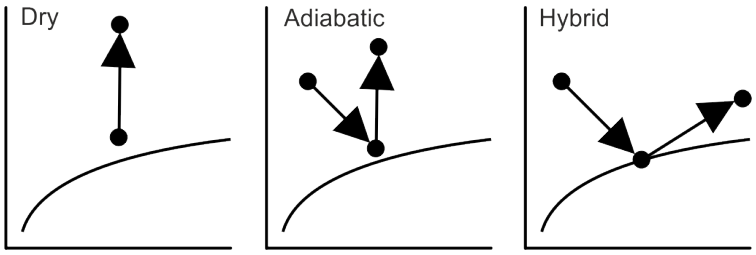
Brine re-cooling in air handling units

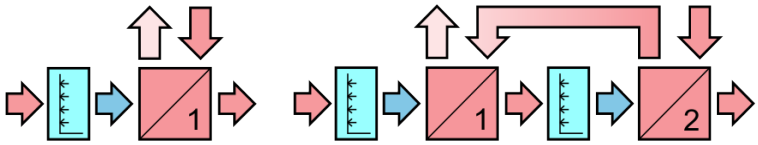
With increasing global warming, the demand for cold water is also increasing, for which chillers and ice storage tanks are used to cover peaks. The majority of the waste heat is not used, which is why it has to be dissipated via a brine re-cooler. If outdoor installation on the roof of the brine re-cooler is not permitted or is not possible for other reasons, brine re-cooling can be carried out just as well, if not better, in an air handling unit in the technical room. Because the COP cold water set should be as large as possible, brine temperatures must be kept as low as possible. Depending on the outside temperature, this requires three different operating modes.

Winter **Transition** **Summer**



The two-stage operation can keep brine temperatures lower. The investment costs are higher, but the operating costs are lower, which pays for itself within a very short time.

Single-stage operation **Two-stage operation**



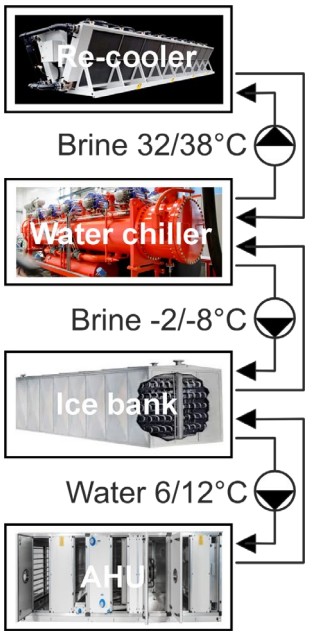
Brine re-coolers on the roof have various disadvantages. In autumn, the heat exchangers clog. These must be cleaned periodically against the direction of the air, i.e. from the inside, with high-pressure water equipment. This requires an inspection door on the rear of the brine air cooler and a catwalk inside.

Due to the risk of freezing, a brine must be used. As standard, this consists of 65% water, 34% ethylene glycol and 1% corrosion inhibitors. The freezing limit is -19°C. Clariant, for example, calls this product **Antifrogen N**, which is non-biodegradable and banned in the food sector. Therefore, a different mixture is used there, consisting of 61% water, 38% propylene glycol and 1% anti-corrosion inhibitors. The freezing limit is -19°C. Clariant, for example, calls this product **Antifrogen L**, which is also non-biodegradable...

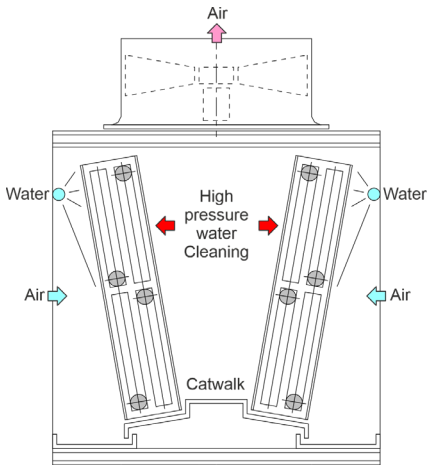
What equipment is needed to have cold water available at air handling unit is actually known, but is repeatedly underestimated by planning engineers, who also argue that cooling energy is about 4 times cheaper than electricity energy due to the COP of the chiller.

Necessary equipment

Brine re-cooler
Chiller
Ice storage
Air handling unit



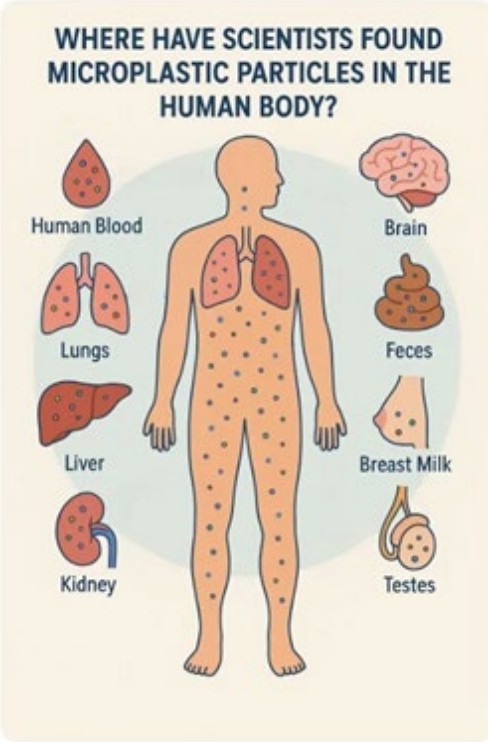
Brine re-cooler on the roof



With regard to brines based on ethylene or propylene glycol, for example Clariant's products Antifrogen N or Antifrogen L, it should be mentioned that if planning engineers use them anyway against better knowledge, they apparently not only don't care, but don't give a shit about the environment. Well, these guys are irreversibly stuffed with microplastics from head to toe anyway, which means that they are not biodegradable either.

It would really be better to use **Temper-20** at a freezing limit of -20°C, which is biodegradable and can also be used in the food sector. In addition, with **Temper-20** the fin coil heat exchangers are even smaller and therefore even more cost-effective.

But back to the problem of brine re-coolers on the roof, with the rest of the equipment, such as the chiller, ice storage and air handlin unit, arranged in the technical room in the basement. This means very long well-insulated pipes from the basement to the roof through several floors, which also requires appropriate high-pressure pumps, **not to mention other high investment and operating costs.**



But now finally back to the only absolutely reasonable justifiable solution, the brine re-cooling in an air handling unit in the technical room, where all other equipment is also arranged.

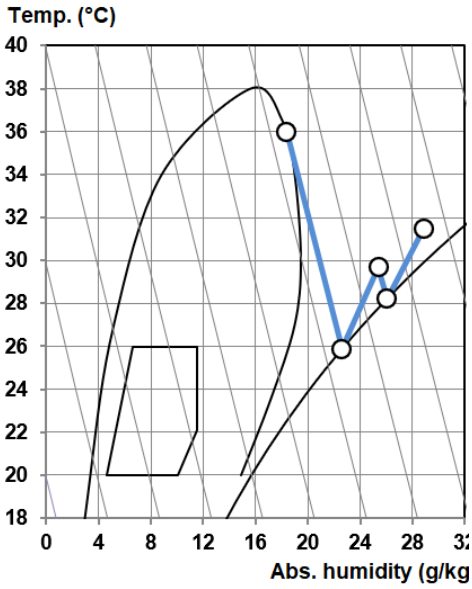
Two-stage brine re-cooling in an air handling unit

We have customers who have installed this optimal solution several times with great success for 25 years and have operated it for several years. One of these customers even dispensed with brines and carried out everything with water, which made it possible to make the fin coil heat exchangers even smaller and even more cost-effective. The only condition was, that below 0°C, no cold water was needed and therefore the centrifugal fan for the outside air could be disconnected from the power supply.

In the picture on the top right, the relative humidity of 100%, the comfort range according to DIN 1946 and the meteorological range for northern European countries can be seen in black color. In gray color, slanted isenthalps are visible. In blue with start and end points, the two-stage adiabatic and hybrid temperature and humidity curve is visible.

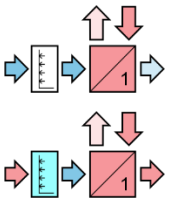
If you don't want to take any risks, you should therefore choose values regarding the maximum enthalpy for the outside air, not the absolutely inadequate values of 32°C/40%, as is far too often celebrated, but values of 36°C/46%, thus ensuring that the brine re-coolers deliver 100% of the required performance even in the sultry midsummer. Anything else is despicable risk management.

Two-stage brine re-cooling



Recooler: 40/35/16-16R-64T-4000A-3.0PA-128C-Cu/AlMg2.5/AISI 304 Software by www.zcs.ch

Capacity total	kW	500.000
Capacity sensible	kW	169.440
Capacity latent	kW	330.560
Surface reserve	%	0.860
Present surface	m2	3455.482
Required surface	m2	3426.007
k-coeff.	W/m2K	41.185
Average temp. diff.	K	3.544



dry

Adiabatic
Hybrid

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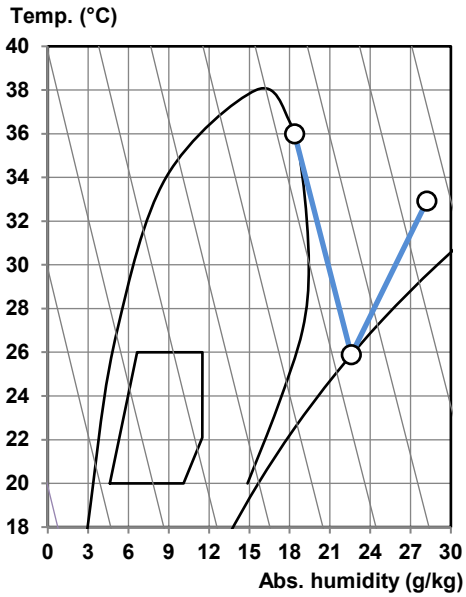
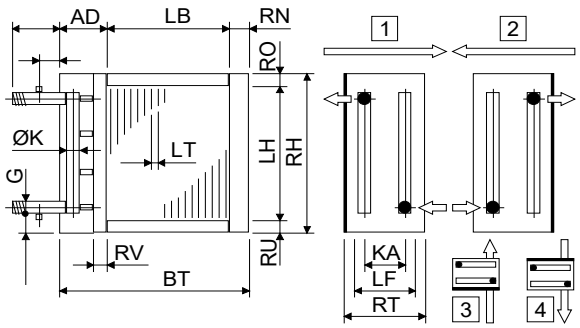
Air humid		Inlet	Outlet	Definition
Fouling factor	m2K/W			5.000E-05
Height over sea level	m			540.000
Pressure	hPa			949.653
Temp. (36.000)	°C	25.885	32.919	20.000
Rel. humidity (46.000)	%	100.000	82.591	40.000
Abs. humidity (18.360)	g/kg	22.597	28.217	6.174
Density humid	kg/m3	1.091	1.063	1.124
Enthalpy humid	kJ/kg	83.636	105.409	35.793
Volume flow humid	m3/h	77458.892	79971.889	74000.000
Mass flow dry	kg/h	82674.265	82674.265	82674.265
Velocity	m/s	2.101	2.169	2.007
Pressure drop dry	Pa		173.622	
Pressure drop wet	Pa		248.136	
Water Temp.	°C	15.000		
Evaporation total	kg/h	814.958		

34 V% Et.glycol		Inlet	Outlet	Definition
Fouling factor	m2K/W			5.000E-05
Temp.	°C	36.000	30.000	33.000
Density	kg/m3	1044.351	1047.053	1045.724
Spec. heat	kJ/kgK	3.624	3.606	3.615
Heat cond.	W/mK	0.453	0.447	0.450
Viscosity	Pas	1.636E-03	1.891E-03	1.756E-03
Volume flow	m3/h	79.462	79.257	79.358
Reynolds	---	8985.812	7773.866	8368.177
Velocity	m/s	0.902	0.900	0.901
Pressure drop	kPa		38.187	



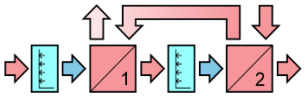
Technical data

Tubes total		Piece	1024	Tubes:		Cu
Tubes blank		Piece	0	Tubes:		smooth
Int. vent./drains		Piece	0/0	Tubes:		staggered
Tube rows on the depth		Piece	16	Collectors:	1.32 m/s	Cu
Tube rows on the height		Piece	64	Connections:	1.32 m/s	Cu
Tube coupling in series		Piece	8	Fins:	ribbed	AlMg2.5
Number of circuits (NC)		Piece	128	Frame:	2.00 mm	AISI 304
Volume		l	856	Circulations:	2	Parallel
Weight		kg	1827	Protection:		without
Connections	G	---	4"	Protection:		---
Frame height	RH	mm	2640	Air flow direction:		horizontal
Frame width	BT	mm	4268			
Frame depth	RT	mm	660			
Finned height	LH	mm	2560			
Finned width	LB	mm	4000			
Finned depth	LF	mm	554			
Frame on top	RO	mm	40			
Frame on bottom	RU	mm	40			
Frame in front	RV	mm	40			
Frame on back (~69mm)	RN	mm	69			
Collector-Diameter	K	mm	108			
Collector covering	AD	mm	199			
Collector distance	KA	mm	520			
Fin spacing	LT	mm	3.000	Delivery:		5-6 weeks
Fin thickness	LD	mm	0.200	Validity:		12 weeks
Tube diameter	DA	mm	16.400	Condit.:		net, prepaid address
Tube thickness	S	mm	0.400	Payment:		30 days net
Tube interval on the height	S1	mm	40.000			
Tube interval on the depth	S2	mm	34.641	**Price net:**	**EUR**	**31795.00**



2 Recooler in serial coupling		Cooler-1	Cooler-2	Total
Capacity total	kW	256.132	243.868	500.000
Capacity sensible	kW	91.239	78.763	170.003
Capacity latent	kW	164.892	165.105	329.997
Surface reserve	%	1.111	0.934	1.040
Present surface	m2	1727.741	1152.668	2880.410
Required surface	m2	1708.764	1142.000	2850.764

Air humid		Definition
Fouling factor	m2K/W	5.000E-05
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Volume flow	m3/h	74000.000



Air humid		Cooler-1	Cooler-2	Total
Temp. in	°C	36.000	29.673	
Rel. humidity in	%	46.000	89.789	Inlet
Abs. humidity in	g/kg	18.360	25.407	
Temp. in	°C	25.885	28.208	
Rel. humidity in	%	100.000	100.000	Adiabatic
Abs. humidity in	g/kg	22.597	26.027	
Temp. out	°C	29.673	31.458	
Rel. humidity out	%	89.789	91.561	Outlet
Abs. humidity out	g/kg	25.407	28.837	
Velocity	m/s	2.119	2.145	---
Pressure drop dry	Pa	86.663	59.734	146.397
Pressure drop wet	Pa	121.833	86.736	208.569
Water Temp.	°C	15.000	15.000	---
Evaporation total	kg/h	582.643	283.586	866.229

34 V% Et.glycol (0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	36.000	30.000	33.000
Density	kg/m3	1044.351	1047.053	1045.724
Spec. heat	kJ/kgK	3.624	3.606	3.615
Heat cond.	W/mK	0.453	0.447	0.450
Viscosity	Pas	1.636E-03	1.891E-03	1.756E-03
Mass flow	kg/h	83134.546	83134.546	83134.546
Volume flow	m3/h	79.604	79.399	79.500
Reynolds	---	9001.882	7787.769	8383.142
Velocity	m/s	0.904	0.901	0.903
Pressure drop	kPa		54.837	

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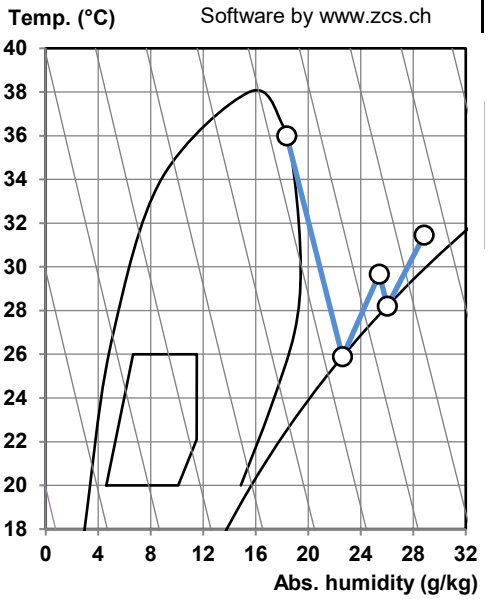
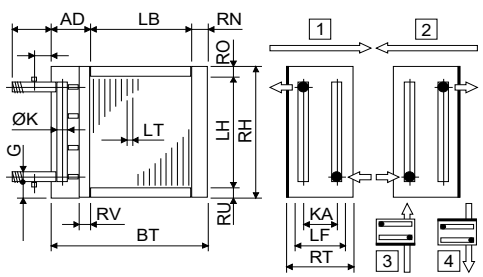
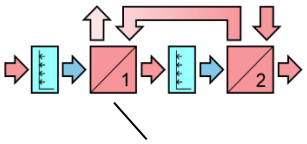


Technical data			Cooler-1	Cooler-2		Cooler-1	Cooler-2
Tubes total		Piece	512	384	Tubes:	Cu	Cu
Tubes blank		Piece	0	0	Tubes:	smooth	smooth
Int. vent./drains		Piece	0/0	0/0	Tubes:	staggered	staggered
Tube rows on the depth		Piece	8	6	Collectors:	Cu	Cu
Tube rows on the height		Piece	64	64	Connections:	Cu	Cu
Tube coupling in series		Piece	4	4	Fins:	AlMg2.5	AlMg2.5
Number of circuits (NC)		Piece	128	96	Frame:	AISI 304	AISI 304
Volume		l	451	349	Circulations:	2	2
Weight		kg	961	707	Circulations:	Parallel	Parallel
Connections	G	---	4"	4"	Protection:	without	without
Frame height	RH	mm	2640	2640	Protection:	---	---
Frame width	BT	mm	4268	4268	Air flow direction:	horizontal	horizontal
Frame depth	RT	mm	380	310			
Finned height	LH	mm	2560	2560			
Finned width	LB	mm	4000	4000			
Finned depth	LF	mm	277	208			
Frame on top	RO	mm	40	40			
Frame on bottom	RU	mm	40	40			
Frame in front	RV	mm	40	40			
Frame on back (~69/69mm)	RN	mm	69	69			
Collector-Diameter	K	mm	108	108			
Collector covering	AD	mm	199	199			
Collector distance	KA	mm	243	174	Delivery:		5-6 weeks
Fin spacing	LT	mm	3.000	3.400	Validity:		12 weeks
Fin thickness	LD	mm	0.200	0.200	Condit.:		net, prepaid address
Tube diameter	DA	mm	16.400	16.400	Payment:		30 days net
Tube thickness	S	mm	0.400	0.400			
Tube interval on the height	S1	mm	40.000	40.000	**Cooler-1:**	**EUR**	**16938.00**
Tube interval on the depth	S2	mm	34.641	34.641	**Cooler-2:**	**EUR**	**12568.00**



Recooler-1: 40/35/16-8R-64T-4000A-3.0PA-128C-Cu/AlMg2.5/AISI 304 Software by www.zcs.ch

Capacity total	kW	256.132
Capacity sensible	kW	91.239
Capacity latent	kW	164.892
Surface reserve	%	1.111
Present surface	m2	1727.741
Required surface	m2	1708.764
k-coeff.	W/m2K	40.323
Average temp. diff.	K	3.717



Recooler-1

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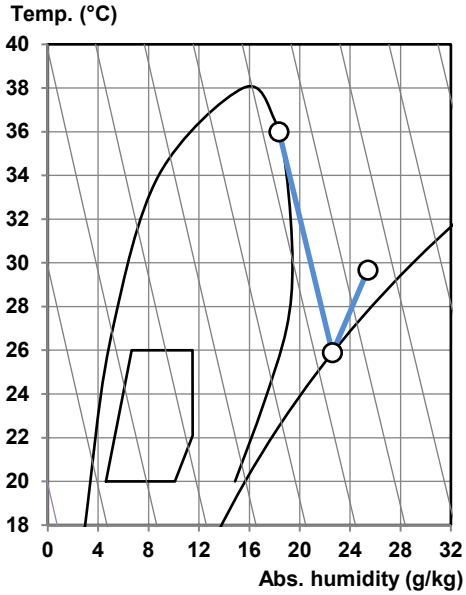
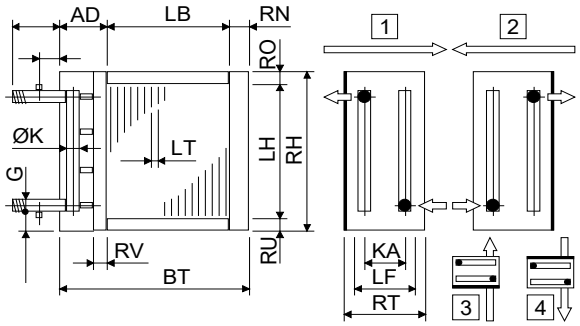
Air humid		Inlet	Outlet	Definition
Fouling factor	m2K/W			5.000E-05
Height over sea level	m			540.000
Pressure	hPa			949.653
Temp. (36.000)	°C	25.885	29.673	20.000
Rel. humidity (46.000)	%	100.000	89.789	40.000
Abs. humidity (18.360)	g/kg	22.597	25.407	6.174
Density humid	kg/m3	1.091	1.076	1.124
Enthalpy humid	kJ/kg	83.636	94.790	35.793
Volume flow humid	m3/h	77458.892	78781.912	74000.000
Mass flow dry	kg/h	82674.265	82674.265	82674.265
Velocity	m/s	2.101	2.137	2.007
Pressure drop dry	Pa		86.663	
Pressure drop wet	Pa		121.833	
Water Temp.	°C	15.000		
Evaporation total	kg/h	582.643		

34 V% Et.glycol		Inlet	Outlet	Definition
Fouling factor	m2K/W			5.000E-05
Temp.	°C	33.077	30.000	31.539
Density	kg/m3	1045.689	1047.053	1046.377
Spec. heat	kJ/kgK	3.615	3.606	3.611
Heat cond.	W/mK	0.450	0.447	0.449
Viscosity	Pas	1.753E-03	1.891E-03	1.820E-03
Mass flow	kg/h	82986.147	82986.147	82986.147
Volume flow	m3/h	79.360	79.257	79.308
Velocity	m/s	0.901	0.900	0.900
Pressure drop	kPa		22.205	



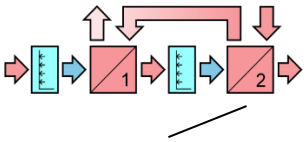
Technical data

Tubes total		Piece	512	Tubes:		Cu
Tubes blank		Piece	0	Tubes:		smooth
Int. vent./drains		Piece	0/0	Tubes:		staggered
Tube rows on the depth		Piece	8	Collectors:	1.32 m/s	Cu
Tube rows on the height		Piece	64	Connections:	1.32 m/s	Cu
Tube coupling in series		Piece	4	Fins:	ribbed	AlMg2.5
Number of circuits (NC)		Piece	128	Frame:	2.00 mm	AISI 304
Volume		l	451	Circulations:	2	Parallel
Weight		kg	961	Protection:		without
Connections	G	---	4"	Protection:		---
Frame height	RH	mm	2640	Air flow direction:		horizontal
Frame width	BT	mm	4268			
Frame depth	RT	mm	380			
Finned height	LH	mm	2560			
Finned width	LB	mm	4000			
Finned depth	LF	mm	277			
Frame on top	RO	mm	40			
Frame on bottom	RU	mm	40			
Frame in front	RV	mm	40			
Frame on back (~69mm)	RN	mm	69			
Collector-Diameter	K	mm	108			
Collector covering	AD	mm	199			
Collector distance	KA	mm	243			
Fin spacing	LT	mm	3.000	Delivery:		5-6 weeks
Fin thickness	LD	mm	0.200	Validity:		12 weeks
Tube diameter	DA	mm	16.400	Condit.:		net, prepaid address
Tube thickness	S	mm	0.400	Payment:		30 days net
Tube interval on the height	S1	mm	40.000			
Tube interval on the depth	S2	mm	34.641	**Price net:**	**EUR**	**16938.00**



Recooler-2: 40/35/16-6R-64T-4000A-3.4PA-96C-Cu/AlMg2.5/AISI 304 Software by www.zcs.ch

Capacity total	kW	243.868
Capacity sensible	kW	78.763
Capacity latent	kW	165.105
Surface reserve	%	0.934
Present surface	m2	1152.668
Required surface	m2	1142.000
k-coeff.	W/m2K	45.715
Average temp. diff.	K	4.671



Recooler-2

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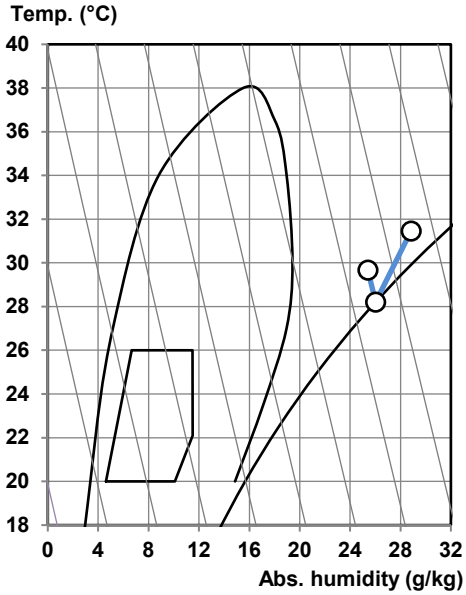
Air humid		Inlet	Outlet	Definition
Fouling factor	m2K/W			5.000E-05
Height over sea level	m			540.000
Pressure	hPa			949.653
Temp. (29.673)	°C	28.208	31.458	20.000
Rel. humidity (89.789)	%	100.000	91.561	40.000
Abs. humidity (25.407)	g/kg	26.027	28.837	6.174
Density humid	kg/m3	1.081	1.068	1.124
Enthalpy humid	kJ/kg	94.828	105.448	35.793
Volume flow humid	m3/h	78475.963	79666.127	74000.000
Mass flow dry	kg/h	82674.265	82674.265	82674.265
Velocity	m/s	2.129	2.161	2.007
Pressure drop dry	Pa		59.734	
Pressure drop wet	Pa		86.736	
Water Temp.	°C	15.000		
Evaporation total	kg/h	283.586		

34 V% Et.glycol		Inlet	Outlet	Definition
Fouling factor	m2K/W			5.000E-05
Temp.	°C	36.000	33.077	34.539
Density	kg/m3	1044.351	1045.689	1045.025
Spec. heat	kJ/kgK	3.624	3.615	3.620
Heat cond.	W/mK	0.453	0.450	0.451
Viscosity	Pas	1.636E-03	1.753E-03	1.693E-03
Mass flow	kg/h	82986.147	82986.147	82986.147
Volume flow	m3/h	79.462	79.360	79.411
Velocity	m/s	1.203	1.201	1.202
Pressure drop	kPa		32.632	



Technical data						
Tubes total		Piece	384	Tubes:		Cu
Tubes blank		Piece	0	Tubes:		smooth
Int. vent./drains		Piece	0/0	Tubes:		staggered
Tube rows on the depth		Piece	6	Collectors:	1.32 m/s	Cu
Tube rows on the height		Piece	64	Connections:	1.32 m/s	Cu
Tube coupling in series		Piece	4	Fins:	ribbed	AlMg2.5
Number of circuits (NC)		Piece	96	Frame:	2.00 mm	AISI 304
Volume		l	349	Circulations:	2	Parallel
Weight		kg	707	Protection:		without
Connections	G	---	4"	Protection:		---
Frame height	RH	mm	2640	Air flow direction:		horizontal
Frame width	BT	mm	4268			
Frame depth	RT	mm	310			
Finned height	LH	mm	2560			
Finned width	LB	mm	4000			
Finned depth	LF	mm	208			
Frame on top	RO	mm	40			
Frame on bottom	RU	mm	40			
Frame in front	RV	mm	40			
Frame on back (~69mm)	RN	mm	69			
Collector-Diameter	K	mm	108			
Collector covering	AD	mm	199			
Collector distance	KA	mm	174			
Fin spacing	LT	mm	3.400	Delivery:		5-6 weeks
Fin thickness	LD	mm	0.200	Validity:		12 weeks
Tube diameter	DA	mm	16.400	Condit.:		net, prepaid address
Tube thickness	S	mm	0.400	Payment:		30 days net
Tube interval on the height	S1	mm	40.000			
Tube interval on the depth	S2	mm	34.641	**Price net:**	**EUR**	**12568.00**