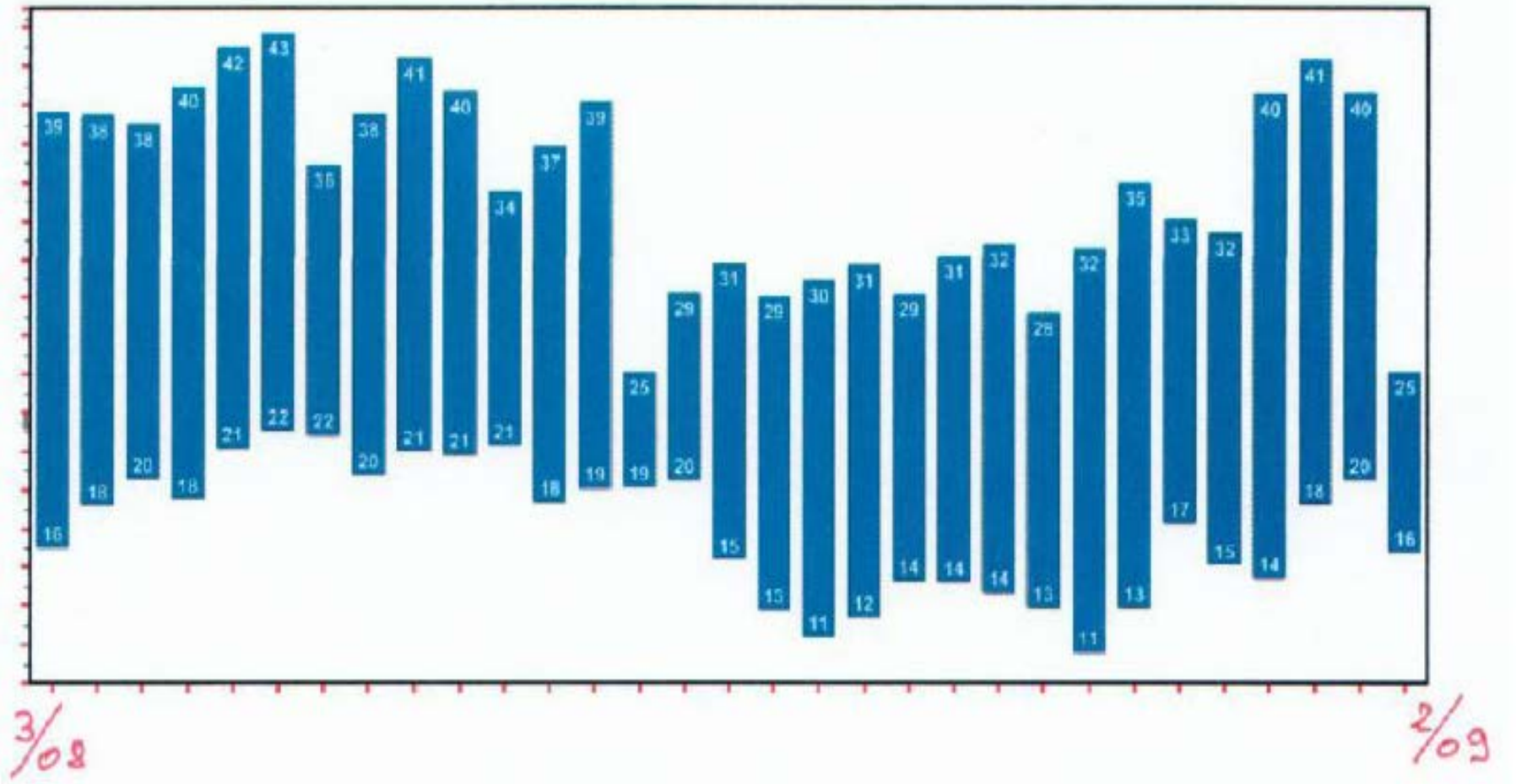
ADIABATIC COOLING FOR CO2 INSTALLATIONS

Problems with ambiant temperatures

- Already two years we see that temperature in Europe rise , specially during July and August.
- In Poland where we are located we have meassured extreme temperatures , and constatated that some transcritical installations run over his limit.
- We think that calculating now, not on 34°C ambient but on 37°C is not the ideal solution.
- Capacity go down , energy cost go up and installation cost is much higher.
- So we propose to consider to start with adiabatic gas cooler.

TEMPERATURE °C JULY-AUGUST 2015 CENTRUM POLAND

39 38 38 40 42 43 36 38 41 40 34 37 39 25 29 31 29 30 31 29 31 32 28 32 35 33 32 40 41 40 25



TEMPERATURE IN SHADOW

- In the blue tabel before we see a big different in peaks of temperature.

- The tabel from 2012 adapted with the temperatures from July – August from this year give a good indication.

- If we go to compair 2009 (337 hr > 25°) with extrapolated 2015 (748 hr > 25°) , there is big different

Temperature Poland 2012 with adapted temp from July August 2015

houers	DT	time	24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	-10°	193,3	10,6	11,4	11,7	12,1	12,9	13,0	13,4	13,6	10,7	9,8	8,1	6,5	5,2	4,1	4,1	4,4	3,1	3,8	4,8	5,6	5,6	5,8	6,2	6,8
	-7,5°	161,0	8,3	8,5	8,2	9,1	8,9	8,9	8,4	8,3	8,0	7,6	7,4	6,2	5,2	4,8	4,9	4,9	3,7	5,4	4,8	4,8	5,3	5,4	6,6	7,3
	-5°	262,0	12,3	12,7	13,0	13,6	14,1	14,1	14,2	14,6	13,5	11,8	10,7	10,2	8,9	8,9	7,7	6,0	7,3	8,4	8,9	9,2	9,8	9,9	10,1	12,1
	-2,5°	514,3	24,3	25,2	24,9	25,8	26,7	26,7	26,0	25,9	23,4	21,7	19,5	18,7	17,5	15,2	16,0	14,0	13,5	18,7	19,9	20,3	20,6	20,8	24,2	24,8
	0°	864,9	43,6	43,7	44,0	44,1	46,5	44,7	44,2	45,1	40,2	37,8	37,2	34,4	33,3	29,4	27,3	27,3	25,0	26,1	27,0	27,2	30,5	31,2	33,9	41,2
	2,5°	777,0	35,3	35,3	35,6	36,8	36,8	37,8	36,2	35,9	35,1	34,8	32,1	32,7	29,9	27,3	28,1	27,8	26,8	27,8	28,7	28,9	30,2	30,7	31,9	34,5
3532	5°	759,2	35,3	35,8	36,0	38,1	38,6	36,7	33,0	32,9	32,1	31,1	30,3	29,4	29,5	26,3	26,6	25,8	26,0	28,0	29,9	30,2	29,9	30,9	32,9	34,0
	7,5°	725,1	37,4	37,6	38,1	40,2	42,9	37,7	33,1	30,9	27,3	26,9	26,5	26,4	25,8	24,7	24,3	24,0	24,6	24,9	25,6	25,8	26,2	28,1	30,6	35,6
1492	10°	766,6	36,0	43,1	44,2	44,6	46,4	44,9	39,6	35,9	32,3	29,2	26,8	25,5	24,9	24,3	23,9	24,0	23,0	23,5	27,4	27,0	27,3	27,8	28,7	36,2
	12,5°	796,5	42,0	42,6	41,4	41,7	40,7	41,6	41,3	36,0	35,6	32,3	30,8	28,3	27,8	26,2	26,0	22,6	23,8	23,6	29,9	30,0	30,4	30,8	31,9	39,2
1557	15°	760,6	36,2	32,3	30,3	30,1	30,1	32,4	34,6	36,4	36,1	34,4	33,4	32,8	32,5	30,5	27,7	27,2	27,3	27,0	27,0	27,1	29,7	31,2	37,5	36,8
	17,5°	619,7	22,0	20,6	19,4	15,7	12,7	17,2	19,8	25,8	31,0	32,7	31,4	31,5	32,0	29,2	27,3	26,3	29,6	27,7	28,8	28,3	27,5	27,2	28,1	27,8
1065	20°	445,5	8,7	6,9	5,8	4,6	3,5	5,6	8,7	13,0	22,2	24,2	26,8	26,5	29,0	26,8	26,1	26,3	27,8	29,1	29,0	26,0	23,8	21,5	15,3	8,4
	22,5°	343,1	6,9	5,0	5,2	4,0	2,0	1,7	6,0	5,2	9,5	17,7	18,0	22,6	24,2	24,5	23,7	23,8	27,1	22,2	24,0	19,0	14,2	13,5	15,9	7,2
647	25°	304,0	5,2	3,5	6,2	3,6	1,2	0,9	5,0	5,0	5,2	7,4	13,2	16,0	18,0	25,0	23,6	23,9	23,8	22,0	18,9	18,0	19,7	19,0	14,1	5,6
	27,5°	202,9	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,2	0,9	2,4	5,0	7,2	8,9	19,7	21,6	19,6	20,8	19,6	13,5	16,0	16,1	16,8	10,0	4,5
344	30°	141,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7	1,9	4,2	5,6	7,2	11,4	12,9	15,6	12,8	15,0	8,2	14,3	12,5	11,5	5,2	2,0
	32,5°	62,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,8	3,0	3,2	3,4	8,0	10,2	9,1	7,5	4,8	4,0	3,9	1,2	0,9	0,0
	35°	31,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	2,3	4,1	6,1	6,9	3,9	2,8	2,2	1,2	0,7	0,0	0,0
100	37,5°	7,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,0	2,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0

2009	25°	195
	27,5°	91
	30°	39
	32,5°	9
	35°	3
	37,5°	0

2015	25°	304
	27,5°	203
	30°	141
	32,5°	62
	35°	31
	37,5°	7

Problem at this temperatures

Installations wich are calculated for 34° air in and 36° out gascooler temp. start to have problems

- Capacity go down and interstage pressure go up,if temperature arrive at 11° C (45 bar) relief valves in liquid line opens.
- Normaly overpressure valves are forbidden on liquid side because if they open , thet dont close before all CO_2 is gone.
- For this problems most company's start to calculate 37°/39° C or parallel compressors and upgrate installation.

Till today projects are calculated for 34° ambiant T°

If Carrefour decide to go to 37° there are some consequences

In Poland the most projects are 32 kw LT and 220 kw MT

With 34° we got 5 compressors MT and 3 compressers LT

Gas cooler 414 kw

With 37° we got 6 compressors MT and 3 compressors LT

Gas cooler 469 kw

Or

Two power packs one LT with 3 compressors and MT with 3 compressors

and second power pack only MT with 3 compressors

And also 2 gas coolers from 265 and 202 kw

CO_2 Calculation Tool Version 1.43

Project name	transcritic ambiant temperature 34°C	22/09/2015 / All data subject to change	
System	Booster (LT and MT)	Net supply	50 Hz / 400 V

Low temperature

Refrigerant	R744		
Evaporator capacity	32 kW		
Number of compressors	3		
Evaporating temperature	-33,0 °C	12,9 bar	
Evaporator superheat	6,0 K		
Suction line superheat	8,0 K		
Int. heat exch. superh.	10,0 K		
Tot. superh./suct. g. temp.	24,0 K /	-9,0 °C	
	Two stage expansion		
Condensing temperature	-9,0 °C	27,25 bar	
Int. heat exch. subc.	3,8 K		
External subcooling	0,0 K		
Tot. subc. / liquid temp.	3,8 K /	1,5 °C	
Desuperheater temp.	35,0 °C		

Medium temperature

Refrigerant	R744		
Evaporator capacity	220 kW		
Number of compressors	5		
Evaporating temperature	-9,0 °C	27,25 bar	
Evaporator superheat	6,0 K		
Suction line superheat	4,0 K		
Int. heat exch. superh.	10,0 K		fl. g. <-> gas cooler
Tot. superh./suct. g. temp.	12,3 K /	3,3 °C	
	Transcritical		Flash gas bypass
High pres. (max. COP fast)	84,0 bar		
Gas cooler outlet temp.	34 °C		
Int. heat exch. subc.	1,2 K		
Tot. subc. / fluid temp.	1,2 K	32,81 °C	
Interstage pressure (ip)	40,0 bar /	5,3 °C	
External subcooling (ip)	0,0 K		
Tot. subc. / liquid temp. (ip)	0,0 K /	5,3 °C	

Low temperature

Compressors	2FSL-4K	2FSL-4K	2FSL-4K	Total
Motor code	40S (Y)	40S (Y)	40S (Y)	
Variable speed drive	50 Hz	No	No	
Cooling cap. compressor	11,11 kW	11,11 kW	11,11 kW	33,33 kW
Evaporator capacity	10,73 kW	10,73 kW	10,73 kW	32,20 kW
Power input	2,51 kW	2,51 kW	2,51 kW	7,54 kW
Current (400 V)	---	5,62 A	5,62 A	---
Max. current	8,60 A	8,60 A	8,60 A	25,80 A
COP/EER compressor	4,42	4,42	4,42	4,42
Mass flow	161 kg/h	161 kg/h	161 kg/h	483 kg/h
Discharge gas temp.	62 °C	62 °C	62 °C	62 °C
Ratio to system capacity	33 %	33 %	33 %	100 %
Ratio to design capacity	34 %	34 %	34 %	**101 %**

Medium temperature

Compressors	4FTC-20K	4CTC-30K	4CTC-30K	4CTC-30K	4CTC-30K	Total
Motor code	40P (PW)	40S (Y)	40S (Y)	40S (Y)	40S (Y)	
Variable speed drive	50 Hz	No	No	No	No	
Motor version	Motor 2	Motor 2	Motor 2	Motor 2	Motor 2	
Cooling cap. compressor	37,34 kW	56,08 kW	56,08 kW	56,08 kW	56,08 kW	261,65 kW
Evaporator capacity	31,33 kW	47,04 kW	47,04 kW	47,04 kW	47,04 kW	219,48 kW
Power input	19,88 kW	30,00 kW	30,00 kW	30,00 kW	30,00 kW	139,86 kW
Current (400 V)	---	48,80 A	48,80 A	48,80 A	48,80 A	---
Max. current	42,00 A	62,60 A	62,60 A	62,60 A	62,60 A	292,40 A
Gas cooler capacity	57,22 kW	86,07 kW	86,07 kW	86,07 kW	86,07 kW	401,51 kW
COP/EER compressor	1,88	1,87	1,87	1,87	1,87	1,87
Mass flow compressor	903 kg/h	1.356 kg/h	1.356 kg/h	1.356 kg/h	1.356 kg/h	6.325 kg/h
Discharge gas temp.	111 °C	111 °C	111 °C	111 °C	111 °C	111 °C
Ratio to system capacity	14 %	21 %	21 %	21 %	21 %	100 %
Ratio to design capacity	14 %	21 %	21 %	21 %	21 %	**100 %**

Power pack
LT 32 kw MT 220 kw
5 compressers

ambiant T° 34°
gas cooler out 36°

gas cooler cap. 414 kw

CO_2 Calculation Tool Version 1.5

All pressures are absolute values

12/10/2015 / All data subject to change

Project name	transcritical ambiant temp 37°		
System	Booster (LT and MT)	Net supply	50 Hz / 400 V

Low temperature

Refrigerant	R744		
Evaporator capacity	32 kW		
Number of compressors	3		
Evaporating temperature	-32,0 °C	13,3 bar	
Evaporator superheat	6,0 K		
Suction line superheat	8,0 K		
Int. heat exch. superh.	10,0 K		
Tot. superh./suct. g. temp.	24,0 K /	-8,0 °C	
	Two stage expansion		
Condensing temperature	-9,0 °C	27,2 bar	
Int. heat exch. subc.	3,8 K		
External subcooling	0,0 K		
Tot. subc. / liquid temp.	3,8 K /	1,5 °C	
Desuperheater temp.	35,0 °C		

Medium temperature

Refrigerant	R744		
Evaporator capacity	220 kW		
Number of compressors	6		
Evaporating temperature	-9,0 °C	27,25 bar	
Evaporator superheat	6,0 K		
Suction line superheat	4,0 K	Flash Gas HX	
Int. heat exch. superh.		No int. heat exch.	
Tot. superh./suct. g. temp.	10,0 K /	1,0 °C	
	Transcritical	Flash gas bypass	
High pres. (max. COP fast)	96,2 bar	(•) FG - Bypass	
Gas cooler outlet temp.	39 °C	( ) FG - Parallel	
Interstage pressure (ip)	40,00 bar /	5,3 °C	
Int. heat exch. subc. (ip)	0,0 K		
External subcooling (ip)	0,0 K		
Tot. subc. / liquid temp. (ip)	0,0 K /	5,3 °C	

Low temperature

Compressors	2FSL-4K	2FSL-4K	2FSL-4K	Total
Motor code	40S (Δ)	40S (Y)	40S (Y)	
Variable speed drive	44 Hz	No	No	
Cooling cap. compressor	10,21 kW	11,60 kW	11,60 kW	33,40 kW
Evaporator capacity	9,86 kW	11,20 kW	11,20 kW	32,27 kW
Power input	2,19 kW	2,49 kW	2,49 kW	7,17 kW
Current (400 V)	5,31 A	5,60 A	5,60 A	16,50 A
Max. current	15,40 A	8,60 A	8,60 A	32,60 A
COP/EER compressor	4,66	4,66	4,66	4,66
Mass flow	148 kg/h	168 kg/h	168 kg/h	484 kg/h
Discharge gas temp.	60 °C	60 °C	60 °C	60 °C
Ratio to system capacity	31 %	35 %	35 %	100 %
Ratio to design capacity	31 %	35 %	35 %	**101** %

Medium temperature

Compressors	4FTC-20K	4CTC-30K	4CTC-30K	4CTC-30K	4CTC-30K	4CTC-30K	Total
Motor code	40P (PW)	40P (PW)	40S (Y)	40S (Y)	40S (Y)	40S (Y)	
Variable speed drive	50 Hz	No	No	No	No	No	
Motor version	Motor 2	Motor 2	Motor 2	Motor 2	Motor 2	Motor 2	
Cooling cap. compressor	32,86 kW	49,63 kW	49,63 kW	49,63 kW	49,63 kW	49,63 kW	281,02 kW
Evaporator capacity	26,08 kW	39,39 kW	39,39 kW	39,39 kW	39,39 kW	39,39 kW	223,01 kW
Power input	22,11 kW	33,31 kW	33,31 kW	33,31 kW	33,31 kW	33,31 kW	188,69 kW
Current (400 V)	—	53,95 A	53,95 A	53,95 A	53,95 A	53,95 A	—
Max. current	42,00 A	62,60 A	62,60 A	62,60 A	62,60 A	62,60 A	355,00 A
Gas cooler capacity	54,97 kW	82,95 kW	82,95 kW	82,95 kW	82,95 kW	82,95 kW	469,71 kW
COP/EER compressor	1,49	1,49	1,49	1,49	1,49	1,49	1,49
Mass flow compressor	872 kg/h	1.318 kg/h	1.318 kg/h	1.318 kg/h	1.318 kg/h	1.318 kg/h	7.460 kg/h
Discharge gas temp.	124 °C	123 °C	123 °C	123 °C	123 °C	123 °C	124 °C
Ratio to system capacity	12 %	18 %	18 %	18 %	18 %	18 %	100 %
Ratio to design capacity	12 %	18 %	18 %	18 %	18 %	18 %	**101** %

power pack

LT 32 kw MT 220 kw

6 compressers

ambiant T° 37

gas cooler out 39°

gas cooler cap. 469 kw

1 power pack LT 32 kw + MT 110 kw gascooler 265 kw

+

1 power pack MT 110 kw gas cooler 202 kw

CO_2 Calculation Tool Version 1.5

All pressures are absolute values
12/10/2015 / All data subject to change

Project name	transcritic 39° 32 kw LT 110 kw MT				
System	Booster (LT and MT)	Net supply	50 Hz	/	400 V

Low temperature

Refrigerant	R744		
Evaporator capacity	32	kW	
Number of compressors	3		
Evaporating temperature	-32,0	°C	13,3 bar
Evaporator superheat	6,0	K	
Suction line superheat	8,0	K	
Int. heat exch. superh.	10,0	K	
Tot. superh./suct. g. temp.	24,0	K / -8,0 °C	
	Two stage expansion		
Condensing temperature	-9,0	°C	27,2 bar
Int. heat exch. subc.	3,8	K	
External subcooling	0,0	K	
Tot. subc. / liquid temp.	3,8	K / 1,5 °C	
Desuperheater temp.	35,0	°C	

Medium temperature

Refrigerant	R744		
Evaporator capacity	110	kW	
Number of compressors	3		
Evaporating temperature	-9,0	°C	27,25 bar
Evaporator superheat	6,0	K	
Suction line superheat	4,0	K	Flash Gas HX
Int. heat exch. superh.			No int. heat exch.
Tot. superh./suct. g. temp.	10,0	K / 1,0 °C	
	Transcritical		Flash gas bypass
High pres. (max. COP fast)	96,2	bar	(•) FG - Bypass
Gas cooler outlet temp.	39	°C	( ) FG - Parallel
Interstage pressure (ip)	40,00	bar / 5,3 °C	
Int. heat exch. subc. (ip)	0,0	K	
External subcooling (ip)	0,0	K	
Tot. subc. / liquid temp. (ip)	0,0	K / 5,3 °C	

Low temperature

Compressors	2FSL-4K	2FSL-4K	2FSL-4K	Total
Motor code	40S (Δ)	40S (Y)	40S (Y)	
Variable speed drive	44 Hz	No	No	
Cooling cap. compressor	10,21 kW	11,60 kW	11,60 kW	33,40 kW
Evaporator capacity	9,86 kW	11,20 kW	11,20 kW	32,27 kW
Power input	2,19 kW	2,49 kW	2,49 kW	7,17 kW
Current (400 V)	5,31 A	5,60 A	5,60 A	16,50 A
Max. current	15,40 A	8,60 A	8,60 A	32,60 A
COP/EER compressor	4,66	4,66	4,66	4,66
Mass flow	148 kg/h	168 kg/h	168 kg/h	484 kg/h
Discharge gas temp.	60 °C	60 °C	60 °C	60 °C
Ratio to system capacity	31 %	35 %	35 %	100 %
Ratio to design capacity	31 %	35 %	35 %	**101 %**

Medium temperature

Compressors	4CTC-30K	4CTC-30K	4CTC-30K	Total
Motor code	40P (PW)	40P (PW)	40S (Y)	
Variable speed drive	60 Hz	No	No	
Motor version	Motor 2	Motor 2	Motor 2	
Cooling cap. compressor	59,56 kW	49,63 kW	49,63 kW	158,82 kW
Evaporator capacity	42,21 kW	35,18 kW	35,18 kW	112,57 kW
Power input	39,98 kW	33,31 kW	33,31 kW	106,61 kW
Current (400 V)	---	53,95 A	53,95 A	---
Max. current	62,60 A	62,60 A	62,60 A	187,80 A
Gas cooler capacity	99,54 kW	82,95 kW	82,95 kW	265,43 kW
COP/EER compressor	1,49	1,49	1,49	1,49
Mass flow compressor	1.581 kg/h	1.318 kg/h	1.318 kg/h	4.216 kg/h
Discharge gas temp.	123 °C	123 °C	123 °C	123 °C
Ratio to system capacity	38 %	31 %	31 %	100 %
Ratio to design capacity	38 %	32 %	32 %	**102 %**

CO_2 Calculation Tool Version 1.5

All pressures are absolute values
12/10/2015 / All data subject to change

Project name	transcritic 37 ° 110 kw MT				
System	Medium temp. / Heat pump	Net supply	50 Hz	/	400 V

Medium temperature

Refrigerant	R744		
Evaporator capacity	110	kW	
Number of compressors	3		
Evaporating temperature	-9,0	°C	27,25 bar
Evaporator superheat	6,0	K	
Suction line superheat	4,0	K	Flash Gas HX
Int. heat exch. superh.			No int. heat exch.
Tot. superh./suct. g. temp.	10,0	K / 1,0 °C	
	Transcritical		Flash gas bypass
High pres. (max. COP fast)	96,2	bar	(•) FG - Bypass
Gas cooler outlet temp.	39	°C	( ) FG - Parallel
Interstage pressure (ip)	40,00	bar / 5,3 °C	
Int. heat exch. subc. (ip)	0,0	K	
External subcooling (ip)	0,0	K	
Tot. subc. / liquid temp. (ip)	0,0	K / 5,3 °C	

Medium temperature

Compressors	4HTC-20K	4CTC-30K	4CTC-30K	Total
Motor code	40P (PW)	40P (PW)	40S (Y)	
Variable speed drive	50 Hz	No	No	
Motor version	Motor 1	Motor 2	Motor 2	
Cooling cap. compressor	21,90 kW	49,63 kW	49,63 kW	121,16 kW
Evaporator capacity	19,79 kW	44,85 kW	44,85 kW	109,50 kW
Power input	14,62 kW	33,31 kW	33,31 kW	81,25 kW
Current (400 V)	---	53,95 A	53,95 A	---
Max. current	39,20 A	62,60 A	62,60 A	164,40 A
Gas cooler capacity	36,52 kW	82,95 kW	82,95 kW	202,41 kW
COP/EER compressor	1,50	1,49	1,49	1,49
Mass flow compressor	581 kg/h	1.318 kg/h	1.318 kg/h	3.216 kg/h
Discharge gas temp.	123 °C	123 °C	123 °C	123 °C
Ratio to system capacity	18 %	41 %	41 %	100 %
Ratio to design capacity	18 %	41 %	41 %	**100 %**

Producers of adiabatic systems

- We have no commercial intrest but we tryd to find producer of adiabatic gas coolers.
- We fund 2 in Europa

- Baltimore coil who are tested now this system in US and can not deliver directly

- MITA an Italian suplier whil can produce now , and they can also deliver batteries who work dry till 34° ambiant if there is leek of water

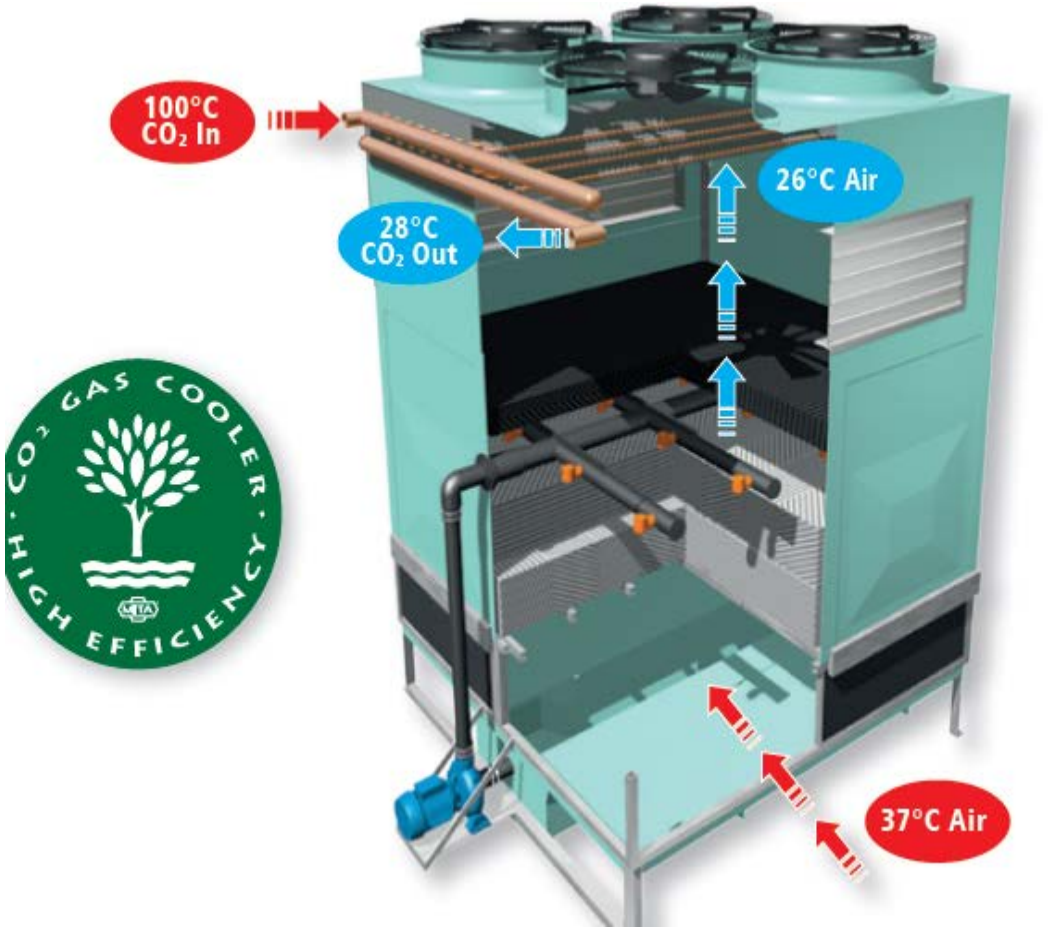
Proposition adiabatic cooling

principe

if ambiant air temperature higher than 26°
adiabatic start and keep entrance air on

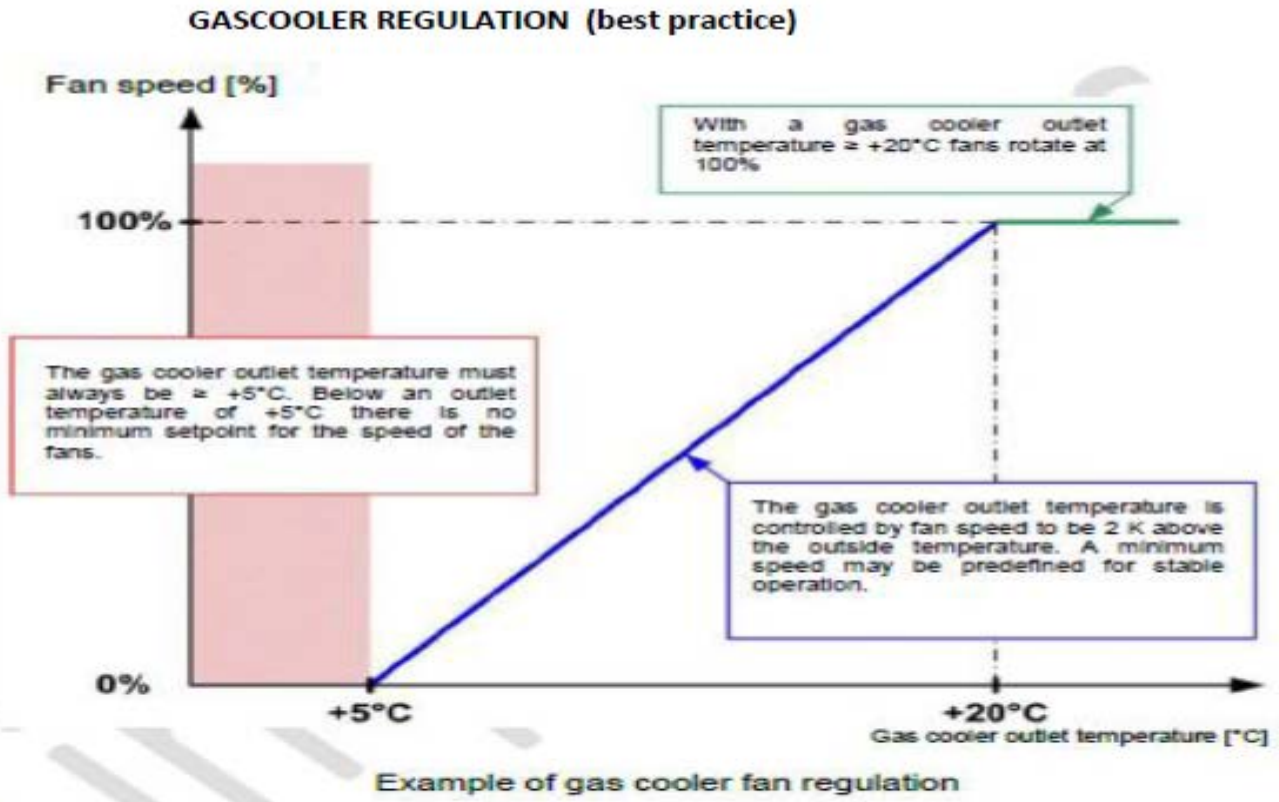
Wet bulb Tw 26°

Example Mita >>>>>>



Regulation gascooler(best practice)

- Regulation fans by powerpack
- Adiabatic pump start at ambient T° 26° C



Water spray system:
The atomizer is controlled in accordance with the ambient temperature and the gas cooler output temperature (adjustable value). The fans and water spray system are controlled in accordance with the capacity demand.

Advantage adiabatic if high temperature

- Battery selection can stay on 34°/36° C

- Higher capacity
- Lower power input
- Lower gas temperature
- Lower gas pressure
- Better COP

POWERPACK LT32 kw MT220 kw		WITH TRADITIONAL GASCOOLER											WITH ADIABATIC GASCOOLER					
ambiant T°	gascooler T° out	capacity full load KW	rating full load %	capacity Power Pack KW	reel load capacity Power Pack KW	NR of compr. Running	absorbd KW	reel absorbd KW	gas in temp. °C	gas pressure BAR	reel COP	evacuate KW gascooler	reel capacity Power Pack KW	reel absorbd KW	H2O L/hr	reel COP	gas in temp. °C	gas P BAR
5° C	7° C	260	1,77	436	246	3	125	71	97	73.8	3,49	317	246	71	O	3.49	97	73.8
6° C	8°C	260	1,75	431	246	3	125	71	97	73.8	3,45	318	246	71	O	3.45	97	73.8
7° C	9° C	260	1,73	427	247	3	125	72	97	73.8	3,42	319	247	72	O	3.42	97	73.8
8° C	10°C	260	1,71	423	247	3	125	73	97	73.8	3,38	320	247	73	O	3.38	97	73.8
9° C	11°C	260	1,68	418	249	3	125	74	97	73.8	3,34	323	249	74	O	3.34	97	73.8
10° C	12°C	260	1,66	413	249	3	125	75	97	73.8	3,30	324	249	75	O	3.30	97	73.8
11° C	13°C	260	1,64	409	249	3	125	76	97	73.8	3,27	326	249	76	O	3.27	97	73.8
12° C	14°C	260	1,61	404	251	3	125	78	97	73.8	3,23	329	251	78	O	3.23	97	73.8
13° C	15°C	260	1,59	398	250	3	125	79	97	73.8	3,18	329	250	79	O	3.18	97	73.8
14° C	16°C	260	1,56	393	252	3	125	80	97	73.8	3,14	332	252	80	O	3.14	97	73.8
15° C	17°C	260	1,54	388	252	4	125	81	97	73.8	3,10	333	252	81	O	3.10	97	73.8
16° C	18°C	260	1,51	383	254	4	125	83	97	73.8	3,06	336	254	83	O	3.06	97	73.8
17° C	19°C	260	1,48	377	255	4	125	84	97	73.8	3,02	339	255	84	O	3.02	97	73.8
18° C	20°C	260	1,46	371	254	4	125	86	97	73.8	2,97	340	254	86	O	2.94	97	73.8
19° C	21° C	260	1,43	365	255	4	125	87	97	73.8	2,92	343	255	87	O	2.92	97	73.8
20° C	22° C	260	1,43	360	252	4	125	87	97	73.8	2,88	339	252	87	O	2.88	97	73.8
21° C	23° C	260	1,40	354	253	4	125	89	97	73.8	2,83	342	253	89	O	2.83	97	73.8
22° C	24° C	260	1,37	347	253	4	125	91	97	73.8	2,78	345	253	91	O	2.78	97	73.8
23° C	25° C	260	1,34	340	254	4	125	93	97	73.8	2,72	347	254	93	O	2.72	97	73.8
24° C	26° C	260	1,31	332	253	4	125	95	97	73.8	2,66	349	253	95	O	2.66	97	73.8
25° C	27° C	260	1,24	323	260	4	125	101	97	73.8	2,58	361	260	95	O	2.58	97	73.8
26° C	28° C	260	1,23	319	259	5	125	102	97	73.8	2,55	361	260	95	16	2.55	97	73.8
27° C	29° C	260	1,17	303	260	5	125	107	97	73.8	2.50	367	260	95	39	2.50	97	73.8
28° C	30° C	260	1,11	289	260	5	126	113	97	74.2	2,29	373	260	95	63	2.50	97	73.8
29° C	31° C	260	1,08	282	260	5	129	119	101	76.6	2,19	379	260	95	95	2.50	97	73.8
30° C	32° C	260	1,06	275	260	5	133	126	104	79.1	2,07	386	260	95	118	2.50	97	73.8
31° C	33° C	260	1,03	268	260	5	137	133	108	81.5	1,96	393	260	95	134	2.50	97	73.8
32° C	34° C	260	1,00	262	262	5	140	140	111	84.0	1,87	402	260	95	150	2.50	97	73.8
33° C	35° C	260	1,00	263	263	5 (*)	147	147	114	86.4	1,79	410	260	95	174	2.50	97	73.8
34° C	36° C	260	1,00	261	261	5 (*)	153	153	118	88.8	1,71	414	260	95	185	2.50	97	73.8
35° C	37° C	260	0,98	257	262	5 (*)	158	161	121	91.3	1,63	423	260	95	209	2.50	97	73.8
36° C	38° C	260	0,95	251	264	5 (*)	161	169	124	93.7	1,56	434	260	95	248	2.50	97	73.8
37° C	39° C	260	0,93	245	263	5 (*)	164	176	127	96.2	1,49	440	260	95	295	2.50	97	73.8

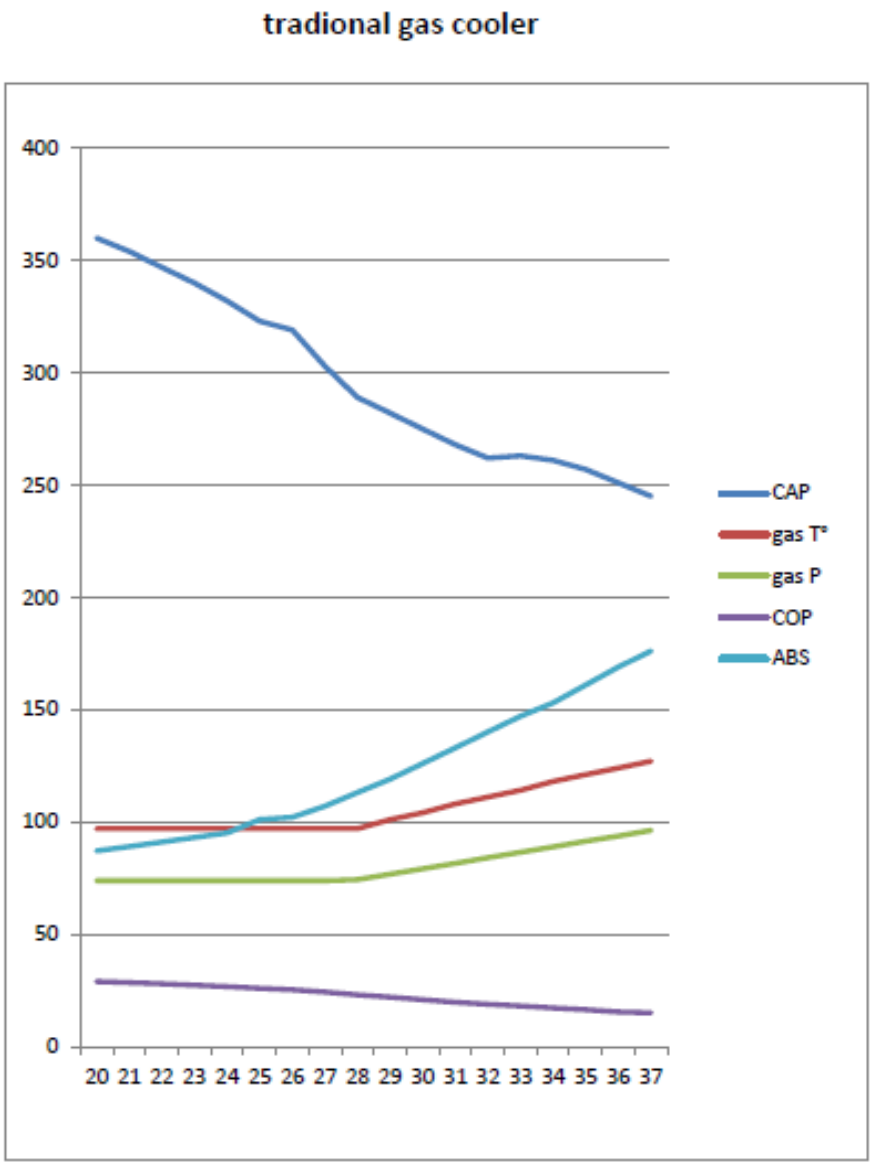
(*) = 60/70 HZ

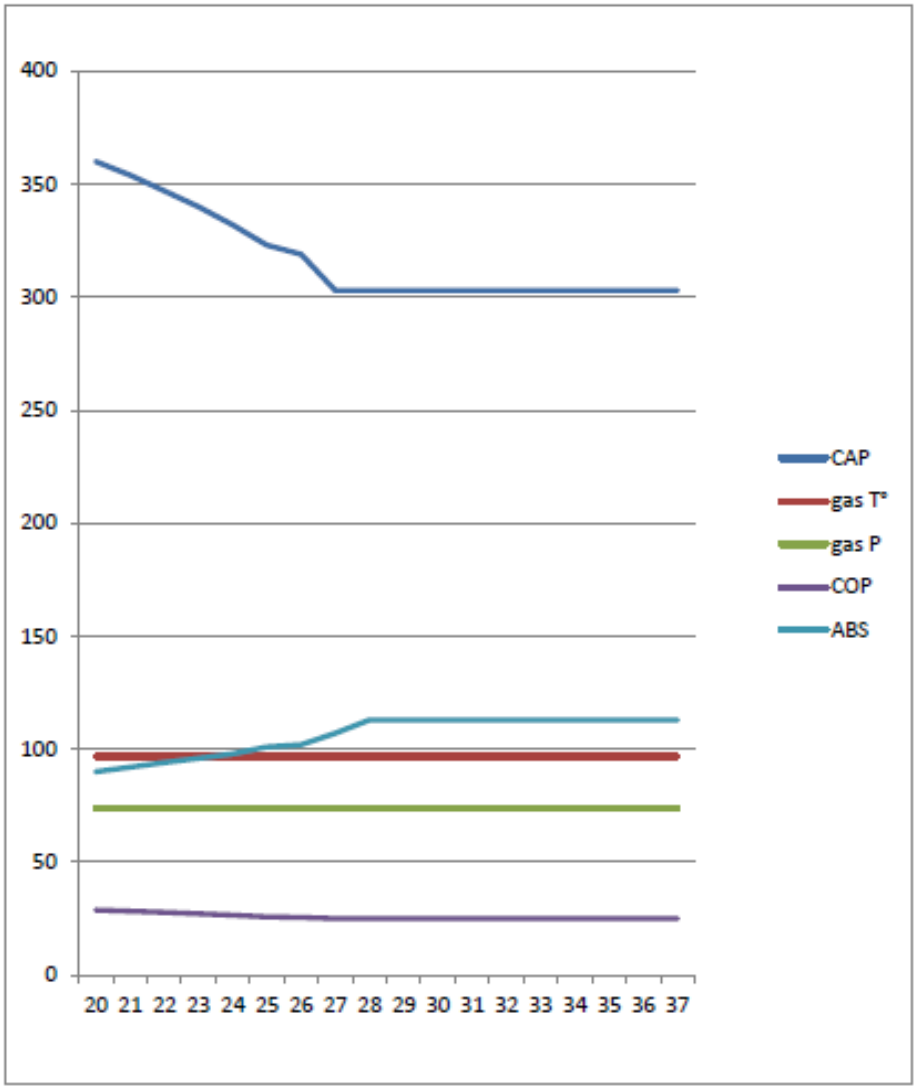
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

1. Ambiant T°
2. T° gascooler out (in transcritical mode)
3. Calculated capacity load
4. Rating powerpack at T° x
5. Capacity powerpack at T° x
6. Reel used capacity at T° x
7. Nmbr compressors running
8. Absorbed power input at T° x
9. Reel absorbed power at T° x
10. Gas in temperature
11. Gas pressure
12. Reel COP
13. To evacuate by gascooler
14. Reel used capacity in adiabatic mode
15. Reel absorbd in adiabatic mode
16. Water consumption in adiabatic mode
17. Reel COP in adiabatic mode
18. Gas temperature in adiabatic mode
19. Gas pressure in adiabatic mode

Powerpack
LT 32 kw
MT 220 kw

visualitation different system





Conclusion

- We think with the higher temperature registered last months it is necessary to take action.
- Adiabatic gas cooling can be a good solution

Lower electric consumption

More capacity

Better COP

Lower gas pressure and longer lifetime installation

Lower installation cost

Comparisation (A) water spray ore coolingtower systems versus (B) adiabatic systems

A		B
• High volume of lost water.	-	No lost water
• Water traitment necesairy.	-	No water traitment
• Airosols (legionela)	-	No airosols
• Intensive maintenance	-	Normal maintenance

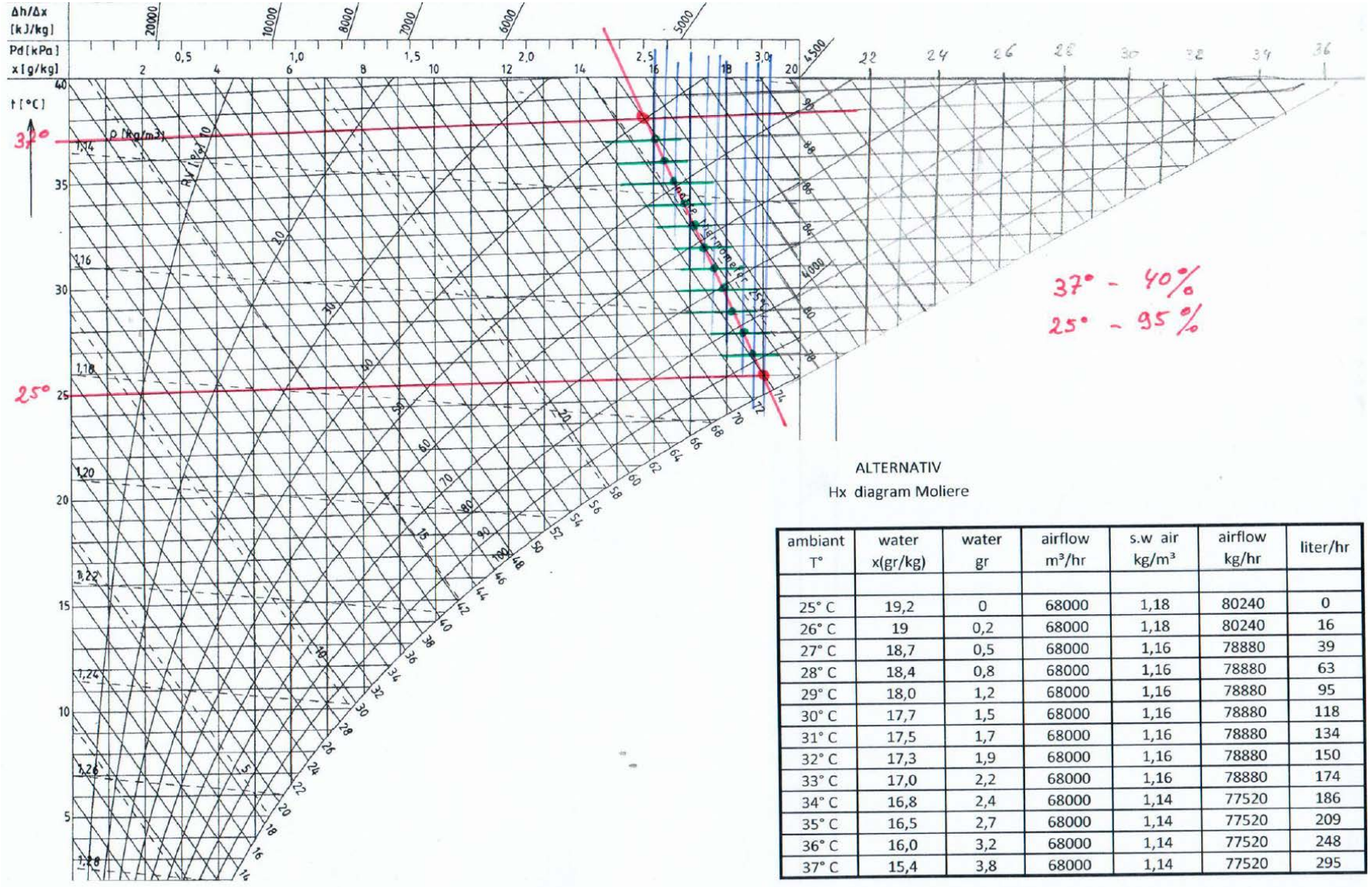
Disadvantage is water consumption but only 59 m³ for July August 2015

Example power pack LT 32 kw MT 220 kw

ambiant T°	water x(gr/kg)	water gr	airflow m³/hr	s.w air kg/m³	airflow kg/hr	liter/hr	hr < 26°
27° C	18,7	0,5	68000	1,16	78880	39	143
28° C	18,4	0,8	68000	1,18	80240	64	102
29° C	18,0	1,2	68000	1,16	78880	95	82
30° C	17,7	1,0	68000	1,16	78880	79	74
31° C	17,5	1,7	68000	1,16	78880	134	45
32° C	17,3	1,9	68000	1,16	78880	150	38
33° C	17,0	2,2	68000	1,16	78880	174	34
34° C	16,8	2,4	68000	1,14	77520	186	28
35° C	13,5	2,7	68000	1,14	77520	209	20
36° C	16,0	3,2	68000	1,14	77520	248	16
37° C	15,4	3,8	68000	1,14	77520	295	7

		59	€ 0,78	€ 46,02
july aug	hrs >26°	m³/water	cost/m³	total

Alternative water content calculation



ALTERNATIV

Hx diagram Moliere

ambiant T°	water x(gr/kg)	water gr	airflow m³/hr	s.w air kg/m³	airflow kg/hr	liter/hr
25° C	19,2	0	68000	1,18	80240	0
26° C	19	0,2	68000	1,18	80240	16
27° C	18,7	0,5	68000	1,16	78880	39
28° C	18,4	0,8	68000	1,16	78880	63
29° C	18,0	1,2	68000	1,16	78880	95
30° C	17,7	1,5	68000	1,16	78880	118
31° C	17,5	1,7	68000	1,16	78880	134
32° C	17,3	1,9	68000	1,16	78880	150
33° C	17,0	2,2	68000	1,16	78880	174
34° C	16,8	2,4	68000	1,14	77520	186
35° C	16,5	2,7	68000	1,14	77520	209
36° C	16,0	3,2	68000	1,14	77520	248
37° C	15,4	3,8	68000	1,14	77520	295

Existing installations on 34°/36°

- We propose to install spray systems with temperature and humidity regulation.
- To avoid that spray turn day and night in summer saison , like now on some older systems.

- The problem here is that condenser producers give a limit on spraying (max 200 hr/ year) to not damage batterys.
- And also only with traited water.

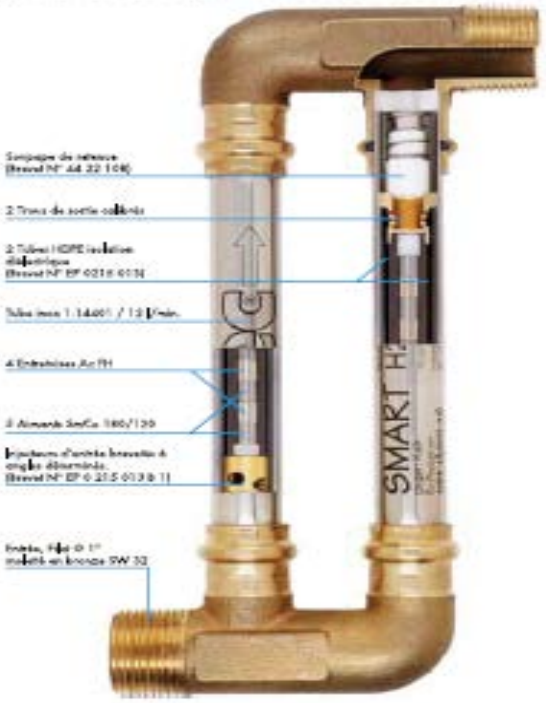
- Without making publicity we think that there is a cheap reel working solution, this system dont take out the lime , but change the structure of the lime.

- After passing the contra magnetic field lime dont make any more contact with metal parts and disappear in atmosphere.

- We use this many years with succes

Lime protection

Un appareil de haute technologie Suisse contre le tartre et la rouille placé sur le circuit d'eau après le compteur, pour maisons, immeubles et industrie.



Nous pratiquons l'écologie de A à Z

Absence de produits chimiques
Maintient une eau potable
Sans énergie - Sans entretien

Thanks for your attention

A.I.S.

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