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CHILLER EFFICIENCY PERFORMANCE WITH INTELLIGENT ADIABATIC CHILLER BOOSTER SYSTEM “SMART COOLING^{TM}” PRO 10

CHECK SPECIALISTS / PN

0	18/06/2019	ISSUE	D. Agnese	D. Mosso	E. Rubicondo	D. Agnese	D. Manta
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FUNCTION CHECK

0	18/06/2019	PRIMA EMISSIONE	F.Chiapparino	G. Gallu	V.Grassia	G. De Paoli
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1.0 FOREWORD, PRESENT SITUATION AND OBJECTIVES

In September 2018, the intelligent adiabatic pre-cooling system SMART COOLING™ was installed on a RC Group chiller Mod. Glider 920 V2 F10, used in the FPTi premise in Foggia for cooling the Engine Test Room.

Type of building: Fiat plant Foggia, Italy.

Chiller booster: “Smart Cooling^{TM}” PRO 10, adiabatic technology with condenser protection.

The main feature of the SMART COOLING™ system is the improvement of the cooling performances of air-condensed chillers through an adiabatic process with the management of the following parameters:

1. Control and elimination of calcium carbonate in water:
2. Water sanitation (against all bacteria, including legionella) through sterilization;
3. Management of the quantity of sprayed water to achieve the best efficiency;
4. Coil protection by means of membranes, that:

1. Prevent water from reaching the coil;
2. Filter air in order to avoid air pollutants to clog the coils;
3. Provide for a correct distribution of the air in order to avoid possible warmer areas or unevenness in the temperature of the air reaching the coil

5. Drainage, filtration and recirculation of unevaporated water, in order to minimize the water consumption.

As soon as weather conditions allowed, the system was started for the summer season. In such occasion, a test was carried on in order to verify the actual increase in EER of the above-mentioned chiller.

2.0 Main components:

The protective membranes: the membranes are installed outside before the condenser, covering 100% of the condenser surface, thus preventing the water mist from coming into direct contact with the condenser. Water filtration, water purification, water sterilisation: the system provides water purification from minerals and water sterilization to avoid the risk of bacterial occurrence.

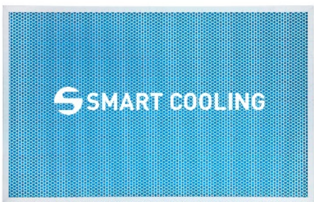
High pressure pump capable of providing water pressure up to 70 bar.

A water recirculation system that drains non-evaporated water into a water purification and pump system.

The control unit, which provides complete system control according to ambient air temperature and humidity, provides the complete operation of the system, analyses the parameters of the chiller, ambient air temperature and humidity, and provides the required amount of water in the adiabatic system according to data gathered.

A high-pressure nozzle panels that provide 5-40-micron droplet water spraying.

A set of fasteners and fixings ensuring the compatibility of the chiller booster system with the chiller.





3.0 Measuring instruments and test procedures:

The test was performed on June 12th, 2019, and was attended by:

- FENICE (customer)
- Mr. Colangelo - CMA (Installer)
- Mr. Gallarate - BLUE-ENERGY GLOBAL (manufacturer of the SMART COOLING™ system)

The test was carried on through a RIELS RIF 600 W ultrasonic flow meter. The RIF 600 W works by sending and receiving an ultrasound signal through a fluid between two transductors, placed on a pipe in a location determined by the instrument itself in accordance with the application.

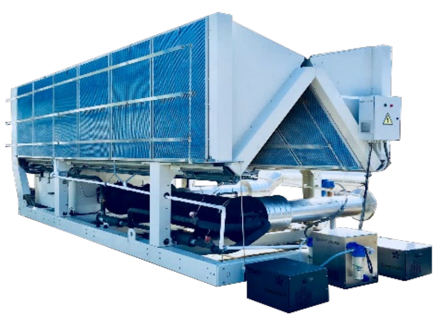
The time difference between sending and receiving the signal through the fluid is directly proportional to it velocity and thus to the volumetric flow. The equipment was connected to the pipes of the chiller in order to verify the efficiency with both the SMART COOLING™ system on and off.

Energy consumption data were retrieved from the equipment in the electrical substation.

The formula for calculating the COP. El/kW ÷ cooling/kW = cop

Equipment tested: **RC Group chiller Mod. Glider 920 V2 F10.**

Chiller without “Smart Cooling™” system



Chiller with “Smart Cooling™” system

In Picture No.2 it can be seen that the chiller condensers are fitted with protective membranes that prevent the water from entering the chiller condenser. To the right there is the chiller booster pump station, which includes 70 bar water preparation, water sterilization, purification. The equipment is equipped with a programmable Siemens controller. The right side of the chiller shows the water drain line connected to the pump station. The water that enters the drain is re-filtered and reused.

(Picture No.2 Chiller equipped with "Smart Cooling™"

4.0 Test of 'Smart Cooling™' equipment:

The RC GLIDER EVO 910 V2 F12 on which the 'Smart Cooling™' system was installed had some issues, that decreased the benefits of implementing the pre-cooling system:

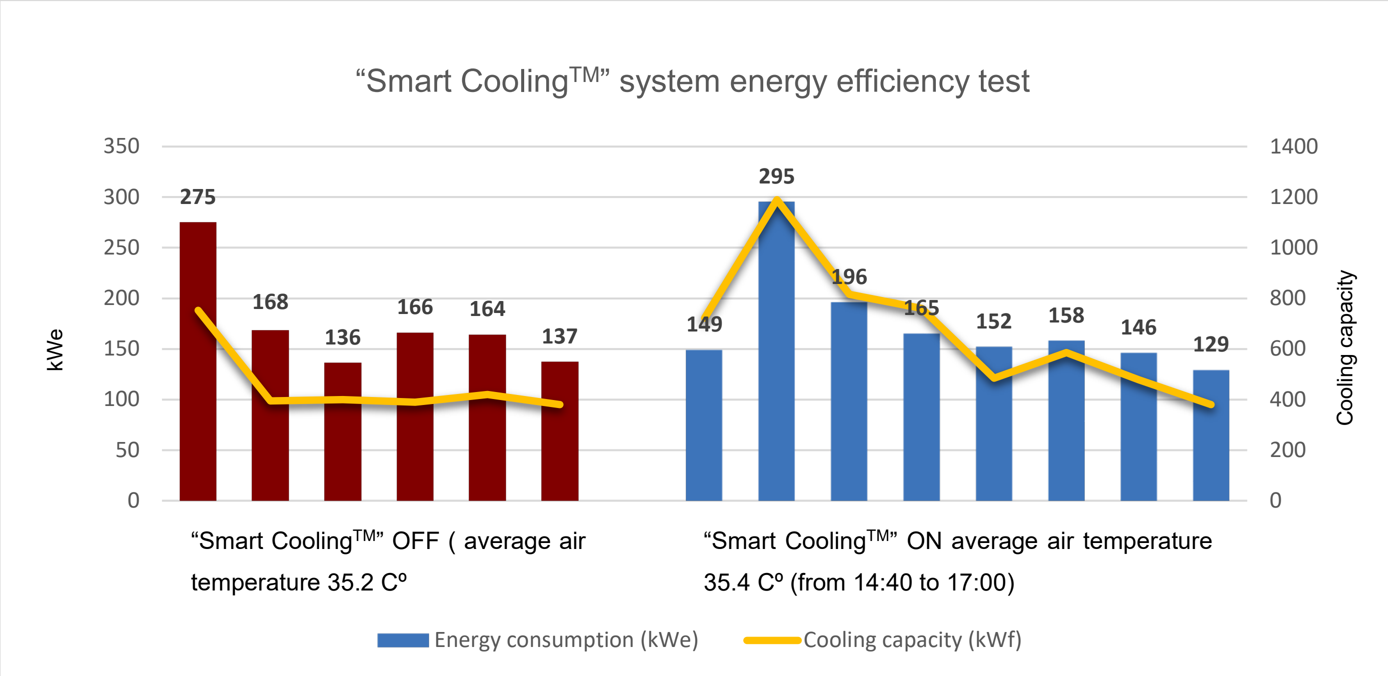
A. In the past years, the fan speed control of the chiller was modified from VARIABLE (according to condensation pressure) to ON-OFF, with two effects on the system:

a. It is not possible to optimize water consumption;

b. With low workloads (cooling capacity at 30% or less), the consumption of the fans (around 20 kW) and of the SMART COOLING™ system (around 2 kW) reduce the SAVING that can be achieved.

B. The chiller appeared to be OVERSIZED, compared to the actual requirements:

a. For the duration of the test, the chiller worked at 100% for one hour, then for another hour reduced its capacity from 100% to 50%, to then stabilize at 30% - 50%.



Summary:

Total savings after the installation of "Smart Cooling™" adiabatic pre-cooling system, cooling equipment can produce noticeably more cooling capacity (the average increase by 23%) and the electrical energy consumption 21% of equipment at average temperature 35°C.

"Smart Cooling™" expected 17% savings for 14h in 24h operational period, which was evaluated as 755 kw/h savings in 24h from 1 chiller based on 10 degrees temperature drop. As we can see in provided results, performance is much higher as "Smart Cooling™" equipment is working more that 14h and actual temperature drop is in average 14 degrees Celsius in condenser coils after protecting the membrane.

5.0 Electrical consumption comparison 12th June 'Smart Cooling™' OFF and 'Smart Cooling™' ON

	Date	Time	Outside air temperature (°C)	Air temperature at the coil (°C)	Energy consumption (kWe)	Cooling capacity (kWf)	EER (ex COP)
SYSTEM OFF	12.06.2019	11:00	37	37	275	753	2,738181818
	12.06.2019	12:00	36	36	168	395	2,351190476
	12.06.2019	12:14	35	35	136	400	2,941176471
	12.06.2019	12:30	34	34	166	390	2,34939759
	12.06.2019	12:45	34	34	164	420	2,56097561
	12.06.2019	13:00	35	35	137	380	2,773722628
SYSTEM ON	12.06.2019	14:40	34	22,7	149	722	4,845637584
	12.06.2019	14:50	35	21,9	295	1190	4,033898305
	12.06.2019	14:57	35	22,3	196	816	4,163265306
	12.06.2019	15:21	34	21,2	165	760	4,606060606
	12.06.2019	15:53	37	25	152	485	3,190789474
	12.06.2019	16:20	36	24,9	158	586	3,708860759
	12.06.2019	16:46	37	25,8	146	478	3,273972603
	12.06.2019	17:00	35	27	129	380	2,945736434

The following tables report performance data of the chiller with two compressors at 100% capacity and one compressor at 100% with both the adiabatic system off and on.

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A. SYSTEM OFF – BOTH COMPRESSORS 100%

Time	Outside air temperature (°C)	Air temperature at the coil (°C)	Energy consumption (kWe)	Cooling capacity (kWf)	EER (ex COP)
11:00	37	37	275	753	2,738181818

B. SYSTEM OFF – ONE COMPRESSOR OFF, THE OTHER AT 100%

Time	Outside air temperature (°C)	Air temperature at the coil (°C)	Energy consumption (kWe)	Cooling capacity (kWf)	EER (ex COP)
12:14	35	35	136	400	2,941176471

A. SYSTEM ON – BOTH COMPRESSORS 100%

Time	Outside air temperature (°C)	Air temperature at the coil (°C)	Energy consumption (kWe)	Cooling capacity (kWf)	EER (ex COP)
14:50	35	21,9	295	1190	4,033898305

A. SYSTEM ON – ONE COMPRESSOR OFF, THE OTHER AT 100%

Time	Outside air temperature (°C)	Air temperature at the coil (°C)	Energy consumption (kWe)	Cooling capacity (kWf)	EER (ex COP)
15:21	34	21,2	165	760	4,606060606

6.0 CONCLUSIONS

The increase in EER and energy saving have both been calculated keeping into account the issues previously reported. Following are the results:

Average COP increase **1,9**
Average decrease in working time **23%**
Average energy saving **21%**

Overall saving during test period **470 kW**
Water consumption during test period **0,61 m³**

Supposing

- 5 Working days per week
- 10 Working hours per day
- 20 weeks per year with the SMART COOLING™ system on
- Water average cost: 1,30 €/m³
- Energy average cost: 0,12 €/kW

The following results:

Saved kW: 141.000

Water consumption: 183 m³

MONEY SAVING: € 16.000,00

Installing the "Smart Cooling™" system on the chiller proved to be a valid solution. The system, furthermore, increases the "life" of the compressors:

- by keeping the condensation pressure uniform even when the air temperature changes,
- by keeping the coils of the chiller clean acting as an air filter.

Undoubtedly installing the SMART COOLING™ system on a chiller serving a productive or technological process (working at around 80% of its capacity) would have given much higher results in terms of SAVING (the AVERAGE saving in our climate is around 39%-40%), but even in this installation it is possible to foresee a ROI of 8 (eight) operational months.

Luca Gallarate
June 18st 2019