

Supply air	m3/h	°C	%	RH (mm)	BT (mm)	LH (mm)	LB (mm)	m/s
Heater 1	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003
Heater 2	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003
Heater 3	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003
Heater 4	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003
Heater 5	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003
Heater 6	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003
Heater 7	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003
Heater 8	10000.000	-11.000	90.000	910.000	1830.000	840.000	1651.000	2.003

Total	80000.000	-11.000	90.000	6800.000	1901.000	6720.000	1651.000	2.003
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Return air	m3/h	°C	%	RH (mm)	BT (mm)	LH (mm)	LB (mm)	m/s
Cooler 1	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 2	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 3	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 4	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 5	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 6	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 7	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 8	10000.000	20.000	40.000	910.000	1830.000	840.000	1651.000	2.003

Total	80000.000	20.000	40.000	6800.000	1901.000	6720.000	1651.000	2.003
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Company
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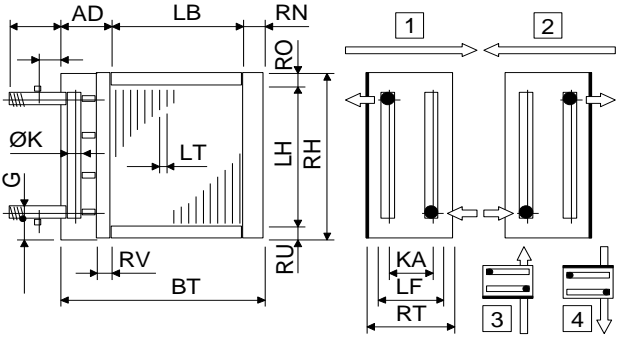
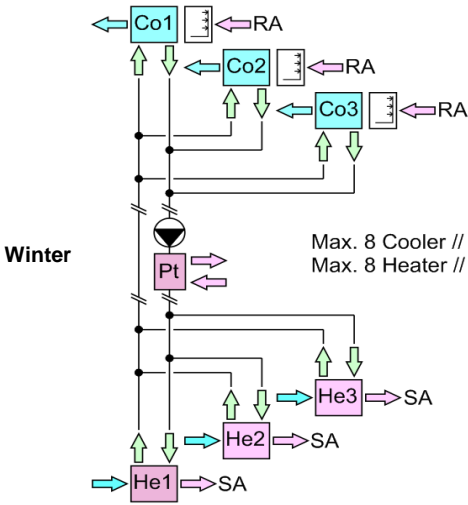
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Plant
Object
Position

Software by www.zcs.ch



CC-System in winter		SA-He tandard plate-HE		RA-Co	Definition
Height over sea level	m				0.000
Pressure	hPa				1013.250
Capacity	%	100.000	44.543	55.457	
Capacity	kW	935.848	416.852	518.996	
Surface reserve	%	0.211		0.074	
Present surface	m2	4662.212		4662.212	



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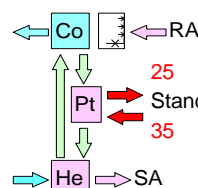
Plant

Object

Position

SA-He	Inlet	Outlet	Definition
Temp.	°C	-11.000	24.000
Rel. humidity	%	90.000	7.134
Volume flow humid	m3/h	71030.381	80513.381
Velocity	m/s	1.778	2.016
Pressure drop	Pa		89.247

RA-Co	Inlet	Outlet	Definition
Temp.	°C	20.000	3.340
Rel. humidity	%	40.000	98.373
Volume flow humid	m3/h	80000.000	75327.388
Velocity	m/s	2.003	1.886
Pressure drop (dry 96 Pa)	Pa		100.583

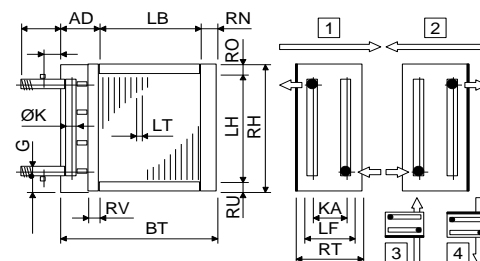


25
Standard plate-HE
35

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25 V% Et.glycol	SA-He tandard plate-HE	RA-Co
Temp. in	°C	32.000
Temp. out	°C	-3.700
Volume flow	m3/h	24.426
Velocity	m/s	1.052
Pressure drop	kPa	180.684

Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	3072	3072	Tubes:	Cu
Tubes blank	Piece	22	22	Tubes:	smooth
Int. vent./drains	Piece	7	7	Tubes:	in line
Tube rows on the depth	Piece	16	16	Tubes:	circular
Tube rows on the height	Piece	192	192	Collectors:	Cu
Tube coupling in series	Piece	50	50	Connections:	Rg7
Number of circuits (NC)	Piece	61	61	Fins:	Al
Volume	l	685	685	Fins:	smooth
Weight	kg	2106	2106	Frame:	AlMg3
Connections	G	---	4"	Protection:	without
Frame height	RH	mm	6800	Protection:	---
Frame width	BT	mm	1901	Air flow direction:	horizontal
Frame depth	RT	mm	730		
Finned height	LH	mm	6720		
Finned width	LB	mm	1651		
Finned depth	LF	mm	560		
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	108		
Collector covering	AD	mm	197		
Collector distance	KA	mm	596		
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

SA-He: 35/35/12-16R-192T-1651A-2.5PA-61C-Cu/Al/AlMg3
RA-Co: 35/35/12-16R-192T-1651A-2.5PA-61C-Cu/Al/AlMg3

SA-He: EUR 31946.00
RA-Co: EUR 31946.00

Supply air	m3/h	°C	%	RH (mm)	BT (mm)	LH (mm)	LB (mm)	m/s
Cooler 1	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 2	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 3	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 4	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 5	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 6	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 7	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003
Cooler 8	10000.000	32.000	40.000	910.000	1830.000	840.000	1651.000	2.003

Total	80000.000	32.000	40.000	6800.000	1901.000	6720.000	1651.000	2.003
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Return air	m3/h	°C	%	RH (mm)	BT (mm)	LH (mm)	LB (mm)	m/s
Heater 1	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003
Heater 2	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003
Heater 3	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003
Heater 4	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003
Heater 5	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003
Heater 6	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003
Heater 7	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003
Heater 8	10000.000	26.000	55.000	910.000	1830.000	840.000	1651.000	2.003

Total	80000.000	26.000	55.000	6800.000	1901.000	6720.000	1651.000	2.003
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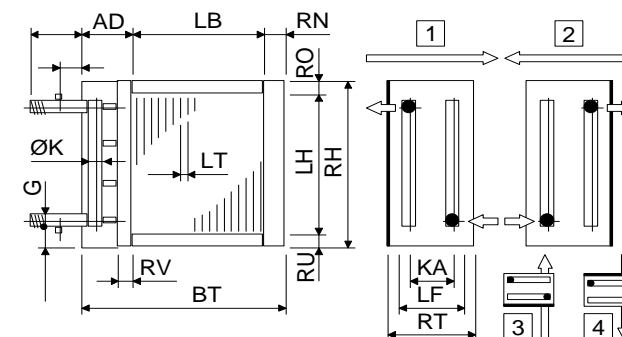
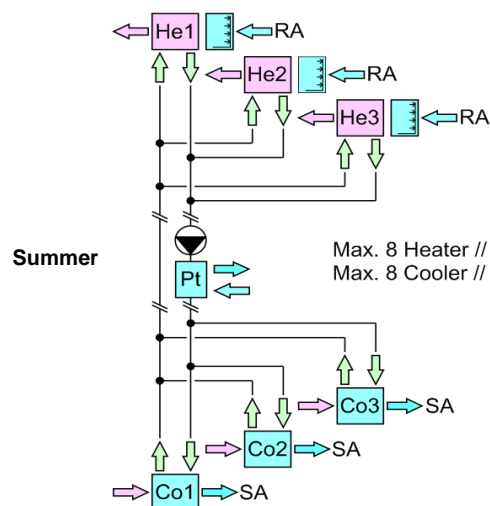
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Plant
Object
Position

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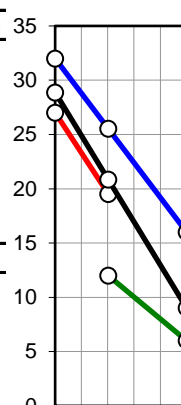


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RA-Hy		Inlet	Outlet	Definition
Temp. (26.000)	°C	19.518	27.019	20.000
Rel. humidity (55.000)	%	100.000	63.639	40.000
Volume flow humid	m³/h	80941.692	83016.136	80000.000
Velocity	m/s	2.027	2.078	2.003
Pressure drop (dry 99 Pa)	Pa		99.337	
Moistening temperature	°C	15.000		

SA-Co		Inlet	Outlet	Definition
Temp.	°C	32.000	16.000	20.000
Rel. humidity	%	40.000	95.121	40.000
Volume flow humid	m3/h	84080.362	79537.168	80000.000
Velocity	m/s	2.105	1.991	2.003
Pressure drop (drv 102 Pa)	Pa		107.247	



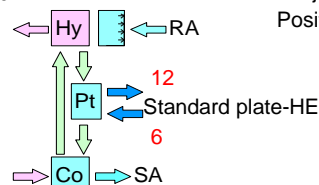
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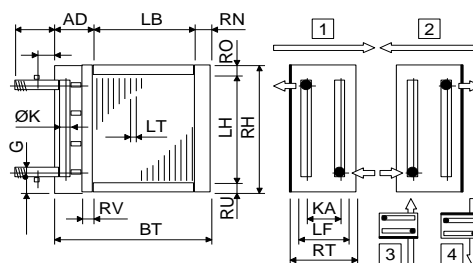
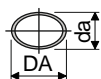
Plant
Object
Position

25 V% Et.glycol		RA-Hy tandard plate-HE		SA-Co
Temp. in	°C	28.875	20.860	9.006
Temp. out	°C	20.860	9.006	28.875
Volume flow	m3/h	23.795	23.795	23.841
Velocity	m/s	1.025		1.027
Pressure drop	kPa	162.028		173.737



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Technical data			RA-Hy	SA-Co	RA-Hy			SA-Co
Tubes total		Piece	3072	3072	Tubes:	Cu	Cu	
Tubes blank		Piece	22	22	Tubes:	smooth	smooth	
Int. vent./drains		Piece	7	7	Tubes:	in line	in line	
Tube rows on the depth		Piece	16	16	Tubes:	circular	circular	
Tube rows on the height		Piece	192	192	Collectors:	Cu	Cu	
Tube coupling in series		Piece	50	50	Connections:	Rg7	Rg7	
Number of circuits (NC)		Piece	61	61	Fins:	Al	Al	
Volume		l	685	685	Fins:	smooth	smooth	
Weight		kg	2106	2106	Frame:	AlMg3	AlMg3	
Connections	G	---	4"	4"	Protection:	without	without	
Frame height	RH	mm	6800	6800	Protection:	---	---	
Frame width	BT	mm	1901	1901	Air flow direction:	horizontal	horizontal	
Frame depth	RT	mm	730	730				
Finned height	LH	mm	6720	6720				
Finned width	LB	mm	1651	1651				
Finned depth	LF	mm	560	560				
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	108	108				
Collector covering	AD	mm	197	197				
Collector distance	KA	mm	596	596				
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	Delivery:		5-6 weeks	
Tube interval on the depth	S2	mm	35.000	35.000	Validity:		12 weeks	
					Condit.:	net, prepaid address		
					Payment:		30 days net	



RA-Hy: 35/35/12-16R-192T-1651A-2.5PA-61C-Cu/Al/AlMg₃
SA-Co: 35/35/12-16R-192T-1651A-2.5PA-61C-Cu/Al/AlMg₃

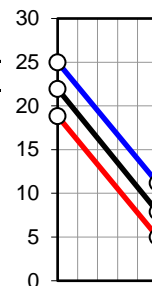
RA-Hy:	EUR	31946.00
SA-Co:	EUR	31946.00

CC-System (DIN EN 308)		SA-He	RA-Co	Definition
Height over sea level	m			0.000
Pressure	hPa			1013.250
Efficiency	%	69.155	69.140	
Capacity	kW	368.982	368.981	
Surface reserve	%	0.086	0.094	
Present surface	m2	4662.212	4662.212	

SA-He		Inlet	Outlet	Definition
Temp.	°C	5.000	18.831	20.000
Rel. humidity	%	0.000	0.000	40.000
Volume flow humid	m3/h	75207.575	78947.134	80000.000
Velocity	m/s	1.883	1.977	2.003
Pressure drop	Pa		91.379	

RA-Co		Inlet	Outlet	Definition
Temp.	°C	25.000	11.172	20.000
Rel. humidity	%	0.000	0.000	40.000
Volume flow humid	m3/h	80615.079	76876.328	80000.000
Velocity	m/s	2.018	1.925	2.003
Pressure drop (dry 94 Pa)	Pa		94.113	

25 V% Et.glycol		SA-He	RA-Co
Temp.	in °C	21.942	7.874
Temp.	out °C	7.874	21.942
Volume flow	m3/h	24.432	24.467
Velocity	m/s	1.053	1.054
Pressure drop	kPa	179.916	184.868



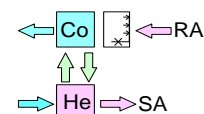
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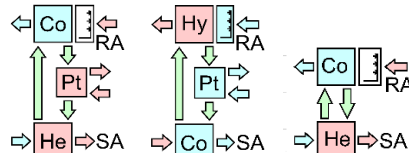
Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	3072	3072	Tubes:	Cu Cu
Tubes blank	Piece	22	22	Tubes:	smooth smooth
Int. vent./drains	Piece	7	7	Tubes:	in line in line
Tube rows on the depth	Piece	16	16	Tubes:	circular circular
Tube rows on the height	Piece	192	192	Collectors:	Cu Cu
Tube coupling in series	Piece	50	50	Connections:	Rg7 Rg7
Number of circuits (NC)	Piece	61	61	Fins:	Al Al
Volume	l	685	685	Fins:	smooth smooth
Weight	kg	2106	2106	Frame:	AlMg3 AlMg3
Connections	G ---	4"	4"	Protection:	without without
Frame height	RH mm	6800	6800	Protection:	---
Frame width	BT mm	1901	1901	Air flow direction:	
Frame depth	RT mm	730	730		
Finned height	LH mm	6720	6720		
Finned width	LB mm	1651	1651		
Finned depth	LF mm	560	560		
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	108	108		
Collector covering	AD mm	197	197		
Collector distance	KA mm	596	596		
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		

SA-He: 35/35/12-16R-192T-1651A-2.5PA-61C-Cu/Al/AlMg3
RA-Co: 35/35/12-16R-192T-1651A-2.5PA-61C-Cu/Al/AlMg3

SA-He: EUR 31946.00
RA-Co: EUR 31946.00

Economy with CC-System

Base value	Definition	
Height over sea level	m	0.000
Pressure	bar	1.013
Volume flow humid at	°C	20.000
Volume flow humid at	%	40.000



CC-System		Winter	Summer	DIN EN 308	
Efficiency Supply air	%	---	---	69.155	
Capacity	kW	935.848	508.244	368.982	A
Surface reserve	%	0.211	0.328	0.086	
Present surface	m2	4662.212	4662.212	4662.212	

Supply air		Winter	Summer	DIN EN 308	
Temp. in	°C	-11.000	32.000	5.000	
Temp. out	°C	24.000	16.000	18.831	
Volume flow humid	m3/h	80000.000	80000.000	80000.000	B
Pressure drop	Pa	89.247	107.247	91.379	C
Fan efficiency	---	0.700	0.700	0.700	D
Fan power	kW	2.833	3.405	2.901	E

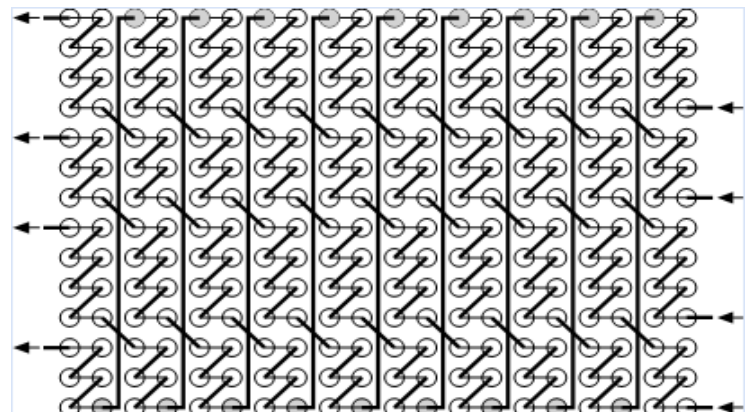
Return air		Winter	Summer	DIN EN 308	
Temp. in	°C	-11.000	19.518	25.000	
Temp. out	°C	90.000	27.019	11.172	
Volume flow humid	m3/h	80000.000	80000.000	80000.000	F
Pressure drop	Pa	100.583	99.337	94.113	G
Fan efficiency	---	0.700	0.700	0.700	H
Fan power	kW	3.193	3.154	2.988	I

25 V% Et.glycol		Winter	Summer	DIN EN 308	
Volume flow	m3/h	24.426	23.841	24.432	J
Pressure drop Supply air	bar	1.807	1.737	1.799	K
Pressure drop Return air	bar	1.999	1.620	1.849	L
Pressure drop Hydraulics	bar	2.000	2.000	2.000	M
Pressure drop Total	bar	5.806	5.358	5.648	N
Pump efficiency	---	0.800	0.800	0.800	O
Pump power	kW	4.924	4.435	4.791	P

Economy		Winter	Summer	DIN EN 308	
Gross useful ratio with CC-System	kW	---	---	368.982	
Need of energy with CC-System	kW	10.950	10.993	10.680	A
Net useful ratio with CC-System	kW	---	---	358.302	Q
Coefficient of performance (COP)	---	---	---	34.549	R

Economy		Winter	Summer	DIN EN 308	
Volume flow humid Total	m3/h	160000.000	160000.000	160000.000	T
Need of energy with CC-System	kW	10.950	10.993	10.680	Q
Specific Recovery Power (SRP)	Ws/m3	246.382	247.351	240.296	U

Adiabatic return air cooling



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

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

$$N = K + L + M$$

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

$$Q = E + I + P$$

$$R = A - Q$$

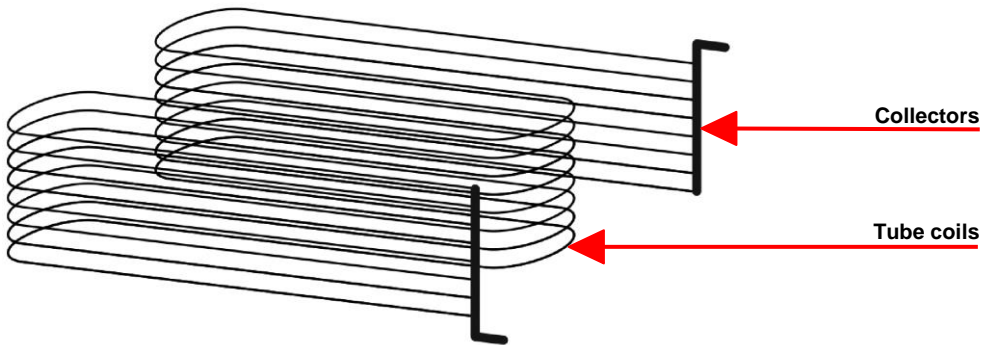
$$S = \frac{A}{Q}$$

$$T = B + F$$

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

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.

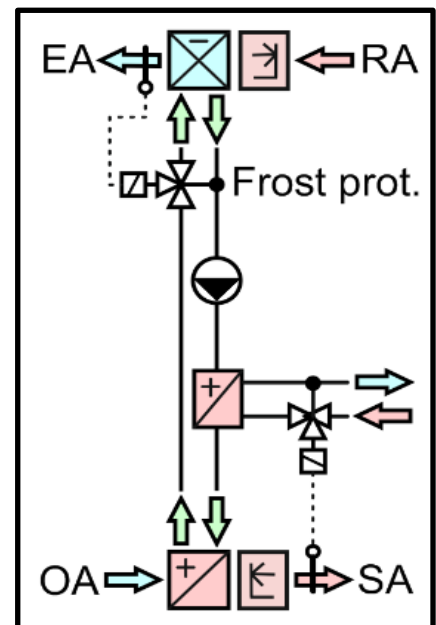
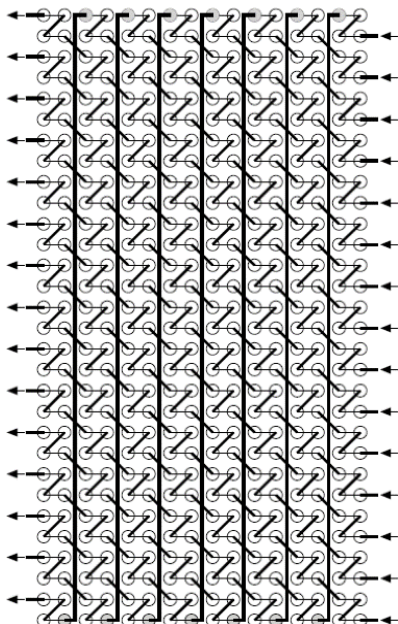


Typical applications			Heater	Cooler	CC-System
Pressure drop total	---	kPa	10.000	40.000	200.000
Coil pressure drop	T	kPa	6.500	33.000	193.000
Pressure drop collectors	C	kPa	3.500	7.000	7.000
Pressure ratio	T/C	---	1.857	4.714	27.571

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



Supply air	Capacity kW	Inlet °C	Outlet °C	Volume flow m3/h	Pressure drop kPa
Heater 1	116.981	32.000	-3.700	3.053	161.119
Heater 2	116.981	32.000	-3.700	3.053	161.119
Heater 3	116.981	32.000	-3.700	3.053	161.119
Heater 4	116.981	32.000	-3.700	3.053	161.119
Heater 5	116.981	32.000	-3.700	3.053	161.119
Heater 6	116.981	32.000	-3.700	3.053	161.119
Heater 7	116.981	32.000	-3.700	3.053	161.119
Heater 8	116.981	32.000	-3.700	3.053	161.119

Total	935.848	32.000	-3.700	24.426	161.119
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Return air	Capacity kW	Inlet °C	Outlet °C	Volume flow m3/h	Pressure drop kPa
Cooler 1	64.765	-3.700	16.207	3.048	177.010
Cooler 2	64.765	-3.700	16.207	3.048	177.010
Cooler 3	64.765	-3.700	16.207	3.048	177.010
Cooler 4	64.765	-3.700	16.207	3.048	177.010
Cooler 5	64.765	-3.700	16.207	3.048	177.010
Cooler 6	64.765	-3.700	16.207	3.048	177.010
Cooler 7	64.765	-3.700	16.207	3.048	177.010
Cooler 8	64.765	-3.700	16.207	3.048	177.010

standard plate-HE	416.852	16.207	32.000	24.384	---
Total	934.969	-3.700	16.207	24.384	177.010



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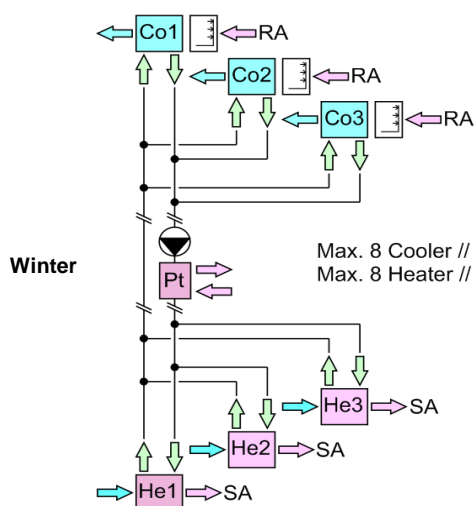
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Return air	Capacity kW	Inlet °C	Outlet °C	Volume flow m3/h	Pressure drop kPa
Heater 1	26.075	28.875	20.932	3.048	151.026
Heater 2	26.075	28.875	20.932	3.048	151.026
Heater 3	26.075	28.875	20.932	3.048	151.026
Heater 4	26.075	28.875	20.932	3.048	151.026
Heater 5	26.075	28.875	20.932	3.048	151.026
Heater 6	26.075	28.875	20.932	3.048	151.026
Heater 7	26.075	28.875	20.932	3.048	151.026
Heater 8	26.075	28.875	20.932	3.048	151.026

andard plate-HE 302.825 ---

Total	511.429	28.875	20.932	24.383	151.026
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Supply air	Capacity kW	Inlet °C	Outlet °C	Volume flow m3/h	Pressure drop kPa
Cooler 1	64.558	9.006	28.715	3.053	160.945
Cooler 2	64.558	9.006	28.715	3.053	160.945
Cooler 3	64.558	9.006	28.715	3.053	160.945
Cooler 4	64.558	9.006	28.715	3.053	160.945
Cooler 5	64.558	9.006	28.715	3.053	160.945
Cooler 6	64.558	9.006	28.715	3.053	160.945
Cooler 7	64.558	9.006	28.715	3.053	160.945
Cooler 8	64.558	9.006	28.715	3.053	160.945

Total	516.461	9.006	28.715	24.423	160.945
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