



Case Study Mechanical Sub-Cooling

No climatic limit to Transcritical applications



#1

Mechanical Sub-Cooling
(CO₂) *No climatic limit to Transcritical applications*

THE FIVE W'S

WHO:

WHAT:

WHERE:

WHY:

WHEN:

#2

Mechanical Sub-Cooling (CO₂)

No climatic limit to Transcritical applications

Système LMP` s patented mechanical sub-cooling for transcritical mode.

- Benefits of mechanical sub-cooling
 - ✓ 17% reduction in energy consumption.
 - ✓ 35% improvement of the EER (Energy Efficiency Rating) of compressors operating in transcritical mode.
 - ✓ Decrease in the number of refrigeration compressors dedicated to keeping systems in positive temperature mode.
 - ✓ Increase in the quality of liquid
- **Ability to install transcritical compressors system in warmer climates.**

No climatic limit to Transcritical applications

Phases in the traditional refrigeration cycle

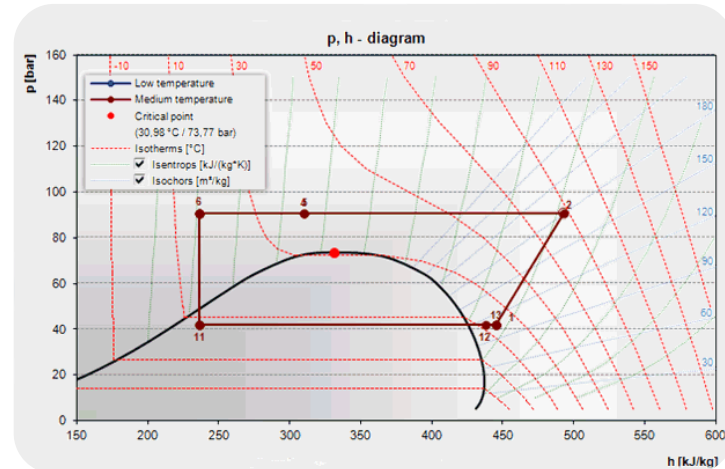
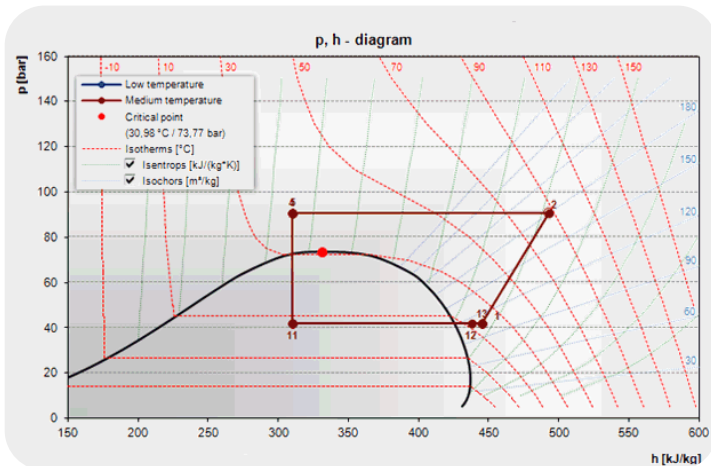
- Compression (Compressors):
- Cooling (Gas-Cooler):
- Liquefaction (Return):
- Evaporation (Refrigerated Display Case):

- Points 13 and 2
- Points 2 and 4
- Points 4 and 11
- Points 11 and 12

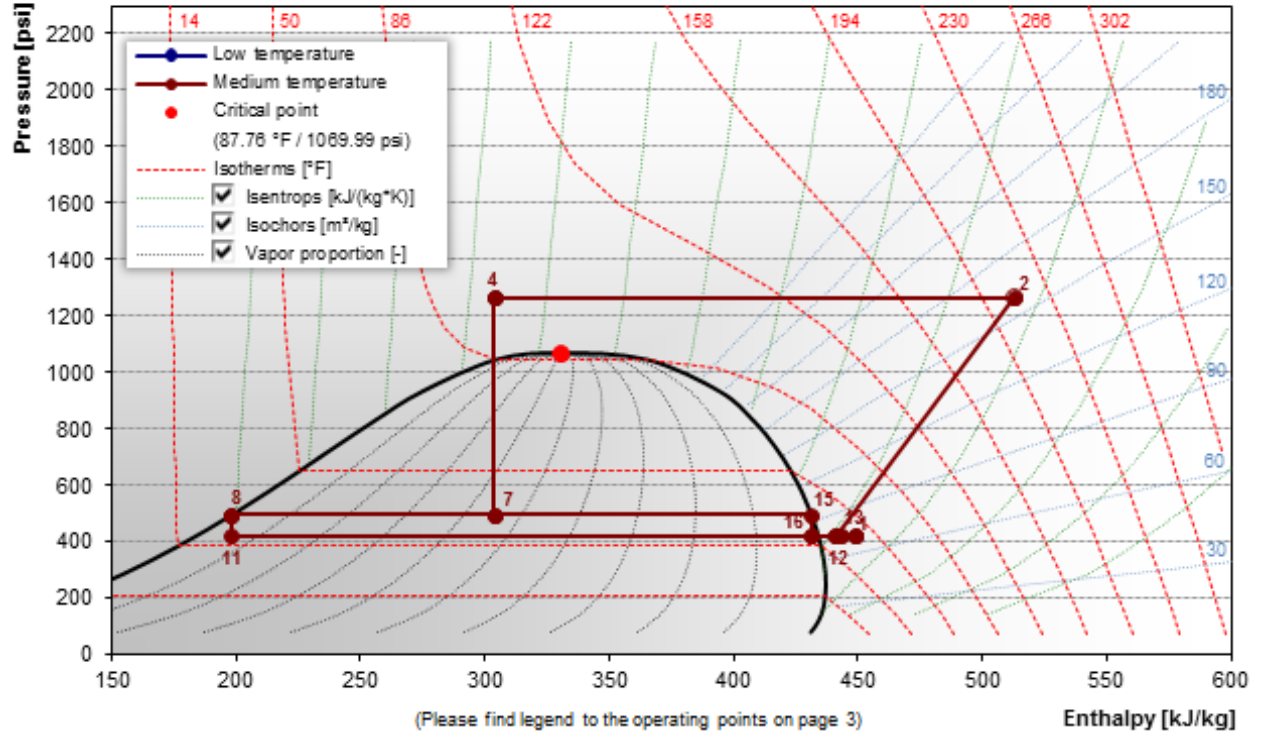
Effects of mechanical sub-cooling:

- Amplified sub-cooling:
- Result: Greater cooling capacity

- Points 4 and 6
- Points 11 and 12



p, h - diagram

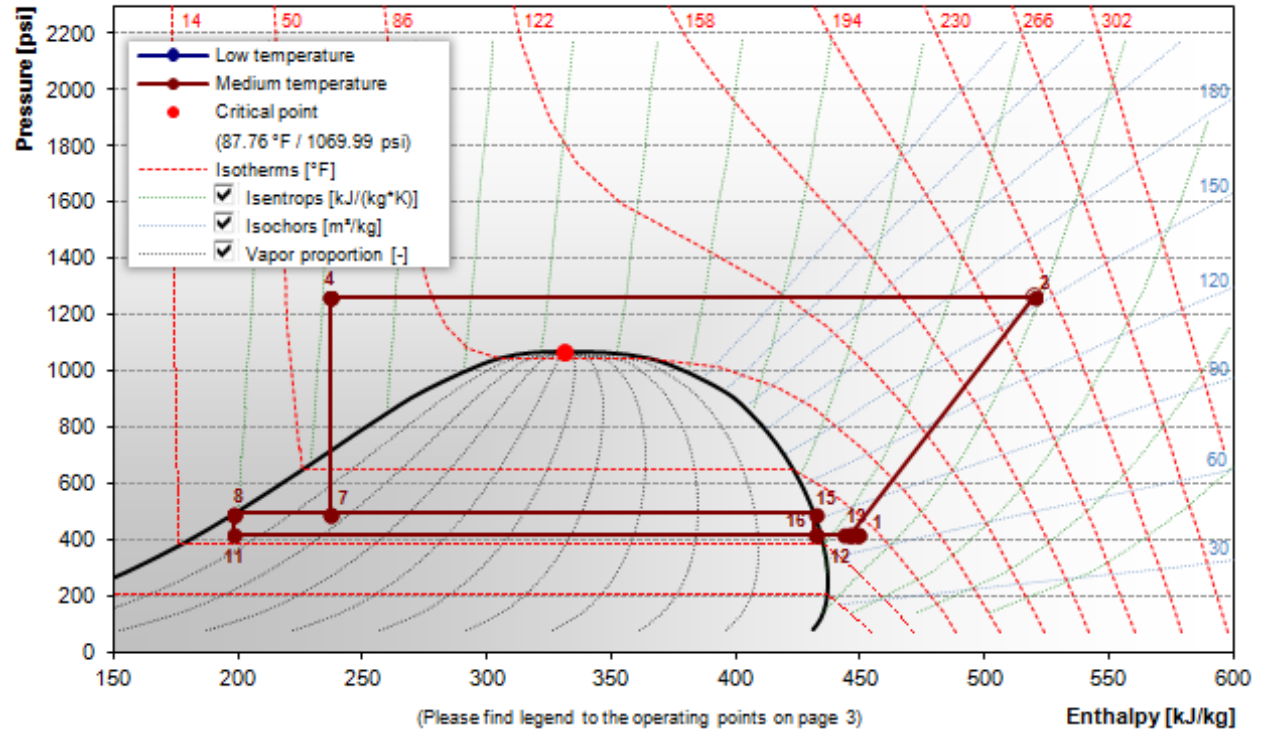


Medium temperature			
Refrigerant	R744		
Evaporator capacity	1520	kBTU/h	
Number of compressors	5		
Evaporating temperature	20.0	°F	422 psi
Evaporator superheat	10.8	°F	
Suction line superheat	7.2	°F	
Int. heat exch. superh.	No int. heat exch.		
Tot. superh./suct. g. temp.	8.0	°F /	28.0 °F
	Transcritical	Flash gas bypass	
High pressure (max. COP)	1263.9	psi	
Gas cooler outlet temp.	95	°F	
Interstage pressure (ip)	495.0	psi /	30.6 °F
Int. heat exch. subc. (ip)	0.0	°F	
External subcooling (ip)	0.0	°F	
Tot. subc. / liquid temp. (ip)	0.0	°F /	30.6 °F

Medium temperature						
Compressors	4FTC-20K	4FTC-20K	4FTC-20K	4FTC-20K	4FTC-20K	Total
Variable speed drive	No	No	No	No	No	
Motor version	Motor 2	Motor 2	Motor 2	Motor 2	Motor 2	
Cooling cap. compressor	164 kBTU/h	164 kBTU/h	164 kBTU/h	164 kBTU/h	164 kBTU/h	818 kBTU/h
Evaporator capacity	160 kBTU/h	160 kBTU/h	160 kBTU/h	160 kBTU/h	160 kBTU/h	799 kBTU/h
Power input	25.03 kW	25.03 kW	25.03 kW	25.03 kW	25.03 kW	125.17 kW
Current (460 V)	33.74 A	33.74 A	33.74 A	33.74 A	33.74 A	168.72 A
Max. current*	42.00 A	42.00 A	42.00 A	42.00 A	42.00 A	210.00 A
Gas cooler capacity	249 kBTU/h	249 kBTU/h	249 kBTU/h	249 kBTU/h	249 kBTU/h	1,245 kBTU/h
COPEER compressor	6.53	6.53	6.53	6.53	6.53	6.53
Mass flow compressor	2,774 lb/h	2,774 lb/h	2,774 lb/h	2,774 lb/h	2,774 lb/h	13,872 lb/h
Mass flow evaporator	1,518 lb/h	1,518 lb/h	1,518 lb/h	1,518 lb/h	1,518 lb/h	7,589 lb/h
Discharge gas temp.	210 °F	210 °F	210 °F	210 °F	210 °F	210 °F
Ratio to system capacity	20 %	20 %	20 %	20 %	20 %	100 %
Ratio to design capacity	11 %	11 %	11 %	11 %	11 %	53 %

EER = 6.53

+20 COMPRESSORS – NO SUBCOOLING



Medium temperature			
Refrigerant	R744		
Evaporator capacity	1122	kBTU/h	
Number of compressors	5		
Evaporating temperature	20.0	°F	422 psi
Evaporator superheat	10.8	°F	
Suction line superheat	7.2	°F	
Int. heat exch. superh.			No int. heat exch.
Tot. superh./suct. g. temp.	14.2	°F / 34.2 °F	
		Transcritical	Flash gas bypass
High pressure (manual)	1263.9	psi	
Gas cooler outlet temp.	62.5	°F	
Interstage pressure (ip)	495.0	psi / 30.6 °F	
Int. heat exch. subc. (ip)	0.0	°F	
External subcooling (ip)	0.0	°F	
Tot. subc. / liquid temp. (ip)	0.0	°F / 30.6 °F	

Medium temperature						
Compressors	4FTC-20K	4FTC-20K	4FTC-20K	4FTC-20K	4FTC-20K	Total
Variable speed drive	No	No	No	No	No	
Motor version	Motor 2	Motor 2	Motor 2	Motor 2	Motor 2	
Cooling cap. compressor	241 kBTU/h	241 kBTU/h	241 kBTU/h	241 kBTU/h	241 kBTU/h	1,207 kBTU/h
Evaporator capacity	236 kBTU/h	236 kBTU/h	236 kBTU/h	236 kBTU/h	236 kBTU/h	1,180 kBTU/h
Power input	25.03 kW	25.03 kW	25.03 kW	25.03 kW	25.03 kW	125.17 kW
Current (460 V)	33.74 A	33.74 A	33.74 A	33.74 A	33.74 A	168.72 A
Max. current*	42.00 A	42.00 A	42.00 A	42.00 A	42.00 A	210.00 A
Gas cooler capacity	327 kBTU/h	327 kBTU/h	327 kBTU/h	327 kBTU/h	327 kBTU/h	1,634 kBTU/h
COPEER compressor	9.64	9.64	9.64	9.64	9.64	9.64
Mass flow compressor	2,687 lb/h	2,687 lb/h	2,687 lb/h	2,687 lb/h	2,687 lb/h	13,434 lb/h
Mass flow evaporator	2,240 lb/h	2,240 lb/h	2,240 lb/h	2,240 lb/h	2,240 lb/h	11,202 lb/h
Discharge gas temp.	219 °F	219 °F	219 °F	219 °F	219 °F	219 °F
Ratio to system capacity	20 %	20 %	20 %	20 %	20 %	100 %
Ratio to design capacity	21 %	21 %	21 %	21 %	21 %	105 %

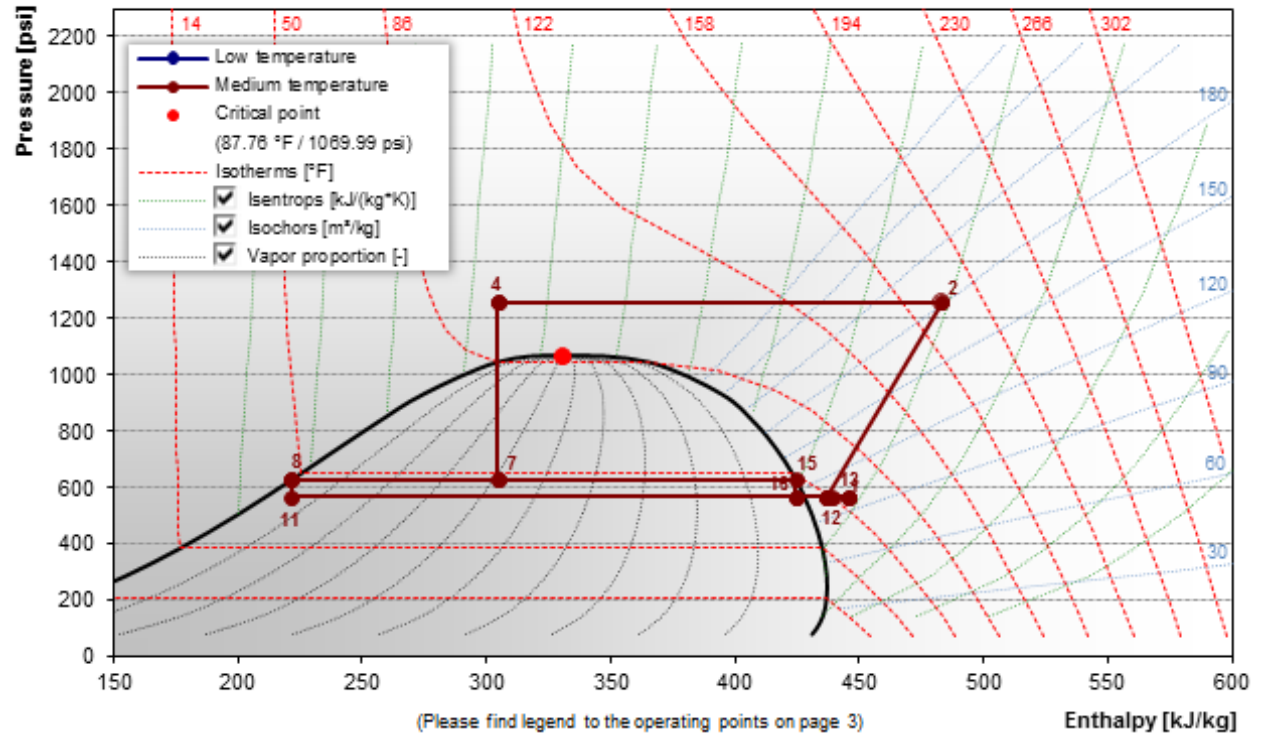
EER = 9.64

+20 COMPRESSORS – WITH SUBCOOLING

#6 Sub-Cooling Compressor (CO₂)

No climatic limit to Transcritical applications

p, h - diagram



Medium temperature			
Refrigerant	R744		
Evaporator capacity	450	kBTU/h	
Number of compressors	2		
Evaporating temperature	40.0	°F	568 psi
Evaporator superheat	10.8	°F	
Suction line superheat	7.2	°F	
Int. heat exch. superh.	No int. heat exch.		
Tot. superh./suct. g. temp.	8.6	°F /	48.6 °F
	Transcritical	Flash gas bypass	
High pressure (max. COP)	1257.4	psi	
Gas cooler outlet temp.	95	°F	
Interstage pressure (ip)	628.0	psi /	47.2 °F
Int. heat exch. subc. (ip)	0.0	°F	
External subcooling (ip)	0.0	°F	
Tot. subc. / liquid temp. (ip)	0.0	°F / 47.2 °F	

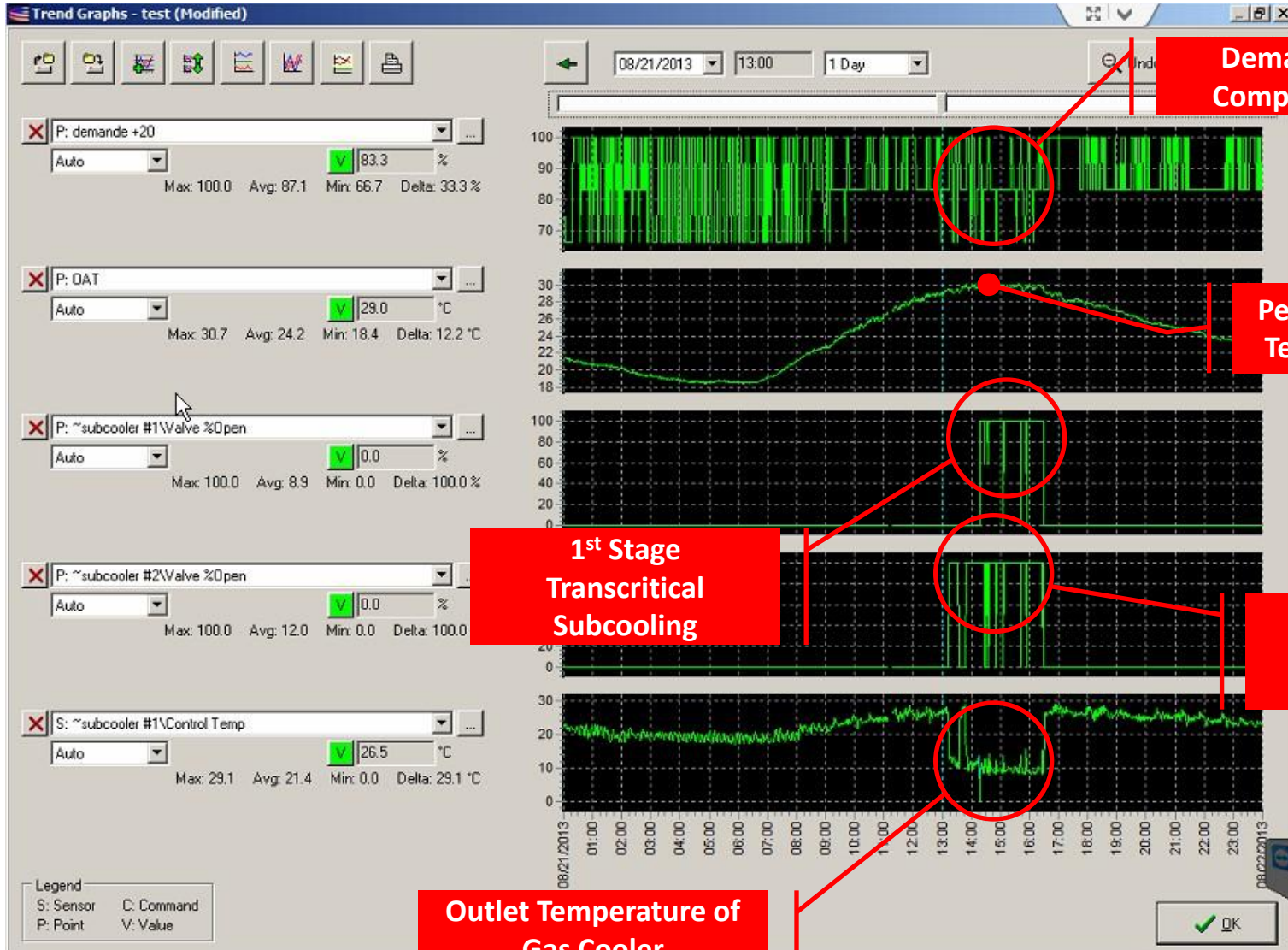
Medium temperature			
Compressors	4FTC-30K	4FTC-30K	Total
	No	No	
Variable speed drive	No	No	
Motor version	Motor 1	Motor 1	
Cooling cap. compressor	245 kBTU/h	245 kBTU/h	490 kBTU/h
Evaporator capacity	238 kBTU/h	238 kBTU/h	476 kBTU/h
Power input	24.91 kW	24.91 kW	49.81 kW
Current (460 V)	35.44 A	35.44 A	70.87 A
Max. current*	58.70 A	58.70 A	117.40 A
Gas cooler capacity	330 kBTU/h	330 kBTU/h	660 kBTU/h
COP/EER compressor	9.84	9.84	9.84
Mass flow compressor	4,301 lb/h	4,301 lb/h	8,602 lb/h
Mass flow evaporator	2,539 lb/h	2,539 lb/h	5,078 lb/h
Discharge gas temp.	174 °F	174 °F	174 °F
Ratio to system capacity	50 %	50 %	100 %
Ratio to design capacity	53 %	53 %	106 %

EER = 9.84

+20 COMPRESSORS – WITH SUBCOOLING

#7 Sub-Cooling Compressor (CO₂)

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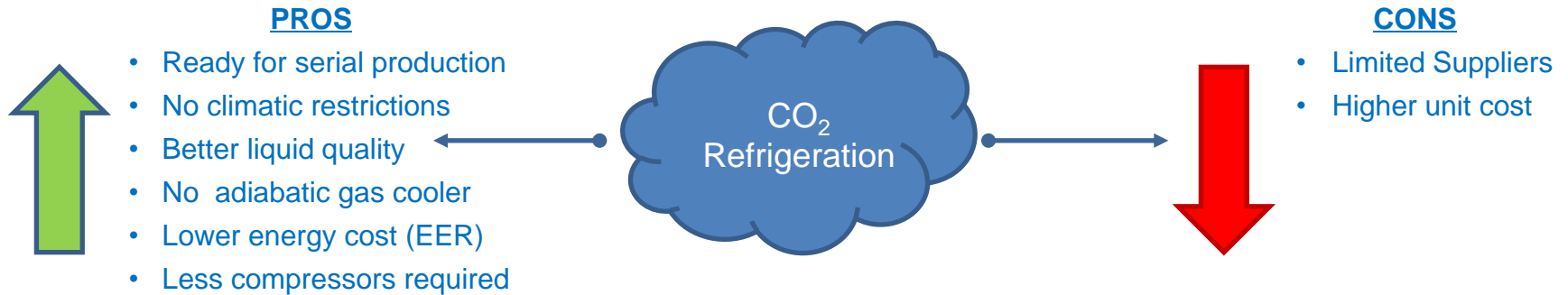
Various Industrial Applications



Blast Freezer / Blast Cooler / Spiral / Warehousing

Mechanical Sub-Cooling (CO₂)

No climatic limit to Transcritical applications



WHY CHOOSE LMP ?

Customer oriented, highly engineered systems.

The most Platinum GreenChill certifications on the market (may 2014)

Energy efficiency strategies.

Lowest maintenance costs.

Training facility and technical support available.

Short learning curve for new operators.

No climatic installation restrictions.



ATMO
sphere

business case

natural refrigerants

June 18-19, 2014 - San Francisco

Thank you very much!