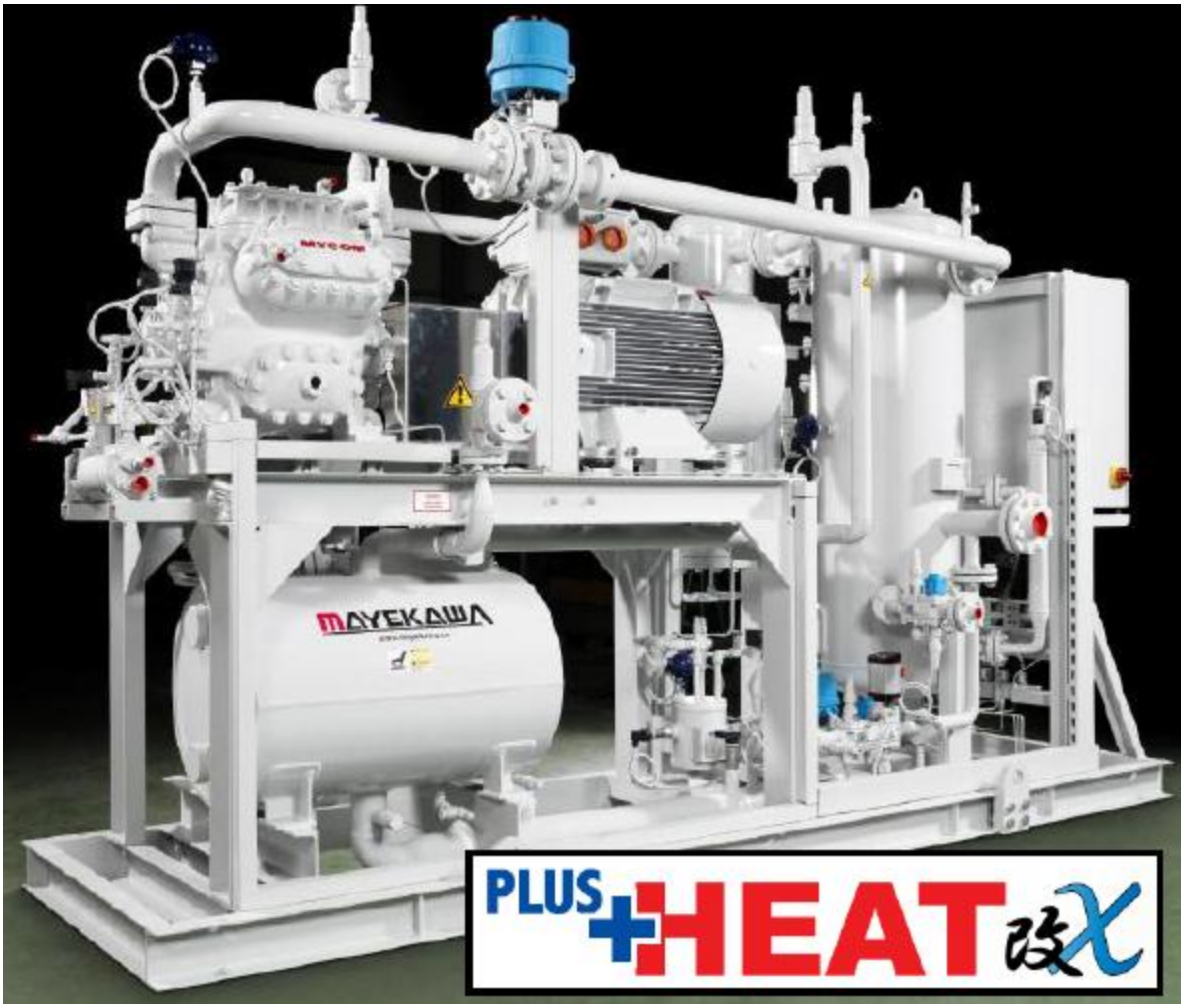
The return of investment 3,5 years.

The efficiency of the heat pump is higher than when applying other comparable technologies.

The heat pump has a long life time (more than 25 years) and has low maintenance costs.

STANDARD HEAT PUMP MODULE.

The heat plus heat pump is shown with small footprint and now available as a standard product enable to install the unit at site with minimized site works.



Compressor and drive motor are installed on the compact steel base structure above the condenser producing the hot water. On the back side the heat source flash tank is visible with all reulation devices and the control panel.

SPECIAL THANK-WORD.

For Mr.Friedl Dresen, the contractor DRESEN + BREMEN from Alfhausen-Germany, who installed the plant and gave us access to all details of this heat pump plant.