



kongres

---

**46th HVAC&R CONGRES AND EXHIBITION :  
IMPROVING ENERGY EFFICIENCY IN CLIMATE AND OZONE FRIENDLY LATEST  
REFRIGERATION TECHNOLOGIES.  
NEW TECHNOLOGY CASE STUDIES USING 'NATURAL 5' REFRIGERANTS**

**2 – 4 . XII 2015 . Beograd, Srbija**

---

# "Natural Five" Refrigerants and Product Solutions

Refrigerant (Natural Five)	NH <sub>3</sub> R-717	CO <sub>2</sub> R-744	HC Hydrocarbon	H <sub>2</sub> O R-718	Air R-728
90°C	Utility hot water	Utility hot water	Utility hot water Heating HVAC	Heat recovery	
60°C		Chilled water Ice making		Chilled water Ice making	
10°C	Cold storage, Freezer, Fish boat				
-15°C	Specific Refrigeration needs				
-25°C	Freezer, Freeze-dry, Super Low temp storage				
-40°C			Cryogenics		Cryogenics
-50°C					
-60°C					
-100°C					
Notes	<ul style="list-style-type: none"> <li>• Conventional system</li> </ul>	<ul style="list-style-type: none"> <li>• Eco-Cute</li> </ul>	<ul style="list-style-type: none"> <li>• Nat'l Proj.</li> <li>• Butane + Propane</li> </ul>	<ul style="list-style-type: none"> <li>• Nat'l Proj.</li> <li>• Adsorption</li> <li>• Heat recovery</li> </ul>	<ul style="list-style-type: none"> <li>• Nat'l Proj.</li> <li>• Air-cycle</li> </ul>

# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

# FIELD CASE



# NATURAL REFRIGERANTS

*-40° C CO<sub>2</sub>/NH<sub>3</sub> cascade system  
combined with  
+60° C hot water NH<sub>3</sub> heat pump*

*in Food Industry*

*presentation by : Jan Boone*

# NATURAL 5 REFRIGERANTS

CO2/NH3 cascade systems combined with  
60° C hot water NH3 heat pumps

## INTRODUCTION

<b>NEED</b>	930kW -40°C (1) 1500kW at -8°C (1) 900kW at -8°C (2) 500kW water at 60°C(1)	freezing & cooling production of fish bites & culinary fish products  Hot water for production process
<b>CHOICE</b>	NH3/CO2	N5 CO2 -40°C(10 barg) NH3 : cascade HS + refrigeration
	60°C hot water	reduce boiler gas consumption NH3 heat pump (ODP & GWP=0) Tc=65°C (28,1 barg) Use 'waste heat' <>condensor load
<b>TIME FRAME</b>	2012 (1) 2015 (2)	

# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

## PLANT VIEW



**NH<sub>3</sub> SYSTEM**

**NH<sub>3</sub> HEAT PUMP**

**CO<sub>2</sub> SYSTEM**

# NATURAL 5 REFRIGERANTS

CO2/NH3 cascade systems combined with  
60° C hot water NH3 heat pumps

## INSTALLED COMPRESSORS

SYSTEM		NH3			CO2	NH3 HP
MODEL		N170JL	N220JS	N220JM	C6HK	N6HK
QTY		1	2	1	3	1
INSTALLED		2012	2012	2015	2012	2012
RPM	rpm	3650	3700	4500	1500	1450
TE	°C	-1	-10	-10	-37	35
TC	°C	35	35	35	-7	65
RT	kW	825	843	1335	343	437
BKW	kW	147	199	318	66	68
QC	kW				408	504
COP		5,64	4,24	4,2	5,2	7,45
HRS	hrs	12749	10487		10273	6880
28/09/2015			11784			

# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

## CO<sub>2</sub> COMPRESSOR 3 SETS MODEL C6HK 50 bar





# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

## NH<sub>3</sub> COMPRESSOR 4 SETS MODEL J 30 bar



# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

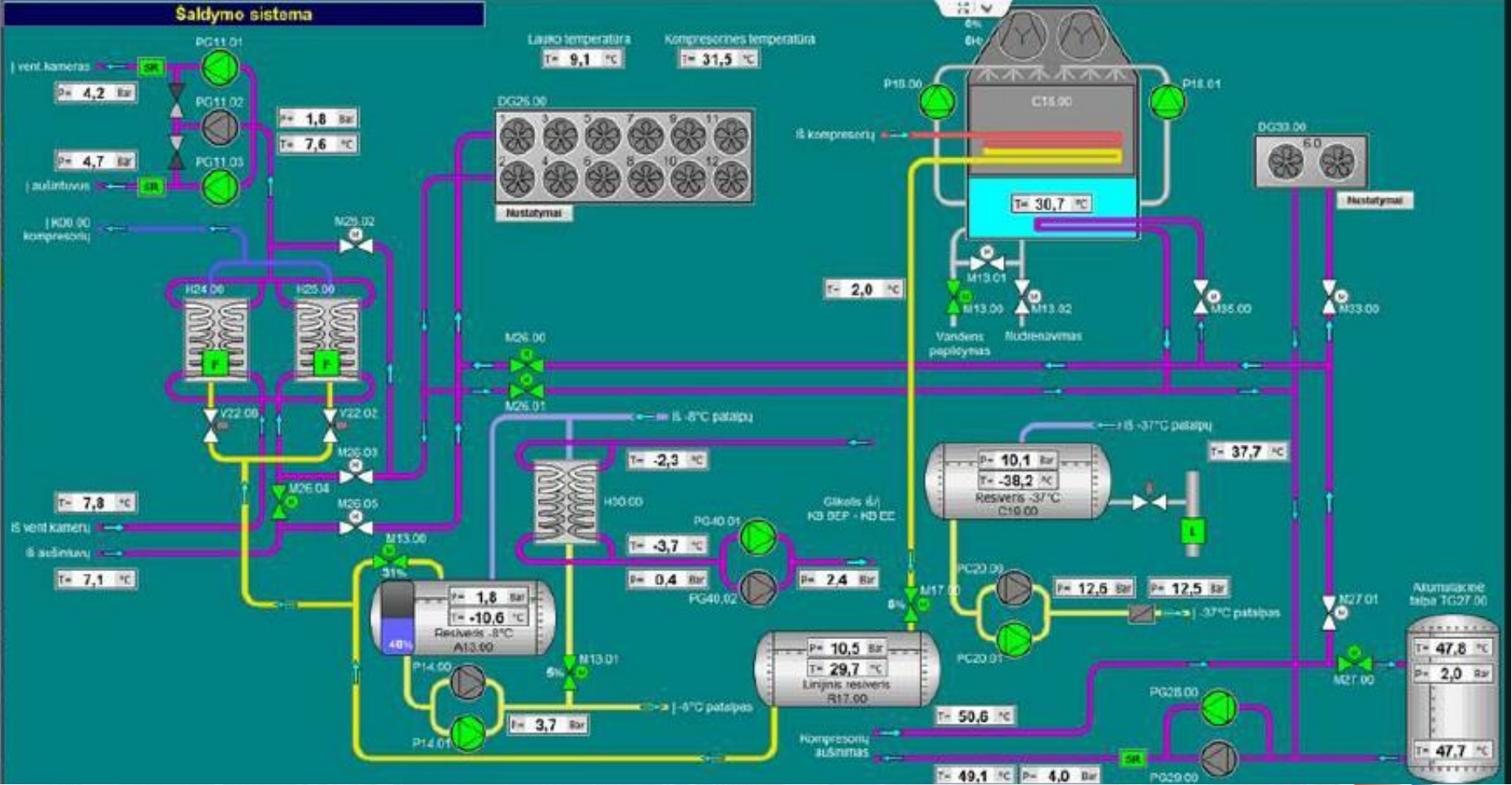
## HOT WATER NH<sub>3</sub> COMPRESSOR MODEL N6HK 50 bar



# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with 60° C hot water NH<sub>3</sub> heat pumps

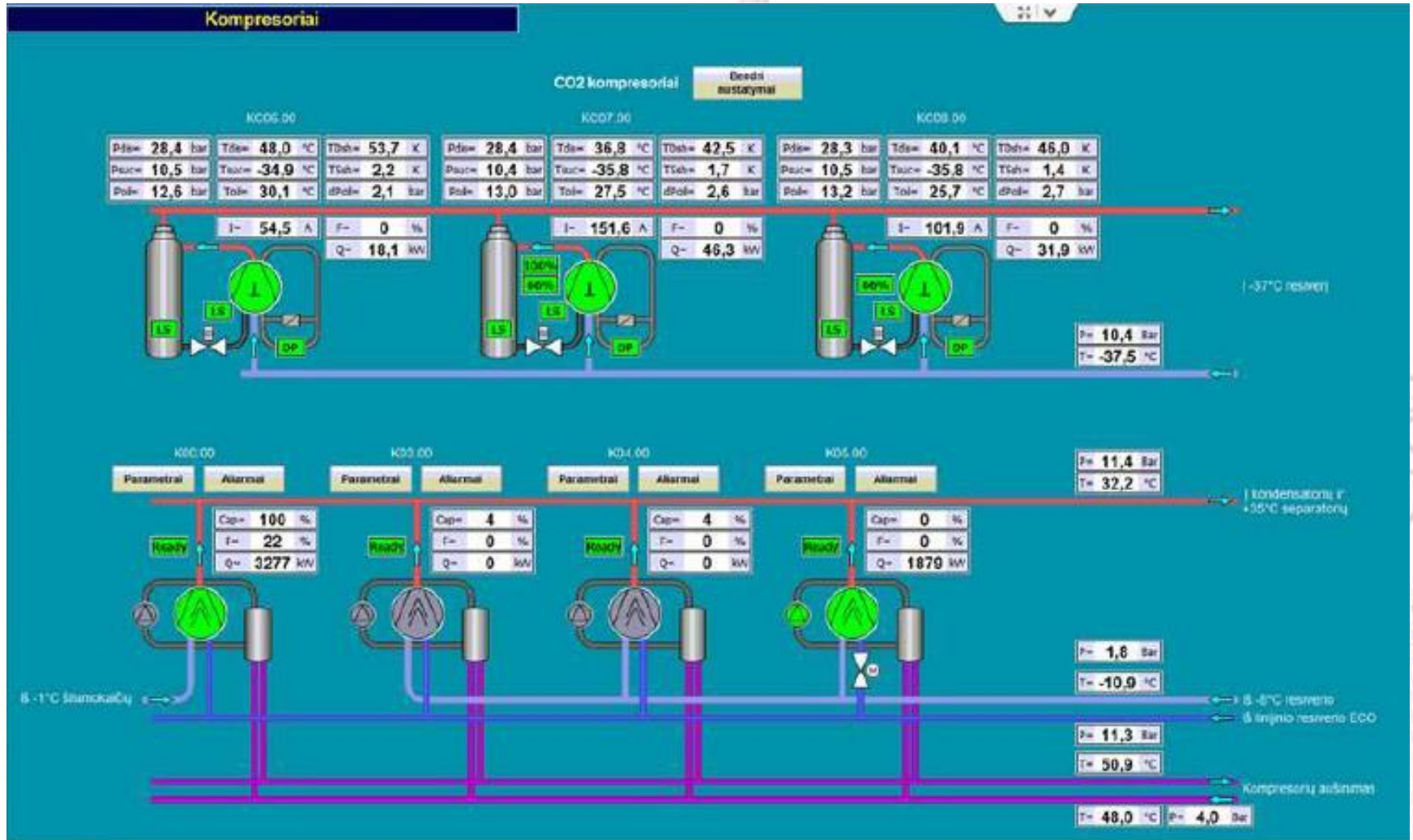
## NH<sub>3</sub> SYSTEM & CO<sub>2</sub> RECEIVER



# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with 60° C hot water NH<sub>3</sub> heat pumps

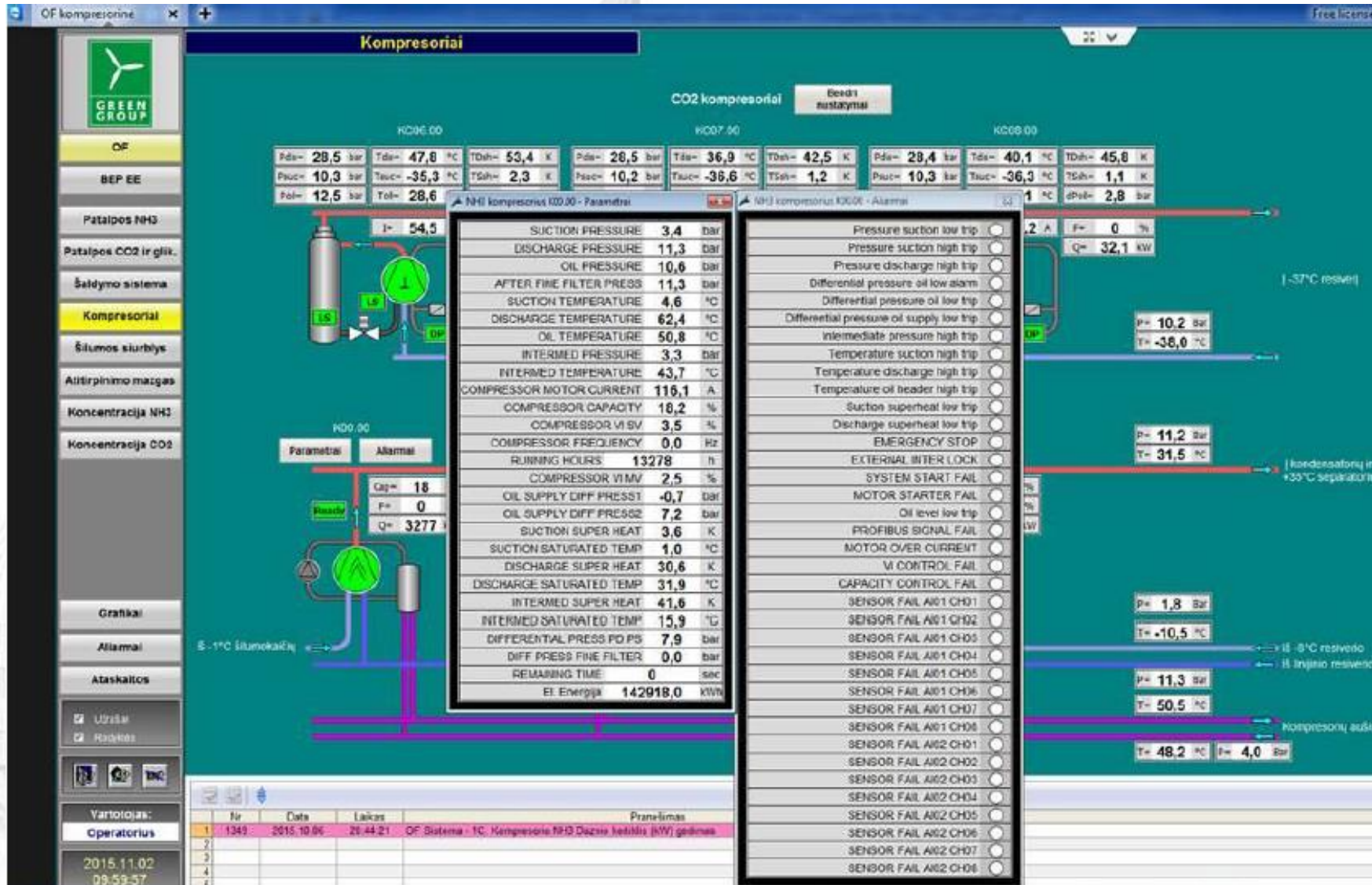
## CO<sub>2</sub> & NH<sub>3</sub> COMPRESSORS



# NATURAL 5 REFRIGERANTS

CO2/NH3 cascade systems combined with 60° C hot water NH3 heat pumps

## N170J STATUS (nr 1)





# N170J STA

## 5 REFRIGERANTS

systems combined with  
H3 heat pumps

OF kompresoriene

GREEN GROUP

OF

BEP EE

Patalpos NH3

Patalpos CO2 ir gliuk.

Šaldymo sistema

**Kompresorial**

Šilumos siurblys

Atšildymo mazgas

Koncentracija NH3

Koncentracija CO2

Grafikai

Ataskaitos

Užrašai

Radiklas

Vartotojas:  
Operatorius

2015.11.02  
09:59:57

- Pressure suction low trip
- Pressure suction high trip
- Pressure discharge high trip
- Differential pressure oil low alarm
- Differential pressure oil low trip
- Differential pressure oil supply low trip
- Intermediate pressure high trip
- Temperature suction high trip
- Temperature discharge high trip
- Temperature oil header high trip
- Suction superheat low trip
- Discharge superheat low trip
- EMERGENCY STOP
- EXTERNAL INTER LOCK
- SYSTEM START FAIL
- MOTOR STARTER FAIL
- Oil level low trip
- PROFIBUS SIGNAL FAIL
- MOTOR OVER CURRENT
- VI CONTROL FAIL
- CAPACITY CONTROL FAIL
- SENSOR FAIL A01 CH01
- SENSOR FAIL A01 CH02

KCC00.00

Tda= 40,1 °C	TDis= 45,8 K
Tauc= -36,3 °C	TDis= 1,1 K
1 °C	dPab= 2,8 bar

2 A I= 0 %  
Q= 32,1 kW

P= 10,2 Bar  
T= -38,0 °C

P= 11,2 Bar  
T= 31,5 °C

P= 1,8 Bar  
T= +10,5 °C

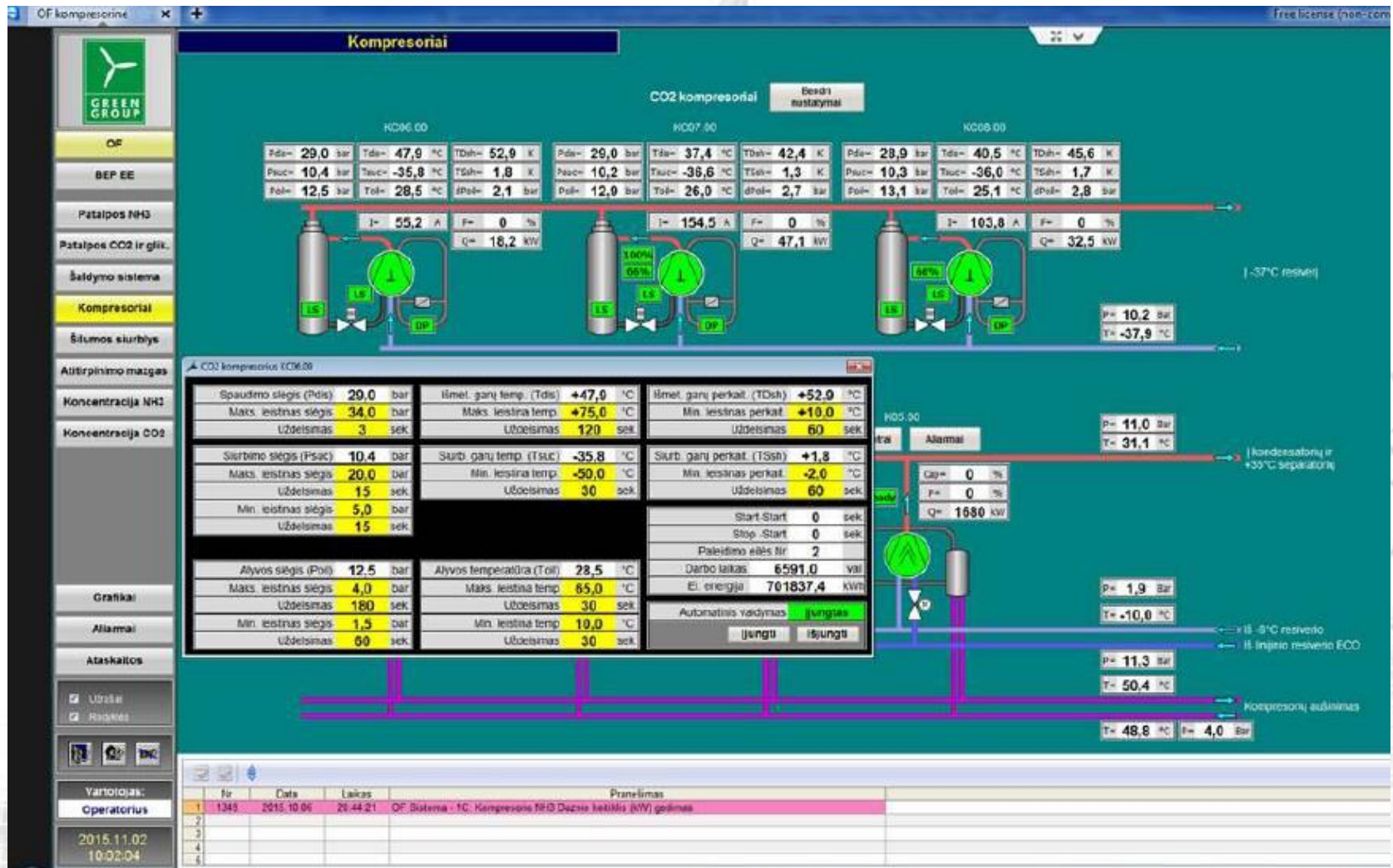
P= 11,3 Bar  
T= 50,5 °C

T= 48,2 °C P= 4,0 Bar

# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with 60° C hot water NH<sub>3</sub> heat pumps

## C6HK STATUS

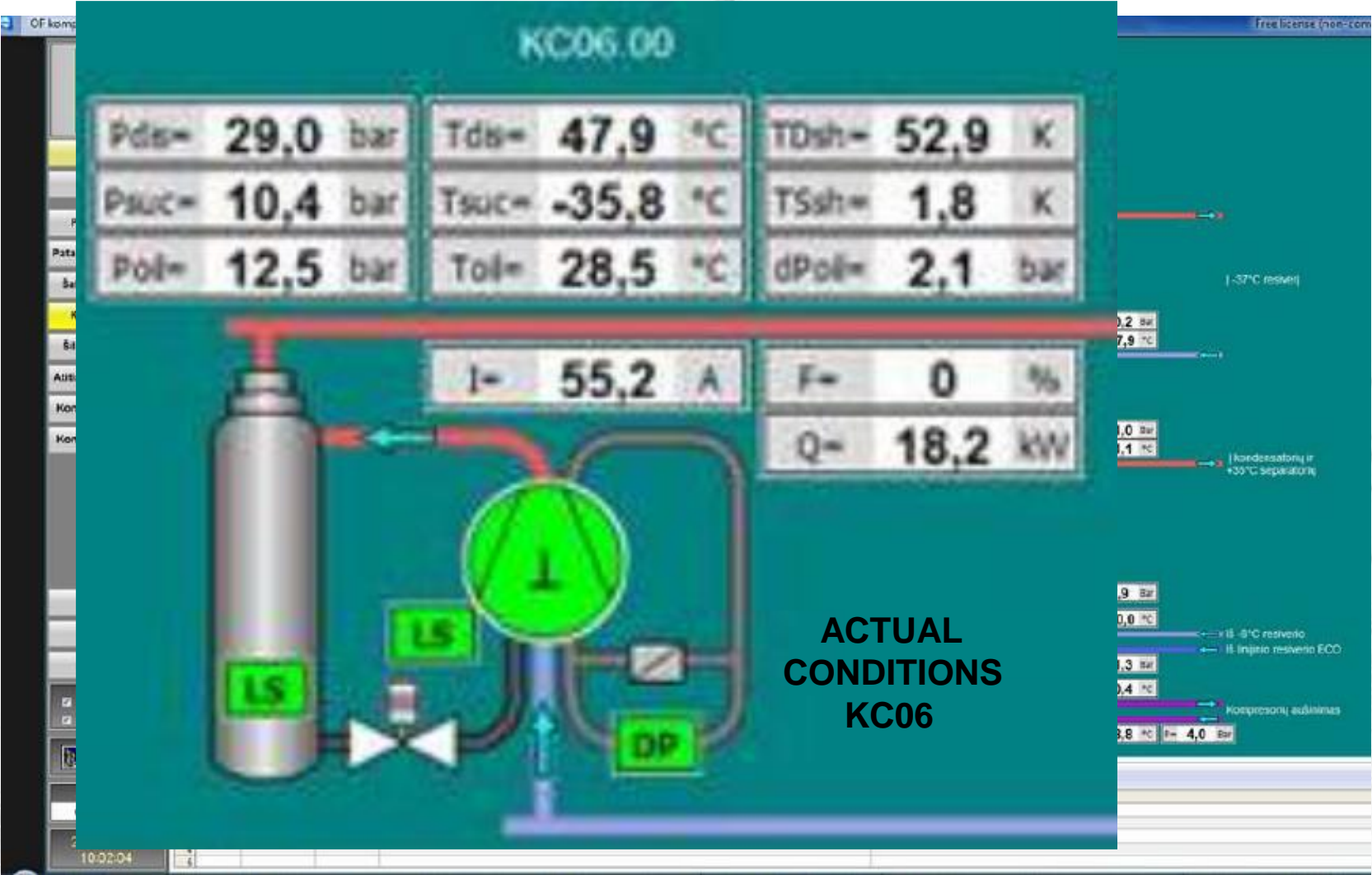




# NATURAL 5 REFRIGERANTS

CO2/NH3 cascade systems combined with 60° C hot water NH3 heat pumps

## C6HK STATUS



# NATURAL 5 REFRIGERANTS

CO2/NH3 cascade systems combined with 60° C hot water NH3 heat pumps

## C6HK STATUS

The screenshot shows a control interface for 'KOMPRESORIAI' (Compressors) with a 'GREEN GROUP' logo. It displays real-time data for three CO2 compressor units (KC06.00, KC07.00, KC08.00) and a summary for 'CO2 kompresorius XCD6.00'. The interface includes a 'Beidri nustatymai' (Settings) button and a 'Pranešimas' (Message) table at the bottom.

Spaudimo slėgis (Pdis) 29,0 bar		Išmet. garų temp. (Tdis) +47,9 °C		Išmet. garų perkait. (TDsh) +52,9 °C	
Maks. leistinas slėgis	34,0 bar	Maks. leistina temp	+75,0 °C	Min. leistinas perkait.	+10,0 °C
Uždelsimas	3 sek.	Uždelsimas	120 sek.	Uždelsimas	60 sek.
Siurbimo slėgis (Psuc) 10,4 bar		Siurb. garų temp. (Tsuc) -35,8 °C		Siurb. garų perkait. (TSsh) +1,8 °C	
Maks. leistinas slėgis	20,0 bar	Min. leistina temp	-50,0 °C	Min. leistinas perkait.	-2,0 °C
Uždelsimas	15 sek.	Uždelsimas	30 sek.	Uždelsimas	60 sek.
Min. leistinas slėgis	5,0 bar			Start-Start	0 sek.
Uždelsimas	15 sek.			Stop -Start	0 sek.
				Paleidimo eilės Nr	2
Alyvos slėgis (Poil) 12,5 bar		Alyvos temperatūra (Toil) 28,5 °C		Darbo laikas	6591,0 val
Maks. leistinas slėgis	4,0 bar	Maks. leistina temp	65,0 °C	Ei. energija	701837,4 kWh
Uždelsimas	180 sek.	Uždelsimas	30 sek.	Automatinis valdymas	<b>Ijungtas</b>
Min. leistinas slėgis	1,5 bar	Min. leistina temp	10,0 °C	Ijungti	Išjungti
Uždelsimas	60 sek.	Uždelsimas	30 sek.		

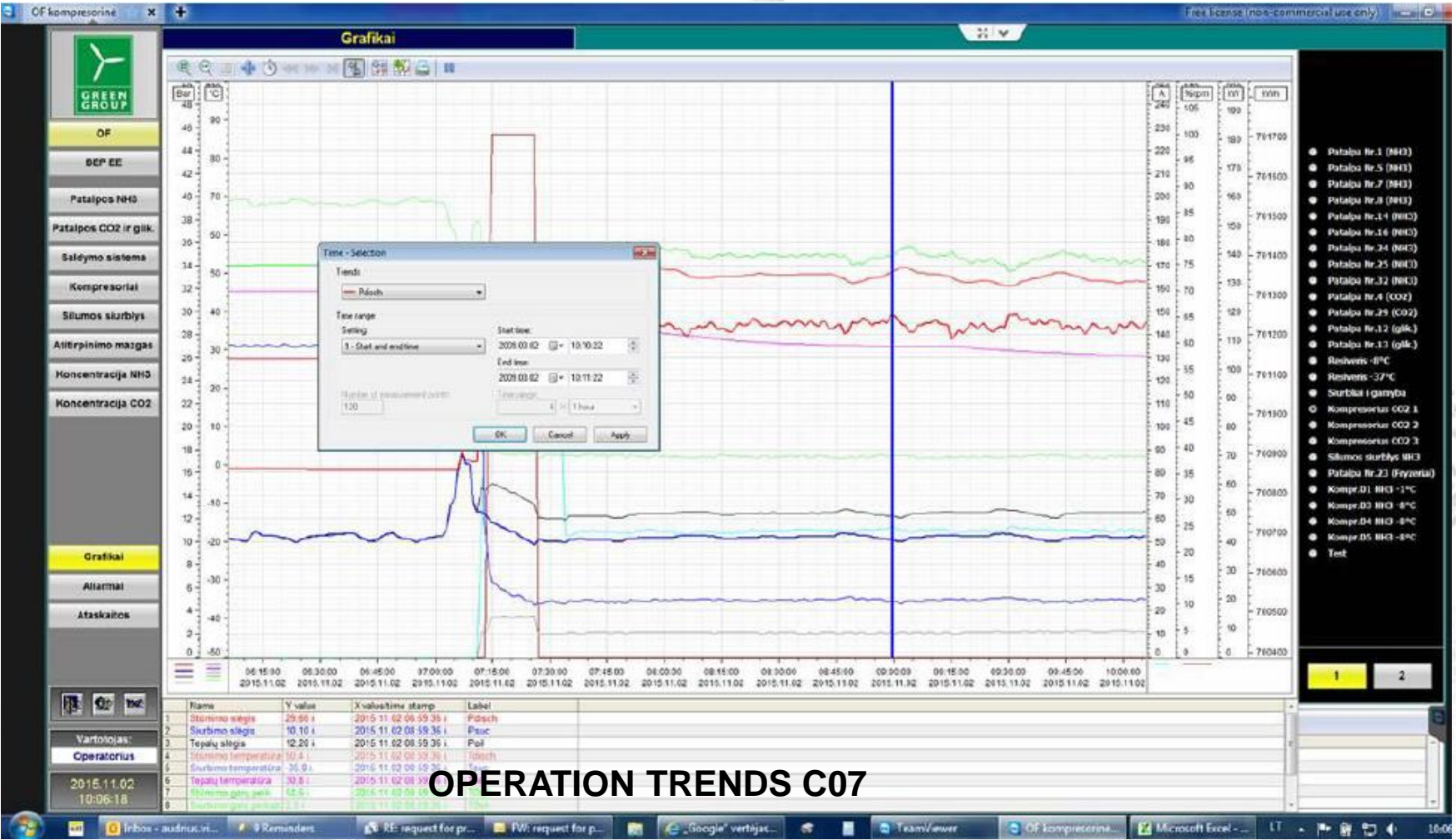
Vartotojas:		Pranešimas	
Operatorius		Nr	Data
2015.11.02 10:02:04		1	2015.10.06
		2	
		3	
		4	
		5	

ACTUAL & PROTECTION SETTINGS KC06

# NATURAL 5 REFRIGERANTS

CO2/NH3 cascade systems combined with 60° C hot water NH3 heat pumps

## C6HK STATUS KC06



### OPERATION TRENDS C07

# N6HK STATUS

## NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with 60° C hot water NH<sub>3</sub> heat pumps



# OPERATION SAVINGS

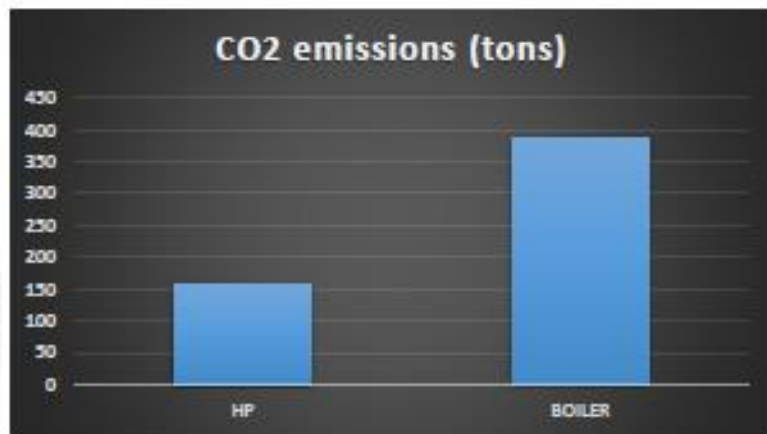
## HOT WATER HEAT PUMP

35m<sup>3</sup>/hr 50->60° C

## NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

	HEAT PUMP	BOILER
Performance(COP)	5,9	0,85
Hot water	406 kW	406 kW
Energy consumption primary (4600 hrs/yr)	317.400 kWh	2.194.200 kWh 219.420 m <sup>3</sup> N.G.
Energy prices	0,06 €/kWh	0,50 €/m <sup>3</sup>
Energy costs	19.044 €	109.710 €
CO <sub>2</sub> emissions	159 ton	387 ton



# OPERATION SAVINGS

## HEAT RECOVERY OIL COOLERS

35m<sup>3</sup>/hr 45,7- $\rightarrow$ 50° C

## NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

	OIL COOLERS	BOILER
Performance(COP)		0,85
Hot water		175 kW
Energy consumption primary (4600 hrs/yr)		947.058 kWh 94.705 m <sup>3</sup> N.G.
Energy prices		0,50 €/m <sup>3</sup>
Energy costs		47.352 €
CO <sub>2</sub> emissions		167 ton

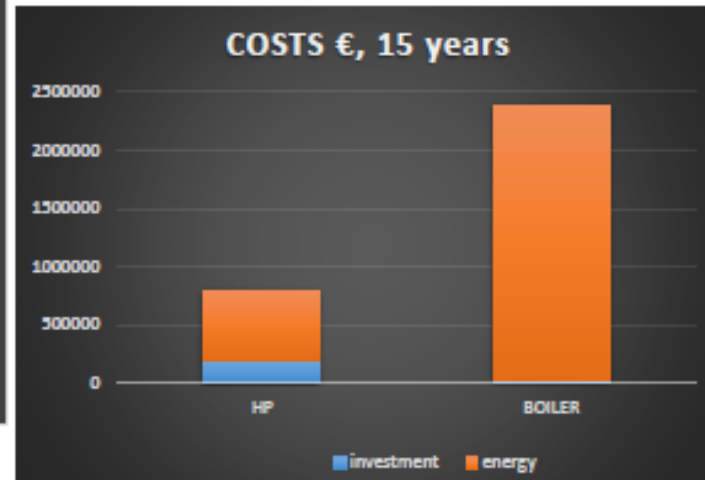
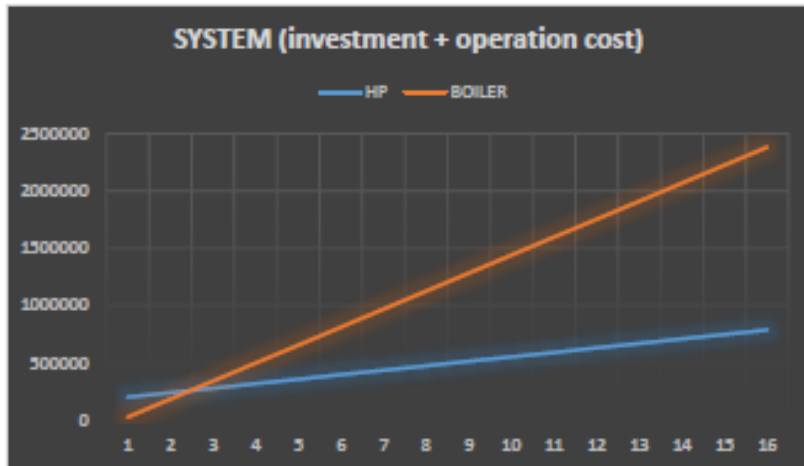
# OPERATION SAVINGS

# NATURAL 5 REFRIGERANTS

## HOT WATER HP + OC heat recovery

CO2/NH3 cascade systems combined with 60° C hot water NH3 heat pumps

	HEAT PUMP	BOILER	SAVINGS
Energy costs/yr	19.044 €	157.062 €	138.018 €
CO2 emissions/yr	159 ton	547 ton	388 ton
investment	200.000 €	25.000 €	-175.000 €
Energycost 15yrs	285.660 €	2.355.930 €	2.070.270 €
Maintenance cost 15y	300.000 €		-300.000 €
Total cost 15y	785.660 €	2.385.930 €	1.600.270 €



R.O.(Investment + energy cost) < 3 years

# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

## TRAINING

Product : organized by Mayekawa to the contractors

System : organized to Contractors, with Mayekawa-support, to the users.





## INSTALLATION + COMMISIONING + OPERATION

Installation	Contractor + Mycom support
Commisioning (monitoring)	Contractor + Mycom support
Finetuning regulation/operation (monitoring)	Stability & long lifetime Machine logbook
Reference registration (monitoring)	Future evaluations (site)
Event registration (monitoring)	For every action (site &/ remote)
Operation registration (monitoring)	Regular basis (site &/ remote)

# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

## SERVICE & MAINTENANCE

Daily checks	Qualified personnel (operators, Contractor service persons)
Routine checks	idem
Main service (overhauls)	J type : every 5 years HK type : every 2 years
Lubrication oil	Regular check Preventive analysis Preventive particle filtration
Registration	For every service & maintenance activity

# NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps



## Special thank-word :

Mr.Egidijus Vilkauskas

CONTRACTOR  
GREEN GROUP  
Lithuania-Vilnius



kggh

Thank you very much !

## NATURAL 5 REFRIGERANTS

CO<sub>2</sub>/NH<sub>3</sub> cascade systems combined with  
60° C hot water NH<sub>3</sub> heat pumps

### MARKET AVAILABILITY

MAYEKAWA REPRESENTATIVE FOR SERBIA :

“KLIMA” doo Smederevo – Serbia

telephone : ++381 26 / 222 109

website : www.klima.co.rs



Ovlašćeni distributer **MAYEKAWA** n.v. **MYCOM** EUROPE s.a.

Petrijevski potok 28, 11300 Smederevo, Serbia, tel./fax ++381 / (0)26 / 4621-715, www.klima.co.rs