

IndustrieWert GmbH
DATA SHEET

Lot No. 5 – 9

Hybrid Dry Coolers JAEGGI AG HTK 2.4/4.8





HTK

Hybrid dry cooler

The reference for
hybrid dry cooling

100 – 4,000 kW

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with an extract from the
JAEGGI product catalogue



Operating characteristics hybrid dry cooler

Hybrid dry coolers dissipate thermal energy to the environment mainly as pure dry coolers. At higher thermal loads and external temperatures, the finned heat exchangers are wetted. The heat is then dissipated mainly via the evaporation of the wetting water.

Figure 1 exemplifies an annual temperature variation and the operating range of the hybrid dry cooler. In the changeover area, the hybrid dry cooler performs a load-dependent switchover to wet operation.

The greater the plant heat load, the earlier the heat needs to be dissipated by the evaporation of water. The switchover point from dry cooling to hybrid operation depends on the operating conditions and the unit design.

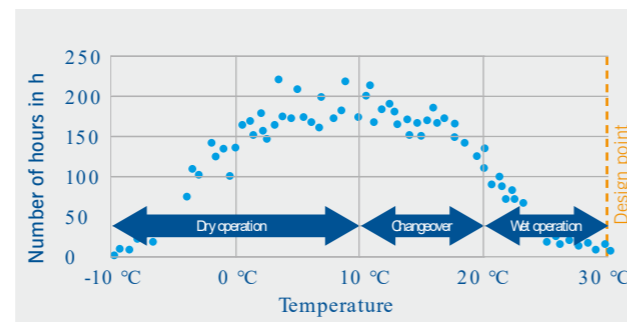


Figure 1: Average annual ambient temperature range (source: Zurich Metronom 1995 - 2005)

Hybrid dry cooler instead of cooling tower

Your advantages

- Low cooling water temperature
- Little space requirement
- No contamination of the primary circuit
- Up to 10 dB quieter than a cooling tower
- Hygienic operation with little maintenance work
- Perfect access for inspection and maintenance
- Plume-free throughout the year

Construction can be modified to suit your particular premises

- Modular series with a range of dimensions and heights
- Height: 2 – 5 m
- Length: 3 – 12 m
- Power range: 100 – 4,000 kW



	Closed cooling tower	Hybrid dry cooler
Total capacity	1,000 kW	1,000 kW
Cooling medium	30 % glycol/70 % water	30 % glycol/70 % water
Cooling medium temperatures	34/29 °C	34/29 °C
Design condition, wetted	34 °C/31.3 %	34 °C/31.3 %
Design condition, dry	-	18 °C
Concentration factor	3	3
Power consumption in kWh per year	47,877	47,877
Additional water costs in €/m ³	3	3
Wastewater costs in €/m ³	1	1
Electricity contract price in €/kWh	0.1	0.1
Investment costs	35,000 €	120,470 € 3.4 times the investment
Water costs in € per year	41,068 €	3,884 € 90 % saved
Operating costs in € per year*	53,434 €	25,736 € 52 % saved

*Operating costs include costs for water and electricity according to the unit design and usual maintenance and depreciation costs

TECHNICAL SUBMITTAL

I. Technical Submittal: Hybrid Coolers

II. Description of Technical Submittal:

This Technical Submittal details the 5no. Jaeggi Hybrid Coolers, Part No: HTK 2.4/4.8-2S-P4-CU-SLNF, to be installed on the 6th Floor, Roof Plant Area.

The hybrid coolers provide closed-circuit cooling of a liquid medium by means of ambient air flow and by evaporation of water. At the lower air temperature range the heat is transferred by convection (dry cooling). With higher ambient air temperatures the finned surface of the heat exchangers can be deluged with water. The heat is then transferred, partly by convection and partly by evaporation, in latent form as invisible water vapour to the ambient air. Even with very low ambient air temperatures these hybrid coolers are free from visible steam clouds (= guaranteed no plume).

- Cooling capacity per unit 953 kW
- Empty weight per unit 5'622 kg

Anti-vibration damping installed under the hybrid cooler to prevent transmission of vibration
Master Control Unit required as there are multiple units being used in sequence- The master controller is accommodated in a separate switchgear cabinet to be supplied with 230V AC. The task of the master controller is as follows:

- Communication to the plant control system by means of common bus system - Administration of the process parameters over a reference cooler - Selection of the available coolers
- Default of setpoints and operating modes
- Selection of the wetting pumps with consideration of running times
- Central information of operating conditions
- Parameters and status of the coolers

Steel cabinet, RAL 7035, with heater and service socket

Hybrid coolers are supplied completely pre-assembled and may be delivered by standard road transport onto the construction site.

Crane/Lifting plan (Weight 5.622 t, plus 1.7 t lifting beam)

III. Manufacturer: Jaeggi

IV. Consultant Ref: Hybrid Dry Coolers

IV. Colour/Finish: The unwetted structural steelwork is hot-dip galvanized or manufactured in high grade stainless steel construction (DIN 1.4301).

Master Control Unit- Steel cabinet, RAL 7035.

Description of hybrid cooler

The hybrid coolers provide closed-circuit cooling of a liquid medium by means of ambient air flow and by evaporation of water. At the lower air temperature range the heat is transferred by convection (dry cooling). With higher ambient air temperatures the finned surface of the heat exchangers can be deluged with water. The heat is then transferred, partly by convection and partly by evaporation, in latent form as invisible water vapour to the ambient air. **Even with very low ambient air temperatures these hybrid coolers are free from visible steam clouds (= guaranteed no plume).**

In the highest ambient air conditions, the majority of latent heat is transferred by evaporation by the deluge water. With falling ambient air temperature the evaporative heat transfer decreases and the convective heat transfer increases until the cooler may be operated in dry cooling mode only. At 100% cooling performance the hybrid cooler can be operated up to an ambient air temperature of 18°C in pure dry cooling mode. During part load or low cooling performance the hybrid cooler can be operated in the dry mode up to an air temperature of approx. 28°C.

The hybrid coolers have a modest energy and water consumption. Between the pure dry cooling mode of operation and maximum duty point, the fans of the hybrid cooler are regulated according to the coolant temperature. This leads to very low power consumption by optimum control of the fans and large water savings throughout the year since deluge operation is only used at higher ambient temperatures. The disconnection of the deluge/wetting pumps, as well as the speed regulation of the fans, take place via an automatic control.

The cooling medium (water or ethylene glycol/water mixture) of the primary cooling circuit flows through the V-configured finned heat exchangers and delivers the heat which is exhausted to the air flow. The induced draft fans are arranged in the warm air stream after the finned tube bundles. All the fans of a hybrid cooler always operate at the same number of revolutions, therefore the interior of the hybrid cooler is not partitioned, which provides good accessibility for maintenance. The deluge/wetting water is provided from open channels, which are adjustable in the height, over the long sides of the two cooling sections and these are uninfluenced by the air flow. By the adjusted angle of inclination and a changing specific airflow, a turbulent water film develops itself over a certain depth of the cooling finned surface.

The water is collected over a water guide plate and into a collecting basin beneath the cooling sections, without noise creation and again uninfluenced by the airflow. The water quantity used amounts to typically 8-10 times the required quantity of water calculated for evaporation. The water film of the excess water provides a self washing which prevents the deposit of air pollutants on the cooling finned surface.

All deluge water flows by gravity into the deluge water basins of the hybrid cooler after switching off the pumps and can be emptied at lower ambient air temperatures via motor operated valves. The refilling of the deluge/wetting water is automated likewise, controlled according to the fan speed and/or the cooling load. Normal draining and make up flow during evaporative cooling is automatically controlled by monitoring the conductivity of water in the basin, thus minimising water consumption.

The water-wettable cooling finned surface can be washed with a high pressure water jet cleaner up to 120 bar pressure. The cooling sections are electrophoretic enamelled and baked. The unwetted structural steelwork is hot-dip galvanized or is manufactured in high-grade stainless steel construction (DIN 1.4301).

Hybrid coolers are supplied completely pre-assembled and may be delivered by standard road transport onto the construction site. Unloading is by the installation contractor or the owner.

Further information can be found on our homepage: www.jaeggi-hybrid.ch

Technical Data

Manufacturer	JAEGGI Hybridtechnologie AG		
	Type:	HTK 2.4/4.8-2S-P4-CU-SLNF	
	Total performance of the system	4.765	kW
	Number of units	5	pcs

Calculation 1 cooler	Cooling capacity per unit	953	kW
	Cooling medium ³	34% ethylene glycol	
	Medium temperatures inlet/outlet (set) ²	43 / 36	°C
	Medium volume flow rate	126.80	m ³ /h
	Reference sea level	100.0	m

Technical data / unit

Water side	Pressure loss	36	kPa
	Tubeside velocity	1.26	m/s
	Hydraulic connection	Parallel, 4-flow, Cross counter current	
	Connections on the headers	4 x DN 125	
	Operating/test pressure	6 / 8	bar

		wet	dry	
Air side	Fan speed	63%	100%	
	Air condition at intake corresponding to wet-bulb temperature	34°C / 40% 23 °C	18°C not relevant	
	Air volume flow rate	21.2	40.7	m ³ /s
	Factor L1	3.67	7.20	
	Air condition at outlet	36.5°C / 74%	38.7°C	
	Factor L2	50	89	
	Number of fans per cooler		2	pcs
	Additional external pressure loss		0	Pa

Wetting per cooler (Design point)	Evaporation quantity	1.309	m ³ /h
	Assumed concentration (softened/ fully desalinated VE)	3 / 8	ratio
	Blowdown (softened/deionized)	0.655 / 0.187	m ³ /h
	Make-up water consumption (softened/deionized)	1.964/1.496	m ³ /h
	Number of wetting pumps	1	pcs
	Power requirement per wetting pump	0.9	kW

Dimensions (per unit)	Length over connection flanges (cooler only)	5'502	mm
	Length over control cabinet roof	6'392	mm
	Width	2'460	mm
	Height from foundation	3'928	mm

Weight (per unit)	Empty weight	5'622	kg
	Cooling medium in internal circuit	901	kg
	Water for wetting, (in basin) approx.	422	kg
	Operating weight	6'945	kg

Heat exchanger	Fin thickness	0.3	mm
	Material and state	AL 99,5	hard
	Fin pitch	2.8	mm
Materials/ Corrosion Protection	pipes/cooling fins	CU/AL, hard as-rolled	
	Water basin	Stainless steel	
	Housing	Steel, hot-dip galvanized	
	fan housings Corrosion protection coils	Steel, hot-dip galvanized KTL (Cataphoretic Coating)	
Fan	Number of fans for 1 unit	2	pcs
	Fan type	SLPF31830	
	Power consumption (mech. Shaftpower) max. ¹	2 x 3.07	kW
	Fan speed (100%)	379	1/min
Fan motor	Number of fans for 1 unit	2	pcs
	Nominal capacity per motor	4.00	kW
	Speed	1440	1/min
	Voltage	400	V
	Nominal current per motor	8.1	A
	Frequency	50	Hz
	Enclosure	IP 55	
	Protection type	Thermo contact	
Drive	low-noise drive	with power transmission belt	
		Operation ratio min. 2.5	
Acoustics	Sound power level per unit ³		
	... Determination in accordance with sound intensity method EN ISO 9614-2		
	wet/dry	71/79	dB(A)
	average acoustic pressure level at 100 m distance from the unit		
... Determination in accordance with method employing free field			
wet/dry	23/31	dB(A)	
... Sound details at 100% rotation speed each, tolerance ±2db(A)			

Partial load of cooling system - dry mode (without wetting)	Air Temp.	Inlet/Outlet Temperature
100% cooling power	18 °C	43 /36.0 °C
80% cooling power	21.6 °C	41.6 /36.0 °C
60% cooling power	25.2 °C	40.2 /36.0 °C
40% cooling power	28.8 °C	38.8 /36.0 °C

A4.898-T1.31-F7.3-26.7-HV23.01.05-V0.15

Important remarks / explanatory notes:

- 1) This unit is equipped with fans that fulfil the efficiency requirements of directive 2009/125/EC (ErP Ordinance).
- 2) MAXIMUM permissible agent intake temperature (at permanent utilisation):
 - agent intake ≤ 60°C: Recooler dry und fan in operation.
 - agent intake ≤ 50°C: Recooler wetted → desalinated (reverse osmosis) or completely desalinated water.
 - agent intake ≤ 40°C: Recooler wetter → other water (e.g. softened).
- 3) incl. fan drive

Scope of supply for each hybrid cooler

According to specified performance data and dimensions:

- removable Plexiglas cover for the entrance into the cooler
- gangway inside the cooler (only with 2.4 metre size tube bundles)
- deluge/wetting cycle, pre-installed, and consisting of
 - 1 No. Inductive conductivity measurement
 - 1 no. Deluge/wetting pump
 - 1 No. Fresh water 1" ball valve with position feedback
 - 0 No. Draining 1½ " ball valve with position feedback
 - 2 No. Level switches for water level control
 - 1 No. Level switch for dry operation pump protection
 - 1 No. Basin heaters each e kW (if offered)
- complete pipework system ready for operation of the deluge/wetting cycle
- complete wiring of the field instruments to the terminal box or control cabinet (if offered)

Isolation against vibration

- anti-vibration damping installed under the hybrid cooler to prevent transmission of vibration
- Mafundplatten assembly dimensioned for lowest spurious frequency
Dimension: 2400x120x25* mm
(* Supplied separately for installation with the cooler - Compression 1.5 mm)

Control of the coolers/condensers

Control cabinet design	HYBRIMATIC RE
Type	Steel control cabinet, RAL 7035, with heating, cooling and service socket
Protection type	IP54
Cable inlet	from below
Status/alarm messages	on operating panel
<u>Components</u>	
Drive control	frequency converter Rockwell Powerflex
Hybrid control (CPU)	Rockwell Micrologix1400
Operating panel	Rockwell Panelview 800

aster unit (optional)

Type	Steel cabinet, RAL 7035, with heater and service socket
Enclosure protection	IP54
Cable entry	from below
Operation/Alarm signals	on operating panel
<u>Components</u>	
Hybrid control (CPU)	Rockwell Micrologix1400
Operating panel	Siemens KTP600

Standards

applicable standards	VDE
Electromagnetic emission	2014/35/EU

Interference resistance 2004/108/EC

Documentation

Electric diagram A4, Eplan
Terminal lists in electric diagram

Configuration of the Control for one Hybrid Cooler

2 Fan Drive Motors	Type 400 V / 50 Hz / 8.12 A / 4 kW
1 Wetting Pump	Type 400 V / 50 Hz / 0.9 kW
0 Basin Heater	
0 Motorised Ball Valves	
1 Safety Switch - Fans	Type rotary drive black - 0/I
1 Level Sensor	Type range 0-1000 Ohm / Contac for TLS
2 Temperature Sensor Inlet/Outlet	Type PT100 with immersion tube
1 Temperature Sensor Outside Ambient Air	Type PT100 inserted
1 service socket-outlet	VDE

7 Terminal Box

Options

Feeds for:

1 Trace Heating (230 VAC / max. 4.0 A)	0	feed water control valve
0 Dosing Plant "Hardness" (230 VAC / max. 1.0 A)	0	Safety Switch Wetting Pumps
0 Dosing Plant "Biocide" (230 VAC / max. 1.0 A)	0	UV germicidal lamps
0 overvoltage protection in infeed		
0 Communication interface: not available		

Technical Characteristics of the Control

Max. Connection Current	27.9 A
Max. Connected Load	8.7 kW
Min. Cross-section Inlet	
Min. Security Inlet	
Operating short-circuit breaking capacity	10.0 kA
Earthing system	TN-S

Digital Input/Output of the Control (potential free contact)

Input Signals / Requirements

1 Setpoint 1	0	Night Operation
1 Setpoint 2	0	Frost Operation

Output Signals (total 16 signals selectable)

Ready Status HTK	Warnings HTK
Operation automatic	Operation frost
Operation Fan 1	Fault Fan 1
Operation Fan 2	Fault Fan 2
Operation Fan 3	Fault Fan 3
Operation Fan 4	Fault Fan 4
Operation Fan 1-x	Fault Wetting Pump 1
Operation Wetting Pump 1	Fault Wetting Pump 2
Operation Wetting Pump 2	Fault Basin Heaters 1 & 2
Operation Basin Heaters 1 & 2	Fault Make-up Water Valve
Make-up Water Valve OPEN	Fault Drain Valve
Drain Valve OPEN	Fault Feed Water Valve
Feed Water Valve OPEN	Fault Trace Heating

Make-up Water valve CLOSED
Drain Valve CLOSED

Feed Water Valve CLOSED
Operation Disinfection
Operation Biocide Dosing Procedure
Signal Safety Switch Fans
Signal safety Switch Wetting Pumps

Fault Harness Stabilising
Fault Hardness Stabilising "Container empty"
Fault Disinfection
Fault Biocide Station
Fault Biocide "Container empty"
Warning dry protection

Analogue Input/Output of the Control (0..10V)

Input Signals

1 Setpoint adjustment Setpoint 1 and Setpoint 2

Output Signals (total 3 signals selectable)

Inlet temperature HTK
Outlet temperature HTK
Ambient Air temperature HTK

Actual Setpoint
Actual Conductivity
Actual Waterlevel

Master Controller

When 2 or more hybrid coolers operate together within a cooling water circuit, we recommend the employment of a master control. The master controller is accommodated in a separate switchgear cabinet to be supplied with 230V AC. The task of the master controller is as follows:

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Terminal Box optional (if control cabinet is installed separately in the building):

Terminal Box with internal wiring at the cooler (EMC-regulations)

(If a third party supplies control separately from the cooler)

- 1 No. Terminal Box IP 65
- 1 No. Isolation Switch for 2 Fan(s)
- 1 No. Isolation Switch for 1 Wetting Pump(s)
- Installation of the conductivity measuring amplifiers (for the wetting cycle)
- Fan motors & Field instruments on terminal box wires.

Initial Start up and Commissioning of the Cooler and Control System on the Site

- Functional control of all components at the cooler
- Adjustment at start up with parameters of the conductivity instruments
- Briefing of personnel with cooler start up
- Instruction manuals, English language, 3 copies

Technical Submittal Form

Technical Submittal: Hybrid Coolers

Description of Technical Submittal:

This Technical Submittal details the 5no. Jaeggi Hybrid Coolers, Part No: HTK 2.4/4.8-2S-P4-CU-SLNF, to be installed on the 6th Floor, Roof Plant Area.

The hybrid coolers provide closed-circuit cooling of a liquid medium by means of ambient air flow and by evaporation of water. At the lower air temperature range the heat is transferred by convection (dry cooling). With higher ambient air temperatures the finned surface of the heat exchangers can be deluged with water. The heat is then transferred, partly by convection and partly by evaporation, in latent form as invisible water vapour to the ambient air. Even with very low ambient air temperatures these hybrid coolers are free from visible steam clouds (= guaranteed no plume).

Cooling capacity per unit 953 kW

Empty weight per unit 5'622 kg

Anti-vibration damping installed under the hybrid cooler to prevent transmission of vibration

Master Control Unit required as there are multiple units being used in sequence- The master controller is accommodated in a separate switchgear cabinet to be supplied with 230V AC. The task of the master controller is as follows:

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- Central information of operating conditions
- Parameters and status of the coolers

Steel cabinet, RAL 7035, with heater and service socket

Hybrid coolers are supplied completely pre-assembled and may be delivered by standard road transport onto the construction site.

Crane/Lifting plan (Weight 5.622 t, plus 1.7 t lifting beam)

Manufacturer: Jaeggi

Consultant Ref: Hybrid Dry Coolers

Location: 6th Floor Roof Plant Room

Values to be observed for make-up and circulation water
JAEGGI Water specification (HTK, HTV)

			<i>Softened makeup water</i>	<i>Low-salt water</i>	Circulation water
Material in contact with water			<i>Stainless steel , aluminium</i>		
Look	-		<i>Clear, without sentiments</i>		
Color	-		<i>colorless</i>		
Smell	-		<i>none</i>		
pH value at 20 °C	-		<i>6,5 – 8,3</i>		
el. Conductivity (25 °C)	µS / cm	EC	<i>< 600</i>	<i>< 20 (after dosing <100)</i>	<i>< 1600 (follow max. concentration factor 3/8)</i>
Alkaline earth metal oxides	mol / m ³	Ca ²⁺ , Mg ²⁺	<i>< 0,02</i>		<i>< 0,2</i>
Overall hardness	°d	GH	<i>< 0,1</i>		<i>< 1</i>
Chloride	g / m ³	Cl ⁻	<i>< 40</i>		<i>< 100</i>
Sulfate	g / m ³	SO ₄ ²⁻	<i>< 90</i>		<i>< 280</i>
Cu-ions	g / m ³	Cu ²⁺	<i>< 0,05</i>		<i>< 0,05</i>
Ammonium	g / m ³	NH ₄ ⁺	<i>< 2</i>		<i>< 2</i>
Colony-forming units	CFU / ml	CFU	<i>< 100</i>		<i>< 10000</i>
Pseudomonas aeruginosa	CFU/100ml	CFU	<i>< 100</i>		<i>< 100</i>
Legionella spp.	KBE/100ml	CFU	<i>< 100</i>		<i>< 100</i>
Max. concentration factor	-	-	<i>3 times</i>	<i>8 times</i>	<i>3 / 8 times</i>

1° german hardness (dH) = 1,8° french hardness (fH)
= 1.25° English (Clark) hardness
= 1.07° USA hardness
= 17.8 mg/liter Calcium Carbonate (CaCO₃)

Stand 06.11.2015

Circulation water values have to be strictly observed none of the limits including concentration factor may be exceed during wetted operation.

- ⇒ *The chemical properties of the wetting water should be regularly analysed. Measurements should be carried out and documented every second week, until the values are verified to be stable. This should be checked every 8 weeks according to the maintenance manual. During noncompliance with the water specification values or lack of measurements and documention JAEGGI will reserve the right to limit the warranty.*
- ⇒ *If one of the mentioned values exceeds the limit constantly during operation, then the concentration factor (upper limit of the conductivity) has to be reduced to keep all values below their specified limits.*

Optional Extras:

1. Factory Function Test: Included as standard (No additional Cost - FOC)

Our standard scope of supply includes a factory function test of all hybrid coolers with their controls prior to delivery.

The standard factory function test includes airflow measurement to confirm fan performance.

2 hybrid coolers, with their individual cooler mounted control cabinets can be connected together with the separate master control cabinet in our factory. The function test includes operation and testing on the speed controlled fan operation, pump operation, valve and instrument functions, electrical and signal checks, etc.

Please note that this is not a Capacity test. See options below for Capacity testing.

Sound Intensity Test to ISO 9614-2. Scanning method. Acoustic test may be carried out at an additional cost during the visit. See Options 8 for details.

Client representatives are welcome to attend/witness this standard function test. Hotel and accommodation will be provided free of charge for up to 5 people. Flights are not included.

Performance and Acoustic Testing

8. Acoustic Testing during FAT (Note: Not an capacity test)

Sound Intensity Test of a single cooler to ISO 9614-2, scanning method. Conducted in accordance with DIN EN ISO 3744 -2011.

The test will be conducted independently by Mueller BBM.

- **Lump Sump / 1 Cooler = t.b.d. (Acoustic)**

Note: The test will be conducted at the same time as the FAT test. Hotel and accommodation will be provided free of charge. Flights for two people included.

9. Independent Performance Test at DMT laboratories, Essen, Germany (Optional)

We are able to offer an independent performance/load test at DMT test facility of TUV Authority in Essen, Germany, where a heat load is available to facilitate thermal testing.

The additional cost for such independent testing is quite expensive and would include:

- a. Set up of the cooler at DMT test facility
- b. Sound intensity test to ISO9614-2
- c. Performance acceptance test, duration 1 day
- d. Transport and loading of the cooler to/from Essen
- e. Travel and accommodation included for up to 4 client representatives
(As specification M-SP-00-XX-01)

Independent performance testing at DMT would add 4 weeks to the delivery schedule

- **Lump Sump / 1 Cooler = t.b.d. (Thermal and Acoustic)**

Important Notes regarding Performance Load Testing

- Performance load testing of the cooler must be performed outdoors (there is not a climate chamber large enough to accommodate the coolers).
- Ambient weather conditions during the test could be lower than the design point. It is only possible to test at the ambient conditions prevailing at the time of test.
- During lower ambient conditions, it is only possible to make a dry mode performance test. A wetted performance test is only possible during summer months.
- A performance test is carried out with water (no glycol). No performance test is possible below 5°C ambient, due to risk of freezing of the test cooling medium.
- It may not be possible to replicate peak design ambient weather conditions during this time.
- Further performance checks may be carried out close to the design ambient conditions at site during IST systems testing.
- The performance of the cooler are calculated by an derivative of the Jaeggi selection software.