



Energy recovery with the leader CCSD

Energy recovery can be carried out in many ways, with only the circuit connect system, short CC-System, the supply air and exhaust air do not have to be combined, so that you can save considerable costs with regard to the air ducts.

Furthermore, only the CC-System and the plate heat exchanger may be used in hospitals, because only with these two systems can air mixing and bacterial moisture transfer be ruled out.

For air volumes of 40,000 m³/h, however, the plate heat exchanger has far too large dimensions in the air direction, which would only make the air conditioning unit more expensive unnecessarily.

Rotor heat exchangers are never an option for us because leaks occur after a short time and the rotor becomes out of round due to frost and can no longer be repaired.

Regenerators are never an option for us because the periodic flap changeover results in pressure surges that are felt to be noticeably uncomfortable.

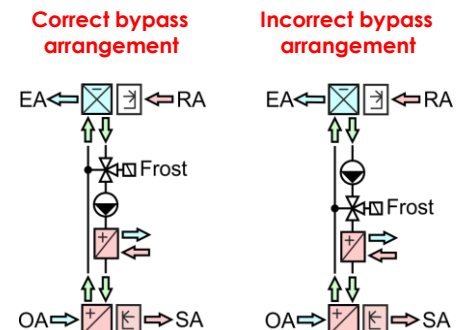
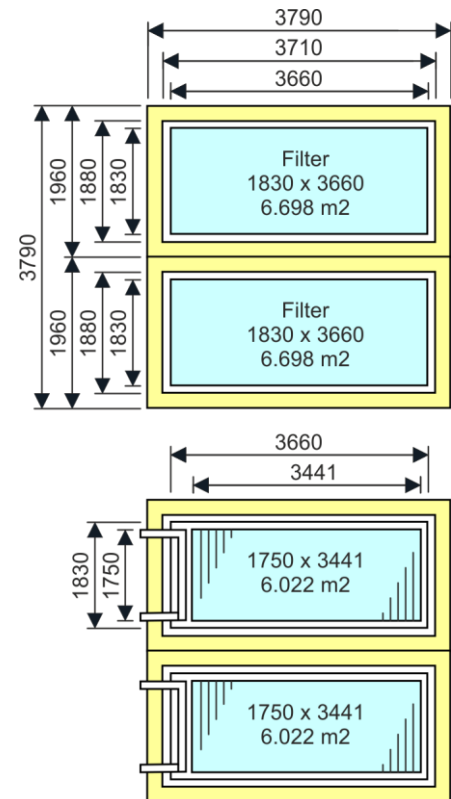
Because the two air handling units must form a square with the rotor heat exchanger, this is also assumed here as an example for all energy recovery systems. Furthermore, the size of the air handling units was chosen so that standard filter units of 610 x 610 mm can be used. In the picture on the right, 3 x 6 filters are provided, resulting in dimensions of 1,830 x 3,660 mm. With a maximum pre-scribed air speed of 2.00 m/s, this results in an air volume of 48,224 m³/h, which, however, cannot be maintained in all energy recovery systems with regard to the inflow area.

With the CC-System, this finned inflow area is the largest of all energy recovery systems and measures 1,750 x 3,441 mm and would allow an air volume of 43,357 m³/h.

On the following pages, 43,350 m³/h is calculated for the supply air and 39,020 m³/h for the exhaust air, i.e. 10% less, which is mostly the case in practice.

However, CC-Systems have big differences!

Only the **CC-System type CCSD** can do without downstream finned heat exchangers in winter for post-heating and in summer for post-cooling, because this is done via 1 or 2 plate heat exchangers in the intermediate carrier. As a result, the air-side pressure drop can be minimized and the fan output can be significantly reduced.



Addendum to other energy recovery systems

Note the very small pressure drops on the air side with the CC-System CCSD of less than 140 Pa in the supply air in the exhaust air. All other systems have a multiple of this, since the pressure drop of the downstream finned heat exchanger for post-heating and post-cooling must also be added to the pressure drop of these energy recovery systems.

Following pages

- Page 2: Heat recovery in winter with little risk of frost, supply air pressure drop 132 Pa, exhaust air pressure drop 136 Pa
- Page 3: Heat recovery in winter without plate heat exchanger in the intermediate carrier, temperature efficiency 76.40%
- Page 4: Heat recovery in winter without the risk of frost with the correct bypass arrangement
- Page 5: Heat recovery in winter without the risk of frost with the wrong bypass arrangement (can also be calculated)
- Page 6: Cold recovery in summer
- Page 7: Heat recovery according to DIN EN 308, temperature efficiency 77.00%
- Page 8: Economy for winter, summer and according to DIN EN 308
- Page 9: Simplified energy recovery for the Frankfurt am Main location (much more precise with the DEH software)
- Page 10: Something about the pressure drop at the intermediate carrier and the selection of a suitable pump
- Page 11: Splitting of the finned heat exchanger with 24 rows of tubes to 2 x 12 rows of tubes in the supply air (VDI 6022)
- Page 12: Internal hydraulic circuits for the finned heat exchanger (supply air 2 x 12 RR, exhaust air 24 RR)

CC-System in winter		SA-He	Pt	RA-Co	Definition
Height over sea level	m				106.000
Pressure	hPa				1000.564
Capacity	%	100.000	36.602	63.398	
Capacity sensible	kW	514.913	188.468	258.483	
Capacity latent	kW	---	---	65.720	
Capacity frost	kW	---	---	2.243	
Capacity total	kW	514.913	188.468	326.445	
Surface reserve	%	0.100		0.435	
Present surface	m2	3795.681		3795.681	



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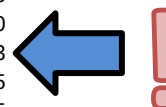
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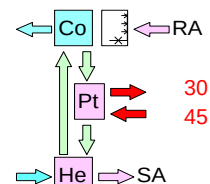
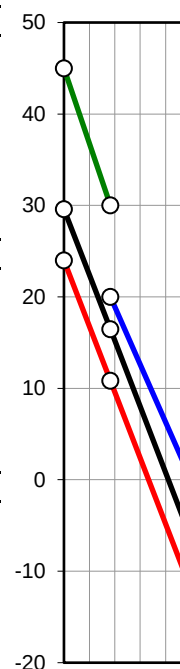
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SA-He (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	-12.000	24.000	20.000
Rel. humidity	%	90.000	6.517	40.000
Abs. humidity	g/kg	1.208	1.208	5.858
Volume flow humid	m3/h	38332.221	43616.185	43350.000
Velocity	m/s	1.768	2.012	2.000
Pressure drop	Pa		131.968	

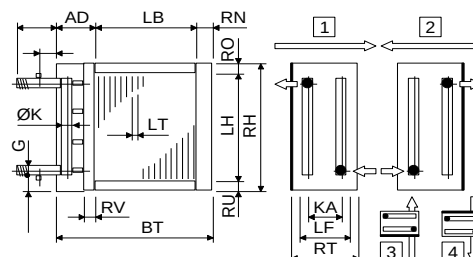
RA-Co (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	20.000	0.020	20.000
Rel. humidity	%	40.000	99.747	40.000
Abs. humidity	g/kg	5.858	3.829	5.858
Volume flow humid	m3/h	39020.000	36243.171	39020.000
Velocity	m/s	1.800	1.672	1.800
Pressure drop (dry 125 Pa)	Pa		135.213	

25 V% Et.glycol		SA-He	Pt	RA-Co
Temp. in	°C	29.587	16.477	-6.413
Temp. out	°C	-6.413	29.587	16.477
Volume flow	m3/h	13.340	13.385	13.337
Velocity	m/s	0.948		0.947
Reynolds	---	4818.823		3925.386
Pressure drop	kPa	186.535		197.132



Software by www.zcs.ch

Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	1200	1200	Tubes:	Cu
Tubes blank	Piece	16	16	Tubes:	smooth
Int. vent./drains	Piece	11	11	Tubes:	in line
Tube rows on the depth	Piece	24	24	Tubes:	circular
Tube rows on the height	Piece	50	50	Collectors:	Cu
Tube coupling in series	Piece	32	32	Collectors:	0.91 m/s
Number of circuits (NC)	Piece	37	37	Connections:	Rg7
Volume	l	466	466	Connections:	0.91 m/s
Weight	kg	1739	1739	Fins:	Al
Connections	G	2 1/2"	2 1/2"	Fins:	smooth
Frame height	RH mm	1830	1830	Frame:	AISI 304
Frame width	BT mm	3660	3660	Air flow direction:	horizontal
Frame depth	RT mm	950	950	Protection:	without
Finned height	LH mm	1750	1750	Protection:	---
Finned width	LB mm	3441	3441		
Finned depth	LF mm	840	840		
Frame on top	RO mm	40	40		
Frame on bottom	RU mm	40	40		
Frame in front	RV mm	30	30		
Frame on back (~53/53mm)	RN mm	53	53		
Collector-Diameter	K mm	76	76		
Collector covering	AD mm	166	166		
Collector distance	KA mm	844	844		
Fin spacing	LT mm	2.500	2.500		
Fin thickness	LD mm	0.200	0.200		
Tube diameter	DA mm	12.400	12.400		
Tube diameter	da mm	12.400	12.400		
Tube thickness	S mm	0.400	0.400		
Tube interval on the height	S1 mm	35.000	35.000		
Tube interval on the depth	S2 mm	35.000	35.000		



Delivery: 5-6 weeks
Validity: 12 weeks
Condit.: net, prepaid address
Payment: 30 days net

SA-He: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

SA-He: EUR 23126.00

RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

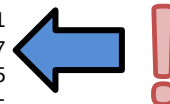
RA-Co: EUR 23126.00

CC-System in winter without Pt		SA-He	RA-Co	Definition
Height over sea level	m			106.000
Pressure	hPa			1000.564
Efficiency	%	76.400	65.279	
Capacity sensible	kW	349.625	270.107	
Capacity latent	kW	---	74.751	
Capacity frost	kW	---	4.767	
Capacity total	kW	349.625	349.625	
Surface reserve	%	0.099	0.095	
Present surface	m2	3795.681	3795.681	

SA-He (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	-12.000	12.448	20.000
Rel. humidity	%	90.000	13.436	40.000
Abs. humidity	g/kg	1.208	1.208	5.858
Volume flow humid	m3/h	38332.221	41920.619	43350.000
Velocity	m/s	1.768	1.934	2.000
Pressure drop	Pa		128.221	

RA-Co (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	20.000	-0.889	20.000
Rel. humidity	%	40.000	100.000	40.000
Abs. humidity	g/kg	5.858	3.550	5.858
Volume flow humid	m3/h	39020.000	36106.438	39020.000
Velocity	m/s	1.800	1.666	1.800
Pressure drop (dry 126 Pa)	Pa		137.245	

25 V% Et.glycol		SA-He	RA-Co	
Temp.	in °C	16.424	-8.148	
Temp.	out °C	-8.148	16.424	
Volume flow	m3/h	13.312	13.312	
Velocity	m/s	0.946	0.946	
Reynolds	---	3803.442	3785.743	
Pressure drop	kPa	198.103	198.383	



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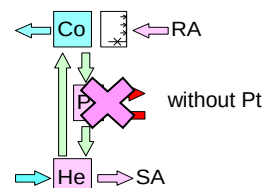
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Plant

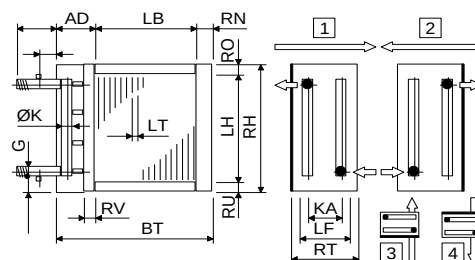
Object

Position



Software by www.zcs.ch

Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	1200	1200	Tubes:	Cu
Tubes blank	Piece	16	16	Tubes:	smooth
Int. vent./drains	Piece	11	11	Tubes:	in line
Tube rows on the depth	Piece	24	24	Tubes:	circular
Tube rows on the height	Piece	50	50	Collectors:	Cu
Tube coupling in series	Piece	32	32	Collectors:	0.91 m/s
Number of circuits (NC)	Piece	37	37	Connections:	Rg7
Volume	l	466	466	Connections:	0.91 m/s
Weight	kg	1739	1739	Finns:	Al
Connections	G	2 1/2"	2 1/2"	Finns:	smooth
Frame height	RH mm	1830	1830	Frame:	AISI 304
Frame width	BT mm	3660	3660	Air flow direction:	horizontal
Frame depth	RT mm	950	950	Protection:	without
Finned height	LH mm	1750	1750	Protection:	---
Finned width	LB mm	3441	3441		
Finned depth	LF mm	840	840		
Frame on top	RO mm	40	40		
Frame on bottom	RU mm	40	40		
Frame in front	RV mm	30	30		
Frame on back (~53/53mm)	RN mm	53	53		
Collector-Diameter	K mm	76	76		
Collector covering	AD mm	166	166		
Collector distance	KA mm	844	844		
Fin spacing	LT mm	2.500	2.500		
Fin thickness	LD mm	0.200	0.200		
Tube diameter	DA mm	12.400	12.400		
Tube diameter	da mm	12.400	12.400		
Tube thickness	S mm	0.400	0.400		
Tube interval on the height	S1 mm	35.000	35.000		
Tube interval on the depth	S2 mm	35.000	35.000		



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SA-He: EUR 23126.00

RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

RA-Co: EUR 23126.00

CC-System in winter		SA-He	Pt1	RA-Co	Definition
Height over sea level	m				106.000
Pressure	hPa				1000.564
Capacity	%	100.000	44.786	55.214	
Capacity sensible	kW	514.913	230.611	235.687	
Capacity latent	kW	---	---	48.615	
Capacity frost	kW	---	---	0.000	
Capacity total	kW	514.913	230.611	284.302	
Surface reserve	%	0.100		0.090	
Present surface	m2	3795.681		3795.681	

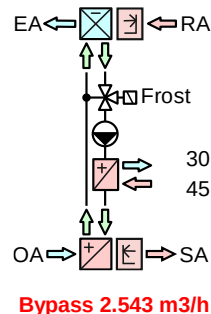
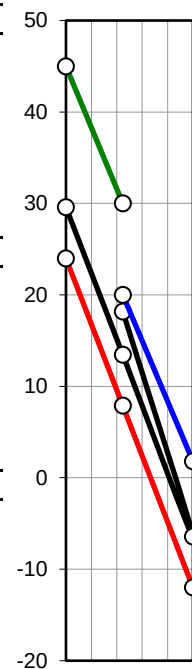
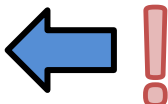


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SA-He (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	-12.000	24.000	20.000
Rel. humidity	%	90.000	6.517	40.000
Abs. humidity	g/kg	1.208	1.208	5.858
Volume flow humid	m3/h	38332.221	43616.185	43350.000
Velocity	m/s	1.768	2.012	2.000
Pressure drop	Pa		131.968	

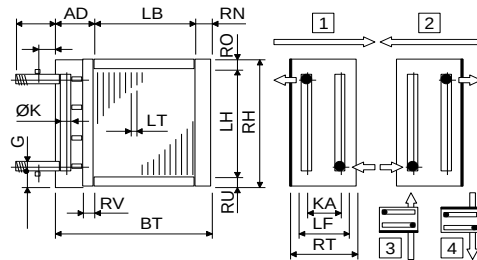
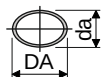
RA-Co (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	20.000	1.800	20.000
Rel. humidity	%	40.000	99.799	40.000
Abs. humidity	g/kg	5.858	4.357	5.858
Volume flow humid	m3/h	39020.000	36510.097	39020.000
Velocity	m/s	1.800	1.684	1.800
Pressure drop (dry 123 Pa)	Pa		131.290	

25 V% Et.glycol		SA-He	Pt1	RA-Co
Temp. in	°C	29.587	13.463	-6.413
Temp. out	°C	-6.413	29.587	18.183
Volume flow	m3/h	13.340	13.380	10.797
Velocity	m/s	0.948		0.767
Reynolds	---	4818.823		3456.202
Pressure drop	kPa	186.535		133.628



Software by www.zcs.ch

Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	1200	1200	Tubes:	Cu
Tubes blank	Piece	16	16	Tubes:	smooth
Int. vent./drains	Piece	11	11	Tubes:	in line
Tube rows on the depth	Piece	24	24	Tubes:	circular
Tube rows on the height	Piece	50	50	Collectors:	Cu
Tube coupling in series	Piece	32	32	Collectors:	0.91 m/s
Number of circuits (NC)	Piece	37	37	Connections:	Rg7
Volume	l	466	466	Connections:	0.91 m/s
Weight	kg	1739	1739	Fins:	Al
Connections	G	2 1/2"	2 1/2"	Fins:	smooth
Frame height	RH	mm	1830	Frame:	AISI 304
Frame width	BT	mm	3660	Air flow direction:	horizontal
Frame depth	RT	mm	950	Protection:	without
Finned height	LH	mm	1750	Protection:	---
Finned width	LB	mm	3441		
Finned depth	LF	mm	840		
Frame on top	RO	mm	40		
Frame on bottom	RU	mm	40		
Frame in front	RV	mm	30		
Frame on back (~53/53mm)	RN	mm	53		
Collector-Diameter	K	mm	76		
Collector covering	AD	mm	166		
Collector distance	KA	mm	844		
Fin spacing	LT	mm	2.500		
Fin thickness	LD	mm	0.200		
Tube diameter	DA	mm	12.400		
Tube diameter	da	mm	12.400		
Tube thickness	S	mm	0.400		
Tube interval on the height	S1	mm	35.000		
Tube interval on the depth	S2	mm	35.000		



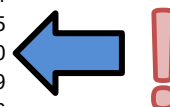
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 RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

CC-System in winter		SA-He	Pt1	RA-Co	Definition
Height over sea level	m				106.000
Pressure	hPa				1000.564
Capacity	%	100.000	43.509	56.491	
Capacity sensible	kW	514.913	224.034	239.534	
Capacity latent	kW	---	---	51.345	
Capacity frost	kW	---	---	0.000	
Capacity total	kW	514.913	224.034	290.879	
Surface reserve	%	0.183		0.316	
Present surface	m2	3795.681		3795.681	



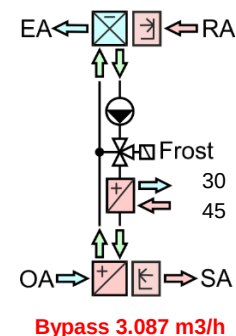
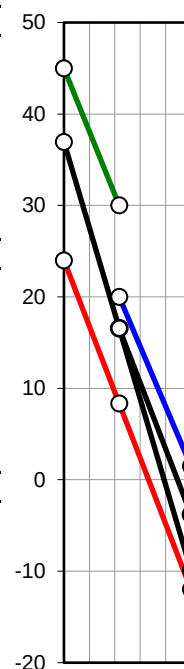
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SA-He (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	-12.000	24.000	20.000
Rel. humidity	%	90.000	6.517	40.000
Abs. humidity	g/kg	1.208	1.208	5.858
Volume flow humid	m3/h	38332.221	43616.185	43350.000
Velocity	m/s	1.768	2.012	2.000
Pressure drop	Pa		131.968	

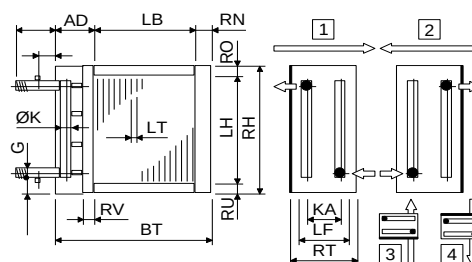
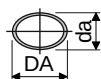
RA-Co (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	20.000	1.500	20.000
Rel. humidity	%	40.000	100.000	40.000
Abs. humidity	g/kg	5.858	4.273	5.858
Volume flow humid	m3/h	39020.000	36465.356	39020.000
Velocity	m/s	1.800	1.682	1.800
Pressure drop (dry 124 Pa)	Pa		131.919	

25 V% Et.glycol		SA-He	Pt1	RA-Co
Temp. in	°C	36.956	16.577	-3.807
Temp. out	°C	-9.883	36.956	16.577
Volume flow	m3/h	10.253	10.298	13.340
Velocity	m/s	0.728		0.948
Reynolds	---	3718.642		4041.580
Pressure drop	kPa	117.972		195.653



Software by www.zcs.ch

Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	1200	1200	Tubes:	Cu
Tubes blank	Piece	16	16	Tubes:	smooth
Int. vent./drains	Piece	11	11	Tubes:	in line
Tube rows on the depth	Piece	24	24	Tubes:	circular
Tube rows on the height	Piece	50	50	Collectors:	Cu
Tube coupling in series	Piece	32	32	Collectors:	0.70 m/s
Number of circuits (NC)	Piece	37	37	Connections:	Rg7
Volume	l	466	466	Connections:	0.70 m/s
Weight	kg	1739	1739	Fins:	Al
Connections	G	---	2 1/2"	Fins:	smooth
Frame height	RH	mm	1830	Frame:	AISI 304
Frame width	BT	mm	3660	Air flow direction:	horizontal
Frame depth	RT	mm	950	Protection:	without
Finned height	LH	mm	1750	Protection:	---
Finned width	LB	mm	3441		
Finned depth	LF	mm	840		
Frame on top	RO	mm	40		
Frame on bottom	RU	mm	40		
Frame in front	RV	mm	30		
Frame on back (~53/53mm)	RN	mm	53		
Collector-Diameter	K	mm	76		
Collector covering	AD	mm	166		
Collector distance	KA	mm	844		
Fin spacing	LT	mm	2.500		
Fin thickness	LD	mm	0.200		
Tube diameter	DA	mm	12.400		
Tube diameter	da	mm	12.400		
Tube thickness	S	mm	0.400		
Tube interval on the height	S1	mm	35.000		
Tube interval on the depth	S2	mm	35.000		



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 RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

SA-He: EUR 23126.00
 RA-Co: EUR 23126.00

CC-System in summer		RA-Hy	Pt	SA-Co	Definition
Height over sea level	m				106.000
Pressure	hPa				1000.564
Capacity	%	45.094	54.906	100.000	
Capacity sensible	kW	117.652	143.252	233.195	
Capacity latent	kW	0.000	---	27.710	
Capacity frost	kW	---	---	0.000	
Capacity total	kW	117.652	143.252	260.905	
Surface reserve	%	0.183		0.067	
Present surface	m2	3795.681		3795.681	

RA-Hy (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp. (26.000)	°C	19.356	28.276	20.000
Rel. humidity (54.175)	%	100.000	58.552	40.000
Abs. humidity (11.500)	g/kg	14.261	14.261	5.858
Volume flow humid	m3/h	39455.236	40658.384	39020.000
Velocity	m/s	1.820	1.876	1.800
Pressure drop (dry 126 Pa)	Pa		126.312	

SA-Co (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	32.000	16.000	20.000
Rel. humidity	%	40.000	97.883	40.000
Abs. humidity	g/kg	12.014	11.250	5.858
Volume flow humid	m3/h	45566.689	43125.589	43350.000
Velocity	m/s	2.102	1.989	2.000
Pressure drop (dry 150 Pa)	Pa		155.716	

25 V% Et.glycol		RA-Hy	Pt	SA-Co
Temp. in	°C	28.746	21.607	12.894
Temp. out	°C	21.607	12.894	28.746
Volume flow	m3/h	15.300	15.282	15.300
Velocity	m/s	1.087		1.087
Reynolds	---	7911.132		7136.224
Pressure drop	kPa	218.428		223.865



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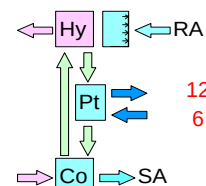
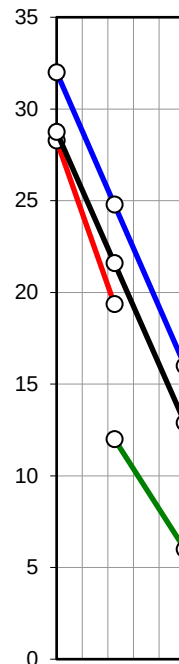
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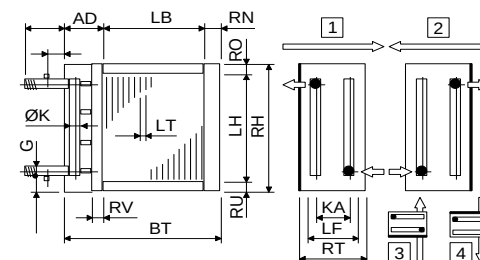
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Plant
Object
Position



Software by www.zcs.ch

Technical data		RA-Hy	SA-Co	RA-Hy	SA-Co
Tubes total	Piece	1200	1200	Tubes:	Cu
Tubes blank	Piece	16	16	Tubes:	smooth
Int. vent./drains	Piece	11	11	Tubes:	in line
Tube rows on the depth	Piece	24	24	Tubes:	circular
Tube rows on the height	Piece	50	50	Collectors:	Cu
Tube coupling in series	Piece	32	32	Collectors:	1.04 m/s
Number of circuits (NC)	Piece	37	37	Connections:	Rg7
Volume	l	466	466	Connections:	1.04 m/s
Weight	kg	1739	1739	Fins:	Al
Connections	G	2 1/2"	2 1/2"	Fins:	smooth
Frame height	RH	mm	1830	Frame:	AISI 304
Frame width	BT	mm	3660	Air flow direction:	horizontal
Frame depth	RT	mm	950	Protection:	without
Finned height	LH	mm	1750	Protection:	---
Finned width	LB	mm	3441		
Finned depth	LF	mm	840		
Frame on top	RO	mm	40		
Frame on bottom	RU	mm	40		
Frame in front	RV	mm	30		
Frame on back (~53/53mm)	RN	mm	53		
Collector-Diameter	K	mm	76		
Collector covering	AD	mm	166		
Collector distance	KA	mm	844		
Fin spacing	LT	mm	2.500		
Fin thickness	LD	mm	0.200		
Tube diameter	DA	mm	12.400		
Tube diameter	da	mm	12.400		
Tube thickness	S	mm	0.400		
Tube interval on the height	S1	mm	35.000		
Tube interval on the depth	S2	mm	35.000		



Delivery: 5-6 weeks
Validity: 12 weeks
Condit.: net, prepaid address
Payment: 30 days net

RA-Hy: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304
SA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

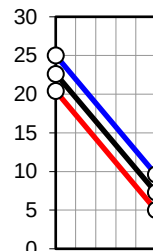
RA-Hy: EUR 23126.00
SA-Co: EUR 23126.00

CC-System (DIN EN 308)		SA-He	RA-Co	Definition
Height over sea level	m			106.000
Pressure	hPa			1000.564
Efficiency	%	77.000	76.988	
Capacity sensible	kW	219.816	219.817	
Capacity latent	kW	---	---	
Capacity frost	kW	---	---	
Capacity total	kW	219.816	219.817	
Surface reserve	%	0.144	0.130	
Present surface	m2	3795.681	3795.681	

SA-He (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	5.000	20.400	20.000
Rel. humidity	%	0.000	0.000	40.000
Abs. humidity	g/kg	0.000	0.000	5.858
Volume flow humid	m3/h	40748.301	43004.283	43350.000
Velocity	m/s	1.880	1.984	2.000
Pressure drop	Pa		136.010	

RA-Co (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Temp.	°C	25.000	9.602	20.000
Rel. humidity	%	0.000	0.000	40.000
Abs. humidity	g/kg	0.000	0.000	5.858
Volume flow humid	m3/h	43678.148	41422.524	43350.000
Velocity	m/s	2.015	1.911	2.000
Pressure drop (dry 139 Pa)	Pa		139.042	

25 V% Et.glycol		SA-He	RA-Co	
Temp.	in °C	22.621	7.289	
Temp.	out °C	7.289	22.621	
Volume flow	m3/h	13.354	13.355	
Velocity	m/s	0.949	0.949	
Reynolds	---	5316.927	5311.835	
Pressure drop	kPa	182.597	182.643	



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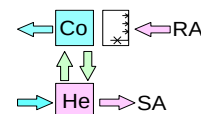
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Plant

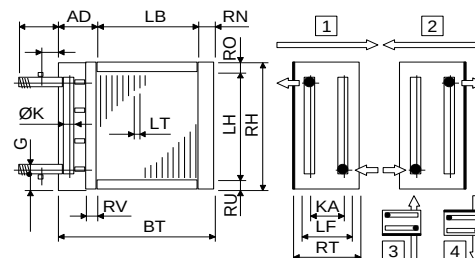
Object

Position



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Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	1200	1200	Tubes:	Cu
Tubes blank	Piece	16	16	Tubes:	smooth
Int. vent./drains	Piece	11	11	Tubes:	in line
Tube rows on the depth	Piece	24	24	Tubes:	circular
Tube rows on the height	Piece	50	50	Collectors:	Cu
Tube coupling in series	Piece	32	32	Collectors:	0.91 m/s
Number of circuits (NC)	Piece	37	37	Connections:	Rg7
Volume	l	466	466	Connections:	0.91 m/s
Weight	kg	1739	1739	Fin:	Al
Connections	G	2 1/2"	2 1/2"	Fin:	smooth
Frame height	RH mm	1830	1830	Frame:	AISI 304
Frame width	BT mm	3660	3660	Air flow direction:	horizontal
Frame depth	RT mm	950	950	Protection:	without
Finned height	LH mm	1750	1750	Protection:	---
Finned width	LB mm	3441	3441		
Finned depth	LF mm	840	840		
Frame on top	RO mm	40	40		
Frame on bottom	RU mm	40	40		
Frame in front	RV mm	30	30		
Frame on back (~53/53mm)	RN mm	53	53		
Collector-Diameter	K mm	76	76		
Collector covering	AD mm	166	166		
Collector distance	KA mm	844	844		
Fin spacing	LT mm	2.500	2.500		
Fin thickness	LD mm	0.200	0.200		
Tube diameter	DA mm	12.400	12.400		
Tube diameter	da mm	12.400	12.400		
Tube thickness	S mm	0.400	0.400		
Tube interval on the height	S1 mm	35.000	35.000		
Tube interval on the depth	S2 mm	35.000	35.000		



Delivery: 5-6 weeks
Validity: 12 weeks
Condit.: net, prepaid address
Payment: 30 days net

SA-He: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

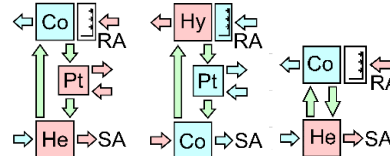
SA-He: EUR 23126.00

RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304

RA-Co: EUR 23126.00

Economy with CC-System

Base value	Definition	
Height over sea level	m	106.000
Pressure	bar	1.001
Volume flow humid at	°C	20.000
Volume flow humid at	%	40.000



CC-System		Winter	Summer	DIN EN 308
Efficiency: Supply air	%	63.398	45.094	77.000
Capacity	kW	326.445	117.652	219.816
Surface reserve	%	0.100	0.067	0.144
Present surface	m2	3795.681	3795.681	3795.681

Supply air		Winter	Summer	DIN EN 308
Temp. in	°C	-12.000	32.000	5.000
Temp. out	°C	24.000	16.000	20.400
Volume flow humid	m3/h	43350.000	43350.000	43350.000
Pressure drop	Pa	131.968	155.716	136.010
Fan efficiency	---	0.700	0.700	0.700
Fan power	kW	2.270	2.679	2.340

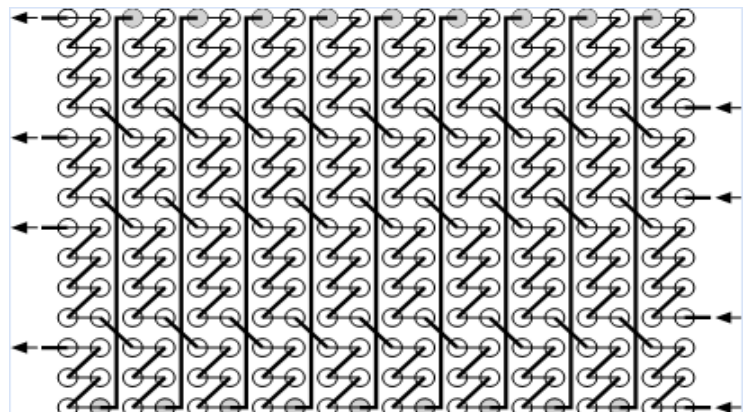
Return air		Winter	Summer	DIN EN 308
Temp. in	°C	-12.000	19.356	25.000
Temp. out	°C	90.000	28.276	9.602
Volume flow humid	m3/h	39020.000	39020.000	43350.000
Pressure drop	Pa	135.213	126.312	139.042
Fan efficiency	---	0.700	0.700	0.700
Fan power	kW	2.094	1.956	2.392

25 V% Et.glycol		Winter	Summer	DIN EN 308
Volume flow	m3/h	13.340	15.300	13.354
Pressure drop Supply air	bar	1.865	2.239	1.826
Pressure drop Return air	bar	1.971	2.184	1.826
Pressure drop Hydraulics	bar	2.000	2.000	2.000
Pressure drop Total	bar	5.837	6.423	5.652
Pump efficiency	---	0.800	0.800	0.800
Pump power	kW	2.704	3.412	2.621

Economy		Winter	Summer	DIN EN 308
Gross useful ratio with CC-System	kW	326.445	117.652	219.816
Need of energy with CC-System	kW	7.067	8.047	7.353
Net useful ratio with CC-System	kW	319.377	109.606	212.464
Coefficient of performance (COP)	---	46.190	14.621	29.897

Economy		Winter	Summer	DIN EN 308
Volume flow humid Total	m3/h	82370.000	82370.000	86700.000
Need of energy with CC-System	kW	7.067	8.047	7.353
Specific Recovery Power (SRP)	W/(m3/s)	308.882	351.683	305.295

Adiabatic return air cooling



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$$E = \frac{B * C}{D * 3600 * 1000}$$

$$I = \frac{F * G}{H * 3600 * 1000}$$

$$N = K + L + M$$

$$P = \frac{J * N * 100000}{O * 3600 * 1000}$$

$$Q = E + I + P$$

$$R = A - Q$$

$$S = \frac{A}{Q}$$

$$T = B + F$$

$$U = \frac{Q * 3600 * 1000}{T}$$



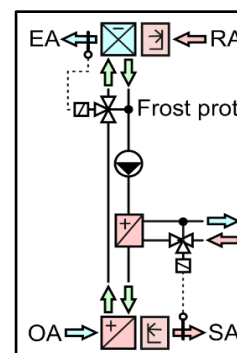
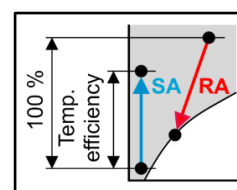
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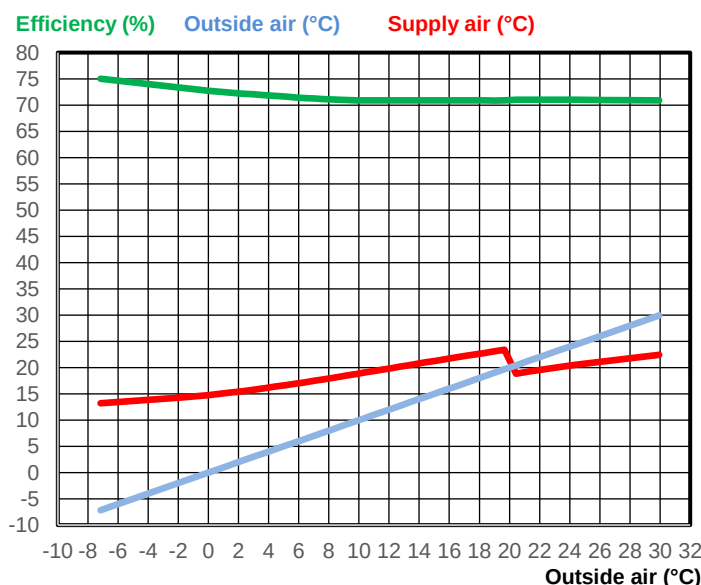
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Object
Position



No	Outside air		Supply air		Return air		Exhaust air		Efficiency	Capacity	Energy
	°C	%	°C	%	°C	%	°C	%	%	kW	MWh
1	-7.2	83.3	13.2	18.2	20.0	40.0	1.6	99.6	75.017	291.661	63.874
2	-1.7	82.3	14.3	26.8	20.2	40.4	4.7	95.2	73.259	229.800	50.326
3	0.0	81.2	14.8	29.6	20.3	40.7	5.7	93.9	72.747	212.081	46.446
4	1.2	77.2	15.2	30.0	20.5	41.1	6.5	92.8	72.430	199.876	43.773
5	2.2	77.0	15.5	31.5	20.6	41.4	7.1	91.9	72.200	190.621	41.746
6	3.0	76.5	15.8	32.4	20.8	41.8	7.7	91.3	72.039	183.657	40.221
7	3.8	75.7	16.1	33.2	20.9	42.2	8.2	90.7	71.881	177.104	38.786
8	4.4	77.4	16.4	35.0	21.1	42.5	8.6	90.3	71.745	171.614	37.583
9	5.1	76.7	16.7	35.7	21.2	42.9	9.1	89.7	71.607	166.123	36.381
10	5.8	75.7	16.9	36.3	21.4	43.2	9.6	89.1	71.466	160.212	35.086
11	6.4	77.8	17.2	38.2	21.5	43.6	10.0	88.7	71.354	155.376	34.027
12	7.0	77.3	17.5	38.9	21.7	43.9	10.5	88.2	71.248	150.618	32.985
13	7.6	78.5	17.7	40.5	21.8	44.3	10.9	87.6	71.136	145.893	31.951
14	8.1	76.5	18.0	40.2	22.0	44.7	11.3	87.2	71.079	142.008	31.100
15	8.7	74.8	18.2	40.1	22.2	45.0	11.7	86.7	71.021	138.189	30.263
16	9.2	76.1	18.5	41.8	22.3	45.4	12.1	86.0	70.941	133.601	29.259
17	9.8	74.7	18.8	41.9	22.5	45.7	12.6	85.2	70.900	129.319	28.321
18	10.4	74.4	19.1	42.6	22.6	46.1	13.0	84.3	70.884	125.156	27.409
19	10.9	73.0	19.3	42.7	22.8	46.5	13.5	83.1	70.889	120.945	26.487
20	11.6	73.2	19.6	43.8	22.9	46.8	14.0	81.6	70.882	116.009	25.406
21	12.1	73.5	19.9	44.8	23.1	47.2	14.5	80.6	70.876	111.951	24.517
22	12.7	71.0	20.2	44.1	23.2	47.5	15.0	79.5	70.889	108.000	23.652
23	13.3	72.7	20.4	46.2	23.4	47.9	15.4	78.4	70.871	103.706	22.712
24	13.9	69.4	20.7	45.1	23.5	48.3	16.0	77.2	70.889	99.091	21.701
25	14.5	69.5	21.0	46.1	23.7	48.6	16.4	76.1	70.882	94.686	20.736
26	15.1	69.7	21.3	47.2	23.8	49.0	17.0	74.8	70.873	89.933	19.695
27	15.7	69.4	21.6	48.0	24.0	49.3	17.5	73.6	70.868	85.168	18.652
28	16.3	67.2	21.9	47.5	24.2	49.7	18.0	72.5	70.879	80.620	17.656
29	17.0	64.3	22.2	46.5	24.3	50.1	18.5	71.2	70.895	75.410	16.515
30	17.7	62.2	22.5	46.2	24.5	50.4	19.1	69.8	70.904	69.754	15.276
31	18.4	62.6	22.8	47.7	24.6	50.8	19.7	68.3	70.888	64.040	14.025
32	19.0	64.6	23.1	50.3	24.8	51.1	20.2	67.3	70.857	59.338	12.995
33	19.7	61.6	23.4	49.1	24.9	51.5	20.8	66.1	70.876	53.991	11.824
34	20.4	57.7	18.9	63.6	18.2	100.0	19.9	89.7	71.048	22.892	5.013
35	21.3	58.5	19.2	66.5	18.4	100.0	20.7	86.8	71.018	30.087	6.589
36	22.2	57.2	19.6	67.0	18.6	100.0	21.4	83.9	71.012	37.439	8.199
37	23.2	54.3	20.0	65.8	18.8	100.0	22.2	80.8	71.022	45.749	10.019
38	24.4	52.3	20.5	66.2	19.0	100.0	23.2	77.0	71.014	56.317	12.333
39	26.2	50.2	21.2	67.7	19.1	100.0	24.7	71.5	70.986	72.703	15.922
40	29.9	46.8	22.4	72.9	19.3	100.0	27.7	60.6	70.886	109.887	24.065

Energy recovery: Heat energy	MWh/a	971.39	EUR/a	58283.00	(60.00 EUR/MWh)
Energy recovery: Cold energy	MWh/a	82.14	EUR/a	6571.00	(80.00 EUR/MWh)
2 Fan + Glycol pump	MWh/a	-62.09	EUR/a	-6209.00	(100.00 EUR/MWh)
Energy recovery: Net useful ratio	MWh/a	991.44	EUR/a	58645.00	(59.15 EUR/MWh)

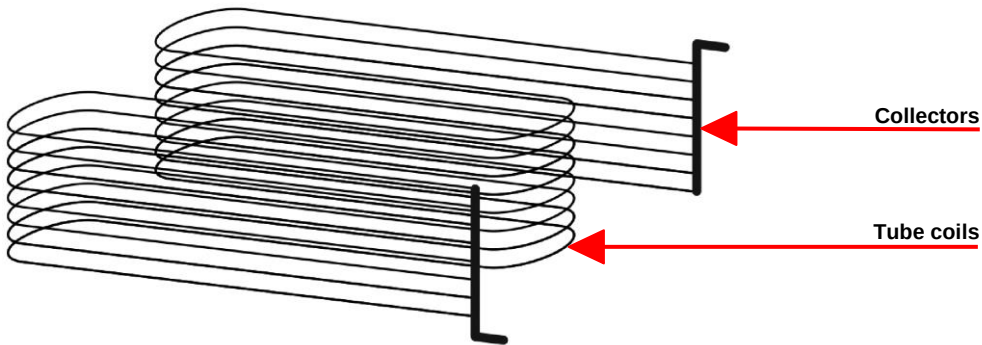


Station Frankfurt am Main
Height over sea level 106.00 m
Pressure 1000.56 hPa
Outside air 43350.00 m3/h
Return air 39020.00 m3/h
Adiabatic return air cooling 1533.00 Hours

Remarks: The temperatures of the outside air were sorted in ascending order and summarized in 40 groups of 219 pieces each. The exhaust air was set to 20°C for the lowest outside air temperature and 26°C for the highest outside air temperature, which corresponds to the comfort range. The exhaust air in summer was pre-cooled adiabatically, which is why the cold recovery is better. Recommendation: Use our software EAC or DEH, which takes different operating times, different air volumes and much more into account.

Optimal pressure drop distribution on the tube coils and the collectors

With the optimal pressure drop distribution on the tube coils and the collectors, it is important that all tube coils receive the same amount of liquid. This is the only way to achieve optimum performance of the heat exchanger. This can only be achieved if the pressure drop in the tube coils is significantly higher than in the collectors. So it's about the pressure ratio (T/C), see below.

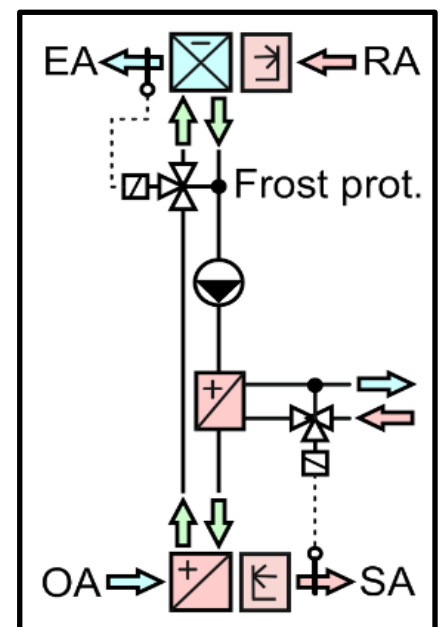
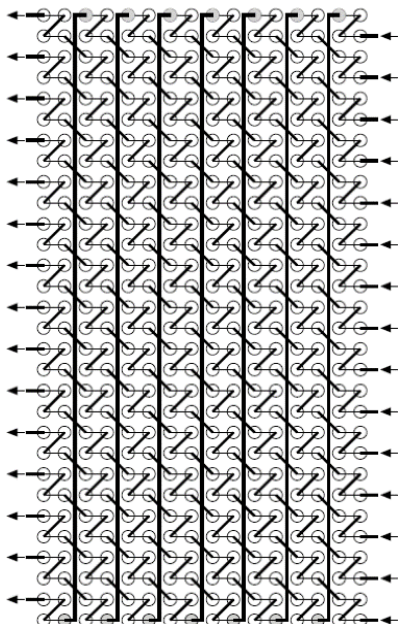


Typical applications			Heater	Cooler	CC-System
Pressure drop total	---	kPa	10.000	40.000	200.000
Coil pressure drop	T	kPa	6.500	33.000	193.000
Pressure drop collectors	C	kPa	3.500	7.000	7.000
Pressure ratio	T/C	---	1.857	4.714	27.571

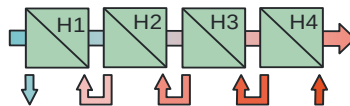
So if you really want to worry about optimal liquid distribution, turn to the air heater and air cooler, but certainly not to the heat exchangers in heat recovery! And yet there are absolute idiots who have applied for patents on an injection for heat recovery, i.e. exactly where it is totally superfluous.

An optimal CC-System must therefore have a pressure drop of 2 bar per heat exchanger in order to achieve maximum performance. In addition, there is the hydraulic system with a further 2 bar pressure drop. In total, a pressure drop of 6 bar is up for debate, which is not a problem when choosing the right pump. Idiots choose centrifugal pumps with a non-linear characteristic. Those familiar with the subject choose gear pumps from www.maag.com with absolutely linear characteristics. This means, for example, that when the speed is reduced to 50 %, the flow rate is exactly 50 %, so regulation is very easy.

www.maag.com



Definition		
Height over sea level	m	106.000
Pressure	hPa	1000.564
Temp.	°C	20.000
Rel. humidity	%	40.000
Air humid	m3/h	43350.000
25 V% Et.glycol	m3/h	13.340



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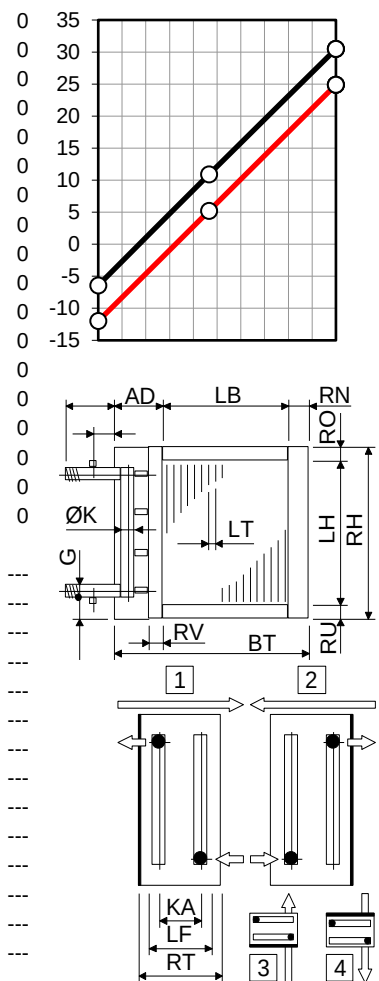
Air humid		Heater 1	Heater 2	Heater 3	Heater 4
Temp. Inlet	°C	-12.000	5.200	24.900	24.900
Rel. humidity Inlet	%	90.000	21.899	6.176	6.176
Temp. Outlet	°C	5.200	24.900	24.900	24.900
Rel. humidity Outlet	%	21.899	6.176	6.176	6.176
Pressure drop (100.46 %)	Pa	63.272	69.300	0.000	0.000

25 V% Et.glycol		Heater 1	Heater 2	Heater 3	Heater 4
Temp. Inlet	°C	10.895	30.476	30.476	30.476
Temp. Outlet	°C	-6.413	10.895	30.476	30.476
Pressure drop (103.03 %)	kPa	102.339	89.852	0.000	0.000

Heat exchanger		Heater 1	Heater 2	Heater 3	Heater 4
Capacity	kW	245.953	281.840	0.000	0.000
Surface reserve	%	0.045	0.459	0.000	0.000
Present surface	m2	1897.840	1897.840	0.000	0.000
Required surface	m2	1896.988	1889.177	0.000	0.000
k-coeff.	W/m2K	23.941	27.914	0.000	0.000
Average temp. diff.	K	5.416	5.345	0.000	0.000

Tubes blank	Piece	8	8	0
Int. vent./drains	Piece	5	5	0
Tube rows on the depth	Piece	12	12	0
Tube rows on the height	Piece	50	50	0
Number of circuits (NC)	Piece	37	37	0
Volume	l	241	241	0
Weight	kg	825	825	0
Connections	G	2 ½"	2 ½"	0
Frame height	RH	1830	1830	0
Frame width	BT	3660	3660	0
Frame depth	RT	530	530	0
Finned height	LH	1750	1750	0
Finned width	LB	3441	3441	0
Frame on top	RO	40	40	0
Frame on bottom	RU	40	40	0
Frame in front	RV	30	30	0
Frame on back (~53/53/0/0)	RN	53	53	0
Collector covering	AD	166	166	0

Tubes	Type	circular	circular	---
Tubes	DA / da	12.40 / 12.40	12.40 / 12.40	---
Tubes	S1 / S2	35.00 / 35.00	35.00 / 35.00	---
Tubes	---	in line	in line	---
Tubes	---	Cu	Cu	---
Tubes	---	smooth	smooth	---
Collector	---	Cu	Cu	---
Connections	---	Rg7	Rg7	---
Fins	LT / LD	2.50 / 0.20	2.50 / 0.20	---
Fins	---	Al	Al	---
Fins	---	smooth	smooth	---
Frame	---	AlMg3	AlMg3	---
Protection	---	without	without	---
Protection	---	---	---	---
Air flow direction	---	horizontal	horizontal	---



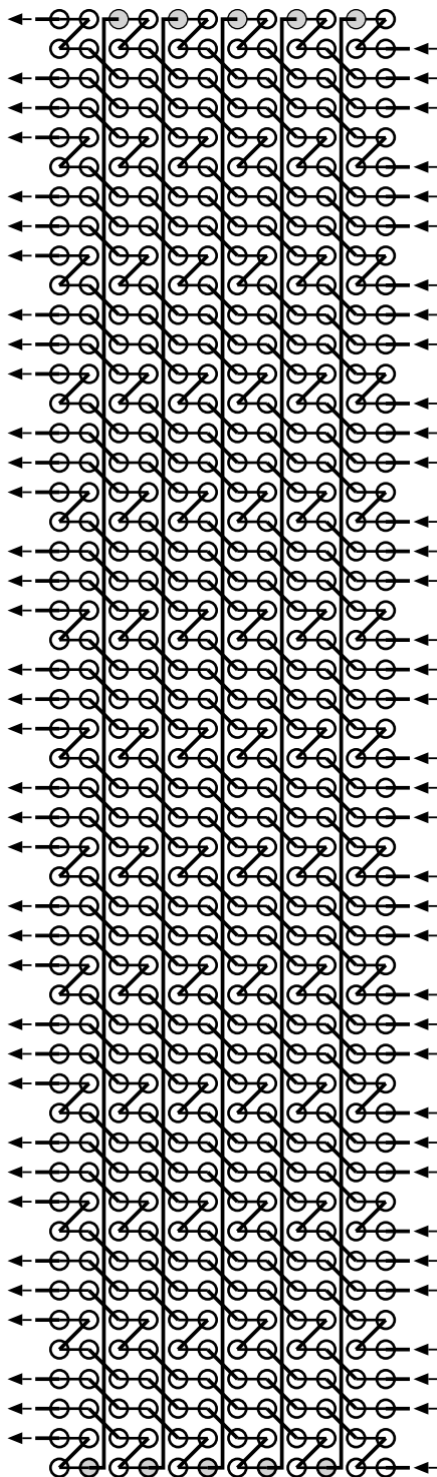
Heater 1: 35/35/12-12R-50T-3441A-2.5PA-37C-Cu/Al/AlMg3	EUR	11614.00	Delivery:	5-6 weeks
Heater 2: 35/35/12-12R-50T-3441A-2.5PA-37C-Cu/Al/AlMg3	EUR	11614.00	Validity:	12 weeks
Heater 3: ---	EUR	0.00	Condit.:	net, prepaid address
Heater 4: ---	EUR	0.00	Payment:	30 days net
Total	EUR	23228.00		



Energy recovery with the leader CCSD

Internal hydraulic circuit of the finned heat exchangers with internal vents and drains and with a maximum percentage of cross-counterflow, generated with the CCSX software from www.zcs.ch.

Supply air: 2 x 12 tube rows



Return air 1 x 24 tube rows

