ATMO EU sphere
solutions for europe
natural refrigerants
15-16 October 2013, Brussels

NATURAL REFRIGERANTS

High pressure compressors in Industrial plants

Presentation by : Mr.Robert Sossi
Authors : Daniel Dick & Jan Boone

NATURAL REFRIGERANTS

High pressure compressors in Industrial plants,

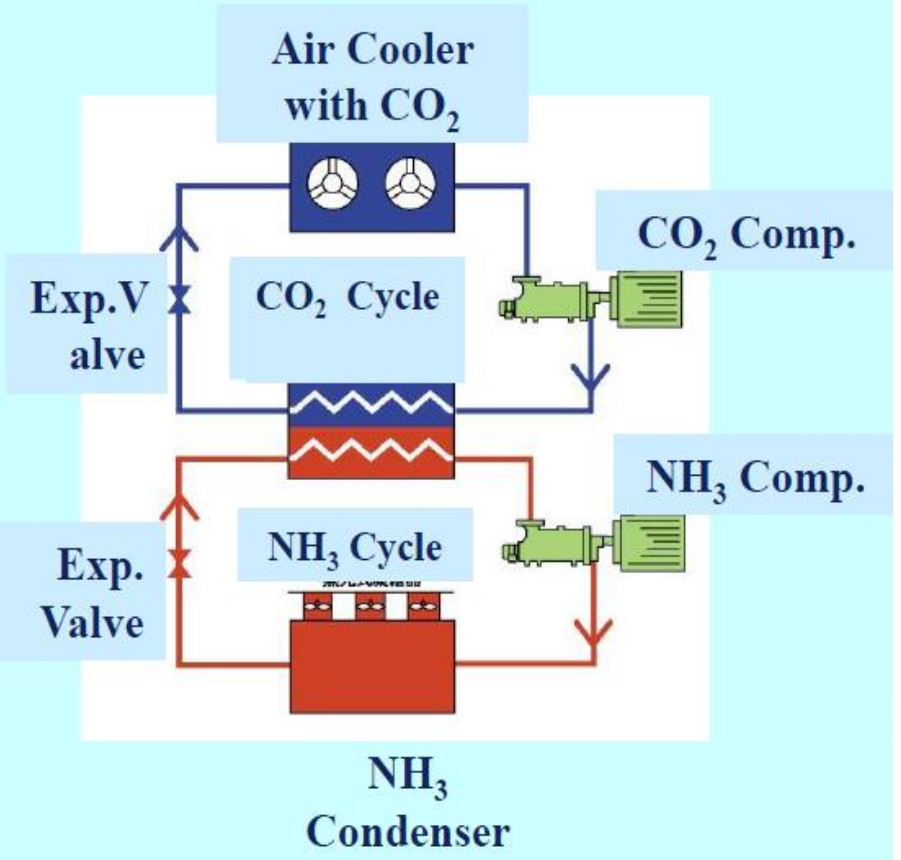
"Natural Five" Refrigerants and Product Solutions

Refrigerant (Natural Five)	NH_3 R-717	CO_2 R-744	HC Hydrocarbon	H_2O R-718	Air R-728
90℃ / 60℃ / 10℃ / -15℃ / -25℃ / -40℃ / -50℃ / -60℃ / -100℃	Utility hot water Heating Chilled water Ice making Cold storage, Freezer, Fish boat Specific Refrigeration needs Freezer, Freeze-dry, Super Low temp storage	Utility hot water Chilled water Ice making	Utility hot water Heating HVAC Cryogenics	Heat recovery Chiller	Cryogenics
Notes	・Conventional system ・National Projects	・Eco-Cute	・Nat'l Proj. ・Butane + Propane	・Nat'l Proj. ・Adsorption ・Heat recovery	・Nat'l Proj. ・Air-cycle

NATURAL REFRIGERANTS

High pressure compressors in Industrial plants,

CO2/NH3 CASCADE COMPRESSION REFRIGERATION



NATURAL REFRIGERANTS

High pressure compressors in Industrial plants,

FIELD CASE

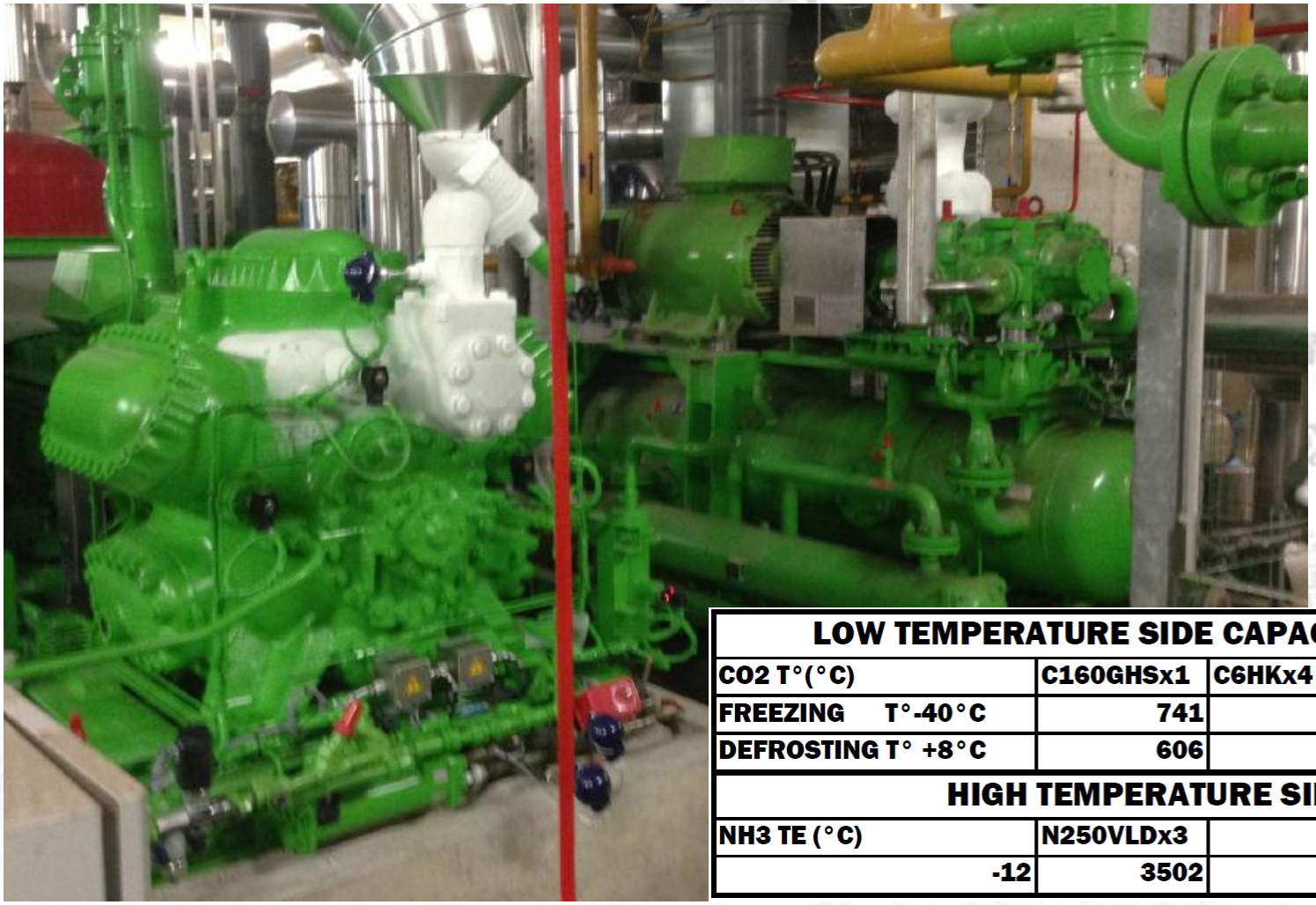
INTRODUCTION

STARTING POINT 3 Mw -35°C	freezing plant for bakery products requiring -35°C product temperatures for nominal 3000 kW to be realised in 2 phases contractor : **Cofely Axima Refrigeration France**
CHOICE CO2 -40°C N5 direct charge compressors	CO2/NH3 cascade system CO2 at -40°C (9,8 bara) to obtain production t° -35°C CO2 as natural refrigerant CO2 for direct cooling on the freezers applied in a cascade system with limited NH3 qty as natural refrigerant only used for the high t° side high pressure compressors suitable for hot gas defrosting operation design pressures up to 50bar, resp. 66bar in f(compressor model) defrosting at +8°C (42,8 bara)
TIME FRAME	new plant : phase 1 : 2011 followed by 2: 2013

NATURAL REFRIGERANTS

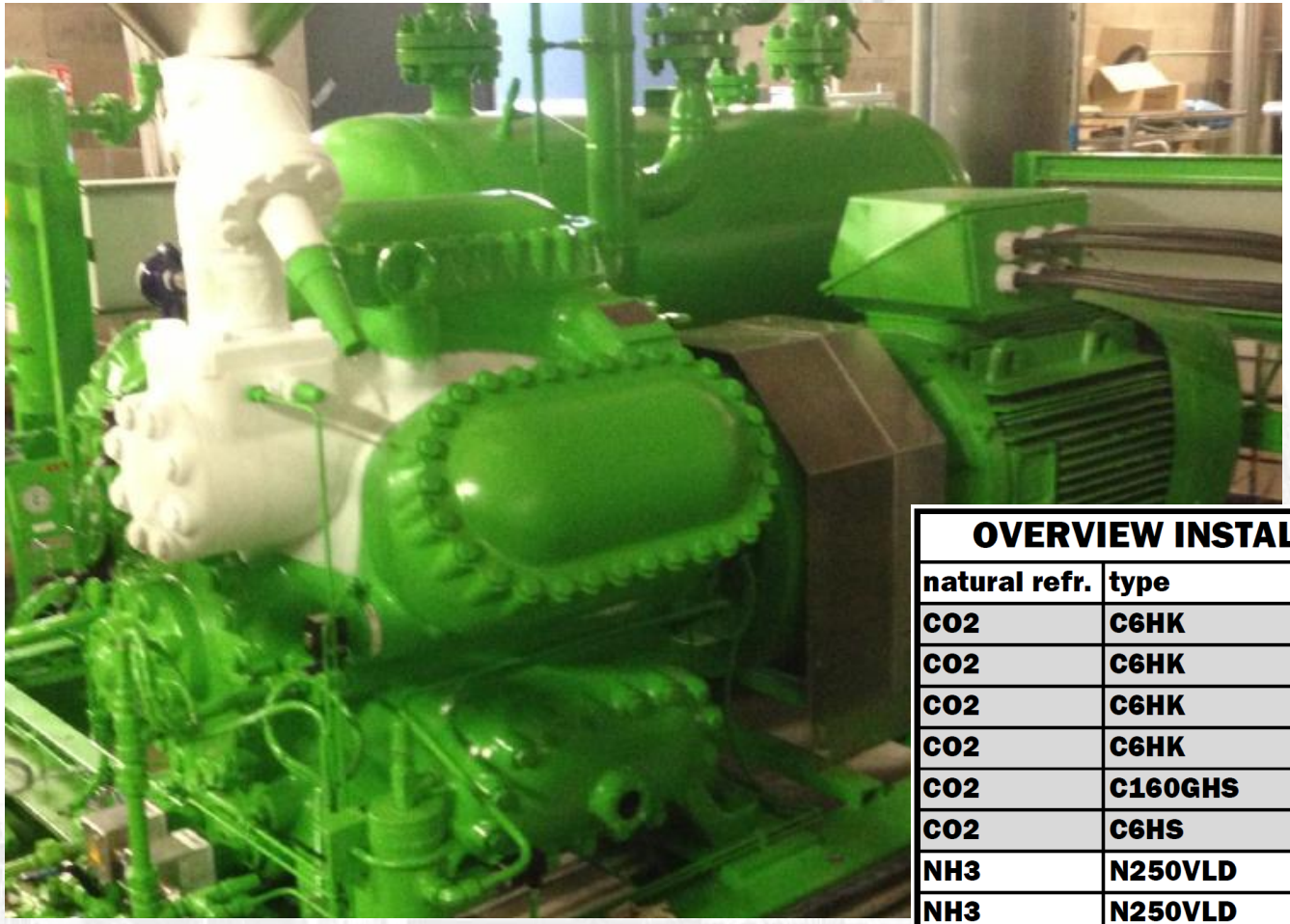
High pressure compressors in Industrial plants,

EQUIPMENT



LOW TEMPERATURE SIDE CAPACITIES (kW)			
CO2 T°(°C)	C160GHSx1	C6HKx4	C6HSx1
FREEZING T°-40°C	741	1196	940
DEFROSTING T° +8°C	606	696	
HIGH TEMPERATURE SIDE			
NH3 TE (°C)	N250VLDx3		
-12	3502		

EQUIPMENT



OVERVIEW INSTALLED COMPRESSORS :				
natural refr.	type	unit	date	hours
CO2	C6HK	C1	2011	7997
CO2	C6HK	C2	2011	1664
CO2	C6HK	C3	2011	5444
CO2	C6HK	C4	2011	877
CO2	C160GHS	C5	2011	71
CO2	C6HS	C6	2013	1871
NH3	N250VLD	CV1	2011	19895
NH3	N250VLD	CV2	2011	5107
NH3	N250VLD	CV3	2011	5603

EFFICIENCY ANALYSIS

DESIGN

CO2/NH3 CASCADE		RT	BKW	THR	COPc-each	COPc-total
TE=-40°C	TC=+35°C	kW	kW	kW		
CO2 LS	C160GHS	741	200	941	3,7	
	C6HK	1196	289	1485	4,1	
	C6HS	940	212	1152	4,4	
	total	2877	701	3578	4,1	
NH3 HS	N250VLDx2	3502	1006		3,5	
	N250VLD					
TOTAL		2877	1707			1,68

AVERAGE

CO2/NH3 CASCADE		RT	BKW	THR	COPc-each	COPc-total	
TE=-40°C	TC=+29,5°C	kW	kW	kW			
CO2 LS	C160GHS	741	200	941	3,7		
	C6HK	1196	289	1485	4,1		
	C6HS	940	212	1152	4,4		
	total	2877	701	3578	4,1		
NH3 HS	N250VLDx2	3575	825		4,3		181 kW
	N250VLD						
TOTAL		2877	1526			1,88	12%

CONCLUSION

1	NATURAL REFRIGERANTS are the main trend for refrigeration in food industry	
2	CO2	low temperature at usefull pressures (-40°C 10bara) defrosting temperature (10°C 45bara, 20°C 58bara) maximised COPc direct use in the freezing equipment low cost smaller size equipment less risc for food safety cascade with minimised NH3 charge low insurance costs low CO2 emmision

NATURAL REFRIGERANTS

High pressure compressors in Industrial plants,

COMBINED NH3 CHILLER / HOT WATER HEAT PUMP

NATURAL REFRIGERANTS

High pressure compressors in Industrial plants,

CHILLER		
compressor model		piston N8M
cooling output water temperature capacity	 °C kW	 1,5 1000
bkw	kW	250
COP-c		4,0
HOT WATER HEAT PUMP		
compressor model		piston N6HS
heating output water temperature capacity	 °C kW	 90 1500
bkw	kW	250
COP-h		6,0
COP-total		**5,0**

ATMO EU sphere

solutions for europe

natural refrigerants

15-16 October 2013, Brussels

Thank you very much!