

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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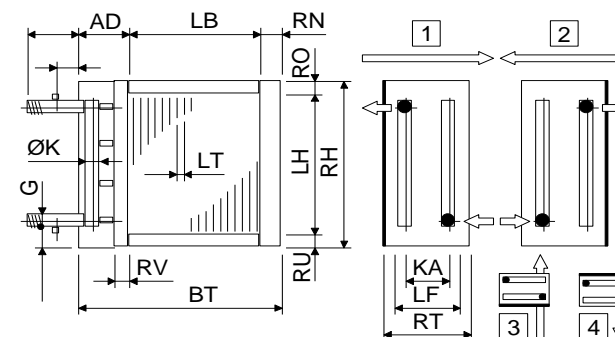
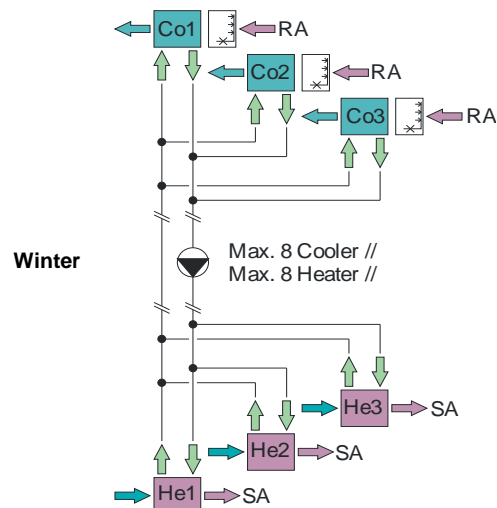
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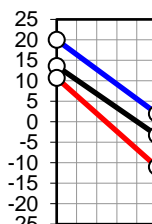


CC-System in winter		SA-He	RA-Co	Definition
Height over sea level	m			0.000
Pressure	hPa			1013.250
Efficiency	%	70.000	58.072	
Capacity	kW	580.116	580.116	
Surface reserve	%	1.633	1.182	
Present surface	m2	4662.212	4662.212	

SA-He		Inlet	Outlet	Definition
Temp.	°C	-11.000	10.700	20.000
Rel. humidity	%	90.000	16.506	40.000
Volume flow humid	m3/h	71030.381	76909.841	80000.000
Velocity	m/s	1.778	1.926	2.003
Pressure drop	Pa		86.345	

RA-Co		Inlet	Outlet	Definition
Temp.	°C	20.000	1.998	20.000
Rel. humidity	%	40.000	99.631	40.000
Volume flow humid	m3/h	80000.000	74916.617	80000.000
Velocity	m/s	2.003	1.876	2.003
Pressure drop (dry 97 Pa)	Pa		102.806	

25 V% Et.glycol		SA-He	RA-Co	
Temp.	in °C	13.600	-3.300	
Temp.	out °C	-3.300	13.600	
Volume flow	m3/h	32.099	32.164	
Velocity	m/s	1.156	1.158	
Pressure drop	kPa	192.804	199.449	



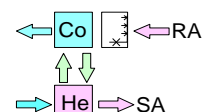
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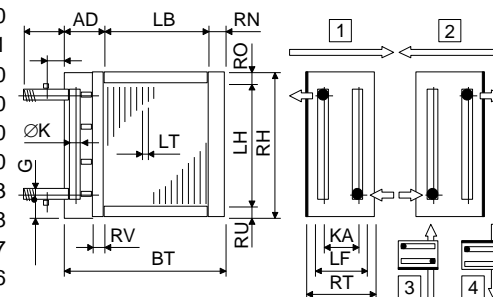
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Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	3072	3072	Tubes:	Cu
Tubes blank	Piece	6	6	Tubes:	smooth
Int. vent./drains	Piece	7	7	Tubes:	in line
Tube rows on the depth	Piece	16	16	Tubes:	circular
Tube rows on the height	Piece	192	192	Collectors:	Cu
Tube coupling in series	Piece	42	42	Connections:	Rg7
Number of circuits (NC)	Piece	73	73	Fins:	Al
Volume	l	685	685	Fins:	smooth
Weight	kg	2106	2106	Frame:	AlMg3
Connections	G	4"	4"	Protection:	without
Frame height	RH	6800	6800	Protection:	---
Frame width	BT	1901	1901	Air flow direction:	horizontal
Frame depth	RT	730	730		
Finned height	LH	6720	6720		
Finned width	LB	1651	1651		
Finned depth	LF	560	560		
Frame on top	RO	40	40		
Frame on bottom	RU	40	40		
Frame in front	RV	30	30		
Frame on back (~53/53)	RN	53	53		
Collector-Diameter	K	108	108		
Collector covering	AD	197	197		
Collector distance	KA	596	596		
Fin spacing	LT	2.500	2.500		
Fin thickness	LD	0.200	0.200		
Tube diameter	DA	12.400	12.400		
Tube diameter	da	12.400	12.400		
Tube thickness	S	0.400	0.400		
Tube interval on the height	S1	35.000	35.000		
Tube interval on the depth	S2	35.000	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-73C-Cu/Al/AlMg3
RA-Co: 35/35/12-16R-192T-1651A-2.5PA-73C-Cu/Al/AlMg3

SA-He: EUR 32006.00
RA-Co: EUR 32006.00

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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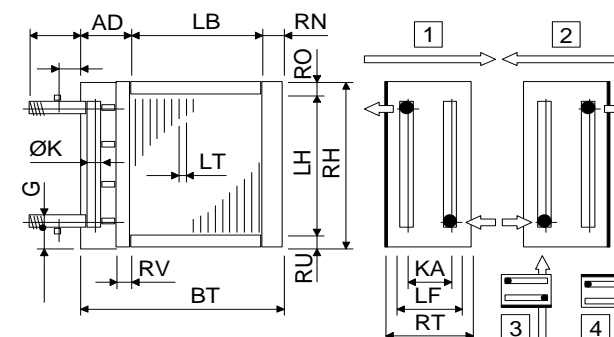
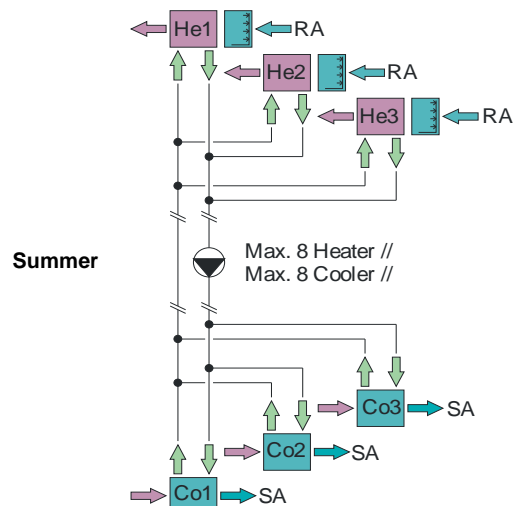
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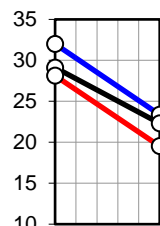


CC-System in summer		RA-He	SA-Co	Definition
Height over sea level	m			0.000
Pressure	hPa			1013.250
Efficiency	%	68.937	69.216	
Capacity	kW	235.655	235.654	
Surface reserve	%	0.002	0.255	
Present surface	m2	4662.212	4662.212	

RA-He		Inlet	Outlet	Definition
Temp. (26.000)	°C	19.518	28.123	20.000
Rel. humidity (55.000)	%	100.000	59.671	40.000
Volume flow humid	m3/h	80941.692	83321.413	80000.000
Velocity	m/s	2.027	2.086	2.003
Pressure drop	Pa		99.591	
Moistening temperature	°C	15.000		

SA-Co		Inlet	Outlet	Definition
Temp.	°C	32.000	23.360	20.000
Rel. humidity	%	40.000	66.185	40.000
Volume flow humid	m3/h	84080.362	81699.866	80000.000
Velocity	m/s	2.105	2.046	2.003
Pressure drop (dry 101 Pa)	Pa		100.882	

25 V% Et.glycol		RA-He	SA-Co
Temp.	in °C	29.117	22.304
Temp.	out °C	22.304	29.117
Volume flow	m3/h	32.099	32.118
Velocity	m/s	1.156	1.156
Pressure drop	kPa	170.075	170.446



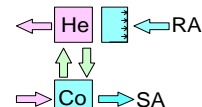
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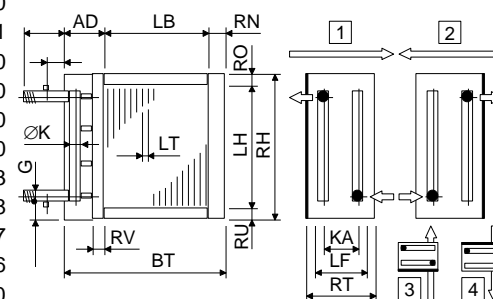
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Technical data		RA-He	SA-Co	RA-He	SA-Co
Tubes total	Piece	3072	3072	Tubes:	Cu
Tubes blank	Piece	6	6	Tubes:	smooth
Int. vent./drains	Piece	7	7	Tubes:	in line
Tube rows on the depth	Piece	16	16	Tubes:	circular
Tube rows on the height	Piece	192	192	Collectors:	Cu
Tube coupling in series	Piece	42	42	Connections:	Rg7
Number of circuits (NC)	Piece	73	73	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 (~53/53)	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

RA-He: 35/35/12-16R-192T-1651A-2.5PA-73C-Cu/Al/AlMg3
SA-Co: 35/35/12-16R-192T-1651A-2.5PA-73C-Cu/Al/AlMg3

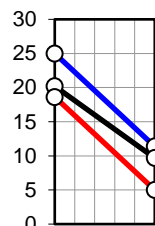
RA-He: EUR 32006.00
SA-Co: EUR 32006.00

CC-System (DIN EN 308)		SA-He	RA-Co	Definition
Height over sea level	m			0.000
Pressure	hPa			1013.250
Efficiency	%	68.166	68.151	
Capacity	kW	363.704	363.704	
Surface reserve	%	0.056	0.095	
Present surface	m2	4662.212	4662.212	

SA-He		Inlet	Outlet	Definition
Temp.	°C	5.000	18.633	20.000
Rel. humidity	%	0.000	0.000	40.000
Volume flow humid	m3/h	75207.575	78893.654	80000.000
Velocity	m/s	1.883	1.975	2.003
Pressure drop	Pa		91.336	

RA-Co		Inlet	Outlet	Definition
Temp.	°C	25.000	11.370	20.000
Rel. humidity	%	0.000	0.000	40.000
Volume flow humid	m3/h	80615.079	76929.816	80000.000
Velocity	m/s	2.018	1.926	2.003
Pressure drop (dry 94 Pa)	Pa		94.157	

25 V% Et.glycol		SA-He	RA-Co
Temp.	in °C	20.204	9.680
Temp.	out °C	9.680	20.204
Volume flow	m3/h	32.193	32.228
Velocity	m/s	1.159	1.160
Pressure drop	kPa	181.712	185.375



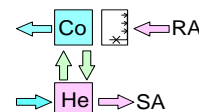
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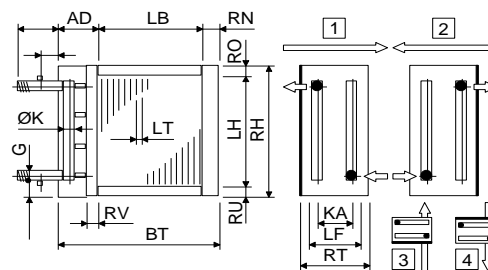
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Technical data		SA-He	RA-Co	SA-He	RA-Co
Tubes total	Piece	3072	3072	Tubes:	Cu
Tubes blank	Piece	6	6	Tubes:	smooth
Int. vent./drains	Piece	7	7	Tubes:	in line
Tube rows on the depth	Piece	16	16	Tubes:	circular
Tube rows on the height	Piece	192	192	Collectors:	Cu
Tube coupling in series	Piece	42	42	Connections:	Rg7
Number of circuits (NC)	Piece	73	73	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		



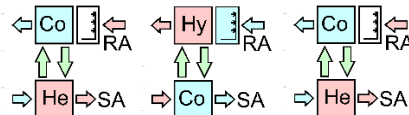
Delivery: 5-6 weeks
Validity: 12 weeks
Condit.: net, prepaid address
Payment: 30 days net

SA-He: 35/35/12-16R-192T-1651A-2.5PA-73C-Cu/Al/AlMg3
RA-Co: 35/35/12-16R-192T-1651A-2.5PA-73C-Cu/Al/AlMg3

SA-He: EUR 32006.00
RA-Co: EUR 32006.00

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	%	70.000	69.216	68.166
Capacity	kW	580.116	235.654	363.704
Surface reserve	%	1.633	0.255	0.056
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	10.700	23.360	18.633
Volume flow humid	m3/h	80000.000	80000.000	80000.000
Pressure drop	Pa	86.345	100.882	91.336
Fan efficiency	---	0.700	0.700	0.700
Fan power	kW	2.741	3.203	2.900

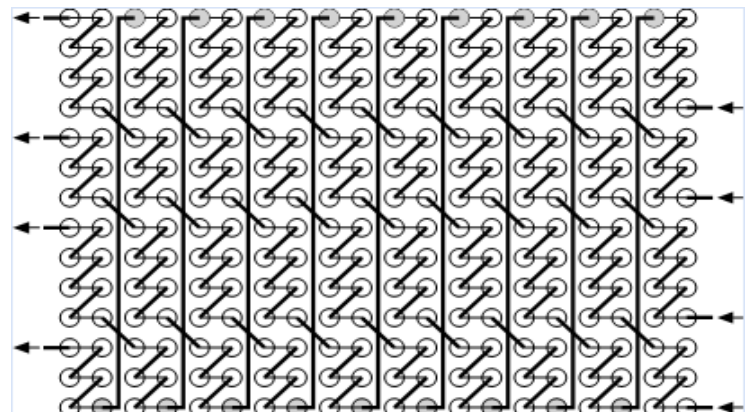
Return air		Winter	Summer	DIN EN 308
Temp. in	°C	20.000	19.518	25.000
Temp. out	°C	1.998	28.123	11.370
Volume flow humid	m3/h	80000.000	80000.000	80000.000
Pressure drop	Pa	102.806	99.591	94.157
Fan efficiency	---	0.700	0.700	0.700
Fan power	kW	3.264	3.162	2.989

25 V% Et.glycol		Winter	Summer	DIN EN 308
Volume flow	m3/h	32.099	32.118	32.193
Pressure drop Supply air	bar	1.928	1.704	1.817
Pressure drop Return air	bar	1.994	1.701	1.854
Pressure drop Hydraulics	bar	2.000	2.000	2.000
Pressure drop Total	bar	5.923	5.405	5.671
Pump efficiency	---	0.800	0.800	0.800
Pump power	kW	6.601	6.028	6.339

Economy		Winter	Summer	DIN EN 308
Gross useful ratio with CC-System	kW	580.116	235.654	363.704
Need of energy with CC-System	kW	12.606	12.392	12.228
Net useful ratio with CC-System	kW	567.511	223.262	351.476
Coefficient of performance (COP)	---	46.020	19.016	29.744

Economy		Winter	Summer	DIN EN 308
Volume flow humid Total	m3/h	160000.000	160000.000	160000.000
Need of energy with CC-System	kW	12.606	12.392	12.228
Specific Recovery Power (SRP)	Ws/m3	283.629	278.823	275.123

Adiabatic return air cooling



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

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

$$N = K + L + M$$

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

$$Q = E + I + P$$

$$R = A - Q$$

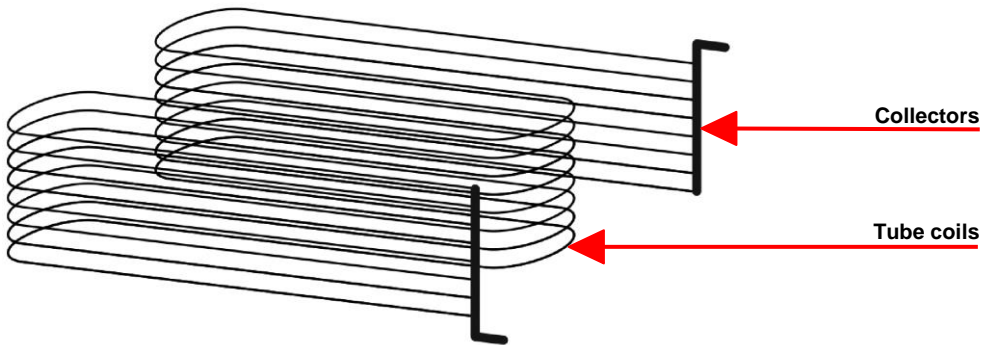
$$S = \frac{A}{Q}$$

$$T = B + F$$

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

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.

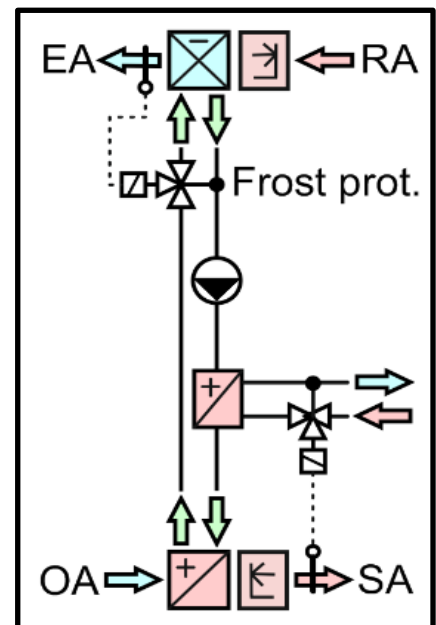
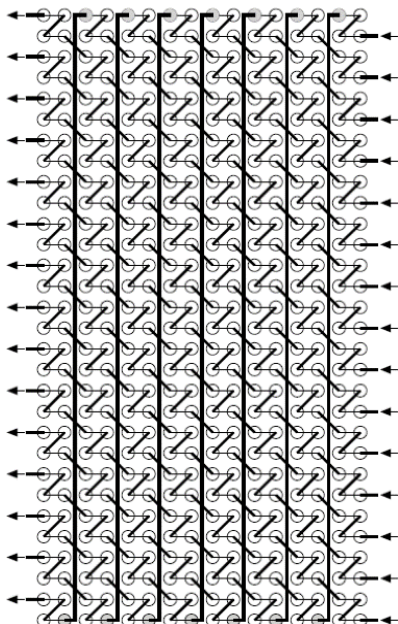


Typical applications			Heater	Cooler	CC-System
Pressure drop total	---	kPa	10.000	40.000	200.000
Coil pressure drop	T	kPa	6.500	33.000	193.000
Pressure drop collectors	C	kPa	3.500	7.000	7.000
Pressure ratio	T/C	---	1.857	4.714	27.571

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	72.515	13.600	-3.300	4.012	200.101
Heater 2	72.515	13.600	-3.300	4.012	200.101
Heater 3	72.515	13.600	-3.300	4.012	200.101
Heater 4	72.515	13.600	-3.300	4.012	200.101
Heater 5	72.515	13.600	-3.300	4.012	200.101
Heater 6	72.515	13.600	-3.300	4.012	200.101
Heater 7	72.515	13.600	-3.300	4.012	200.101
Heater 8	72.515	13.600	-3.300	4.012	200.101

Total	580.116	13.600	-3.300	32.099	200.101
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Return air	Capacity kW	Inlet °C	Outlet °C	Volume flow m3/h	Pressure drop kPa
Cooler 1	72.518	-3.300	13.600	4.021	207.281
Cooler 2	72.518	-3.300	13.600	4.021	207.281
Cooler 3	72.518	-3.300	13.600	4.021	207.281
Cooler 4	72.518	-3.300	13.600	4.021	207.281
Cooler 5	72.518	-3.300	13.600	4.021	207.281
Cooler 6	72.518	-3.300	13.600	4.021	207.281
Cooler 7	72.518	-3.300	13.600	4.021	207.281
Cooler 8	72.518	-3.300	13.600	4.021	207.281

Total	580.147	-3.300	13.600	32.165	207.281
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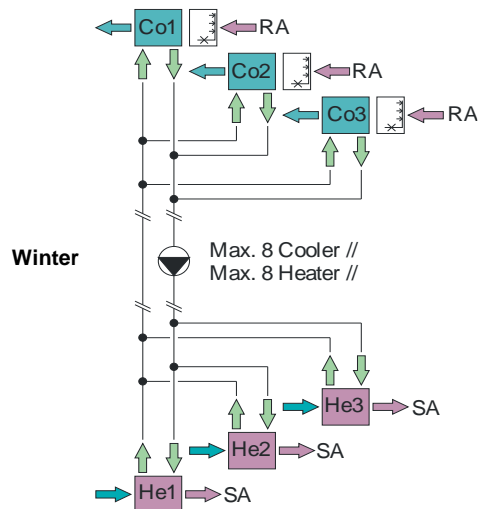
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Return air	Capacity kW	Inlet °C	Outlet °C	Volume flow m3/h	Pressure drop kPa
Heater 1	29.479	29.117	22.310	4.019	177.352
Heater 2	29.479	29.117	22.310	4.019	177.352
Heater 3	29.479	29.117	22.310	4.019	177.352
Heater 4	29.479	29.117	22.310	4.019	177.352
Heater 5	29.479	29.117	22.310	4.019	177.352
Heater 6	29.479	29.117	22.310	4.019	177.352
Heater 7	29.479	29.117	22.310	4.019	177.352
Heater 8	29.479	29.117	22.310	4.019	177.352

Total	235.835	29.117	22.310	32.153	177.352
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Supply air	Capacity kW	Inlet °C	Outlet °C	Volume flow m3/h	Pressure drop kPa
Cooler 1	29.450	22.310	29.126	4.012	177.327
Cooler 2	29.450	22.310	29.126	4.012	177.327
Cooler 3	29.450	22.310	29.126	4.012	177.327
Cooler 4	29.450	22.310	29.126	4.012	177.327
Cooler 5	29.450	22.310	29.126	4.012	177.327
Cooler 6	29.450	22.310	29.126	4.012	177.327
Cooler 7	29.450	22.310	29.126	4.012	177.327
Cooler 8	29.450	22.310	29.126	4.012	177.327

Total	235.599	22.310	29.126	32.099	177.327
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