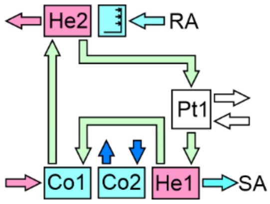
Air cooler calculation

In many industrial processes, you are dependent on dry air, otherwise the products to be manufactured, such as medicines, absorb moisture and become unusable. If a lot of moisture has to be removed from the air, part of the output can be achieved via cold recovery, provided that the exhaust air is pre-cooled adiabatic.

CCSF dehumidification system

A large proportion of cooling capacity and dehumidification must be cooled with cold water via the finned air cooler (Co2). For a long time, this system was in the foreground, with the finned air cooler (Co2) causing high air-side pressure drops throughout the year, i.e. even when it is not in operation. This leads to additional operating costs, because the supply air fan has to do more. It is also important to note, that effective condensate separation must take place after the aftercooler (Co2), otherwise the condensate will enter the reheater.

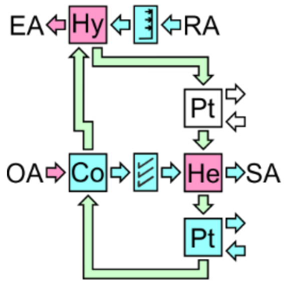
Software CCSF Split



CCSH dehumidification system

Recently, instead of a finned aftercooler (Co2), a plate heat exchanger (Pt) has been integrated into the glycol circuit, which is operated with cold water. In this way, the operating costs of the supply air fan can be significantly reduced. However, another problem arises in, that not all manufacturers of finned heat exchangers can show a type examination, for example by the TUEV Süd in Munich, and have no idea, how to calculate a cooler with a high proportion of latent power. On the other hand, thanks to a totally useless calculation, you are very cheap.

Software CCSH Split



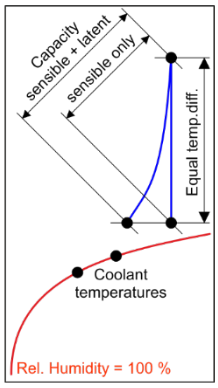
Cooling course

Counterflow in finned heat exchangers exists only in the imagination of producers with insufficient thermodynamic training.

Apparently, these producers of finned heat exchangers are not interested in whether the performance is achieved.

Only those, who calculate the cooling process with at least 15 finite elements in the direction of air, will produce correct results.

Cooling course



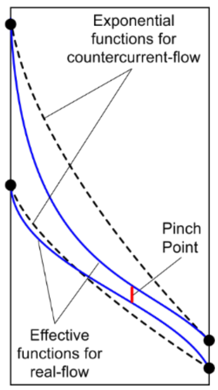
Mean logarithmic temperature difference

The exponential temperature gradients do not apply, since only sensitive power is dissipated at the beginning and latent power only later.

The temperature curve changes and can tend towards zero at the narrowest point, the so-called pinch point.

The effective Δtm can be understood as the area between the two temperature curves and is extremely reduced, which has been confirmed by measurements in the laboratory.

Δtm reduced



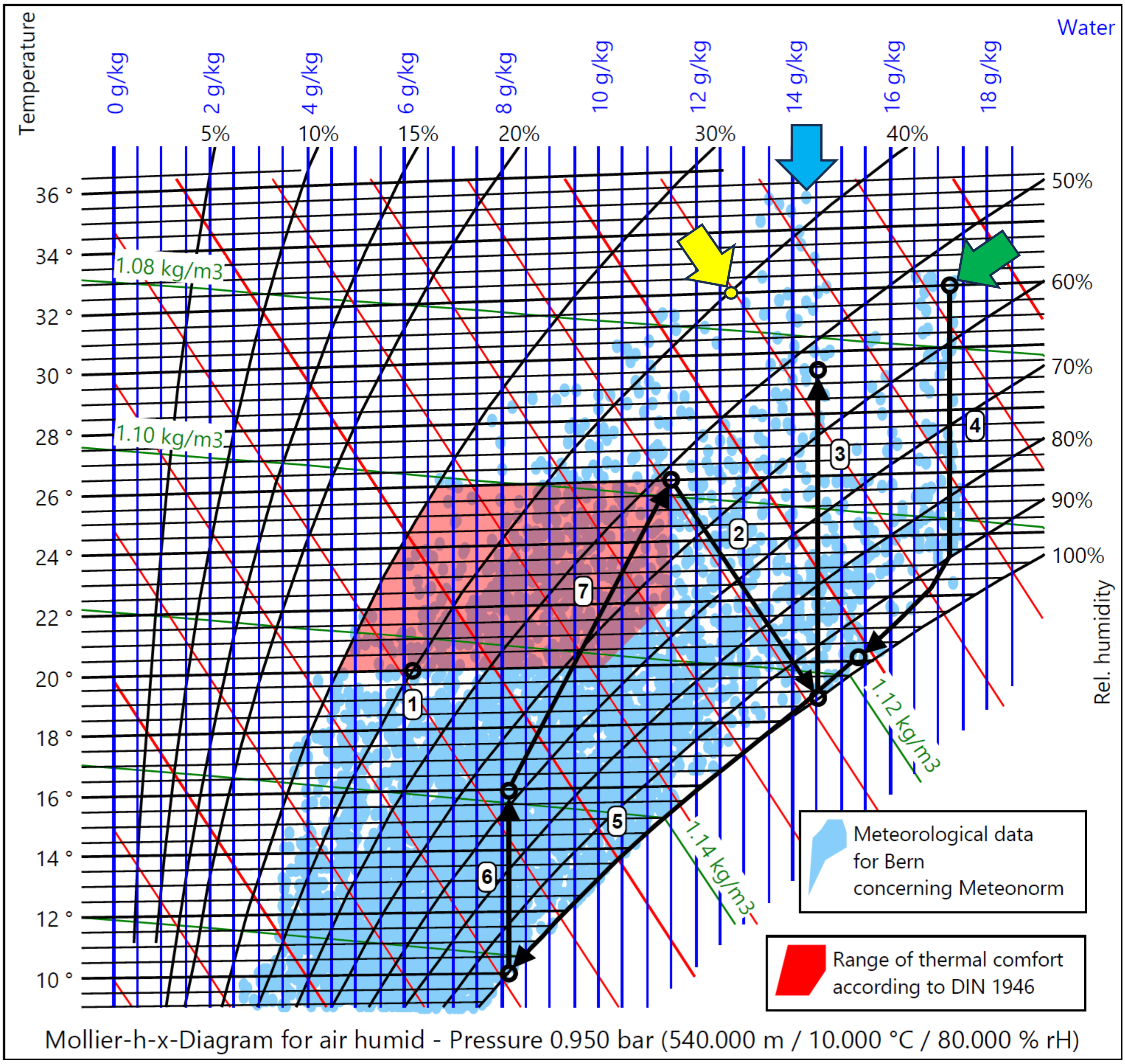
Conclusion: **Latent power reduces the mean logarithmic temperature difference enormously and requires larger heat exchangers!**

CCSF Split: For the outside air, **32°C/40%** is still assumed to be the maximum. Choosing the highest temperature at **35°C/38%**, also does not provide the maximum cooling requirement. We therefore select the highest enthalpy at **32°C/54%**, **see red lines in the Mollier HX diagram**.

Process 1: **Definition**, Bern 540 m, 0.95 bar, 30,000 m3/h (20°C/40%), dry air mass flow 33,517 kg/h
Process 2: **Exhaust air humidification** from 26°C/51.4% to 18.8°C/100% with water of 15°C, 100.6 kg/h
Process 3: **Energy recovery** from 18.8°C/100% to 29.4°C/52.9%, 102.3 kW
Process 4: **Energy recovery** from 32°C/54% to 20.1°C/97.4%, 159.3 kW
Process 5: **Post-cooling** from 20.1°C/97.4% to 10°C/100% with water 6/12°C, 38.1 m3/h, 266.3kW

Anyone who dispenses of a highly effective droplet eliminator (~ 60 Pa) only understands bullshit!

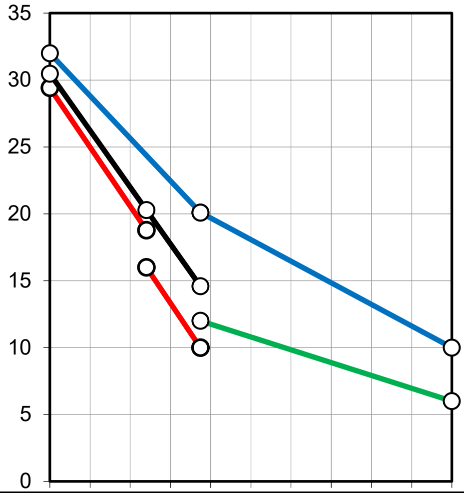
Process 6: **Energy recovery** from 10°C/100% to 16°C/67.6%, 57.1 kW
Process 7: **Heat load** from 16°C/67.6% to 26°C/51.4%, 174.8 kW (sensitive 95.2 kW, latent 79.6 kW)



Page 3: Summer, supply air dehumidification
Page 4: Winter, heating with plate heat exchanger, slight risk of freezing of the exhaust air
Page 5: Winter, heating without a plate heat exchanger, slight risk of freezing of the exhaust air
Page 6: Winter, heating with plate heat exchanger, without risk of freezing of the exhaust air (bypass)
Page 7: DIN EN 308, without plate heat exchanger, temperature efficiency 80.73%
Page 8: Energy recovery and payback period
Page 9: Winter, supply air heater split into 2 x 12 rows of tubes
Page 10: Winter, exhaust air cooler split into 2 x 12 rows of tubes
Page 11: Summary of all data (winter, summer, DIN EN 308) in flowcharts

CC-System in summer		SA-Co1	SA-Co2	SA-He	RA-Hy
Capacity	kW	159.340	266.270	57.063	102.277
Surface reserve	%	3.247	1.410	2.585	2.409
Present surface	m2	2785.209	916.270	464.202	2785.209
Temp. in (26.000)	°C	32.000	20.100	10.000	18.783
Rel. humidity in (51.431)	%	54.000	97.426	100.000	100.000
Abs. humidity in (11.500)	g/kg	17.224	15.351	8.146	14.501
Temp. out	°C	20.100	10.000	16.000	29.410
Rel. humidity out	%	97.426	100.000	67.620	52.919
Abs. humidity out	g/kg	15.351	8.146	8.146	14.501
Velocity	m/s	1.898	1.839	1.792	1.880
Pressure drop	Pa	235.543	111.383	31.708	198.858
Evaporation total	kg/h				100.595

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	30000.000
Return air	m3/h	30000.000
25 V% Et.glycol		
Temp. in	°C	14.600
Temp. out	°C	30.475
Volume flow	m3/h	9.324
Pressure drop total	kPa	375.637
Water		SA-Co2
Temp. in	°C	6.000
Temp. out	°C	12.000
Volume flow	m3/h	38.093
Pressure drop	kPa	44.605



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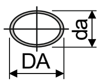
Technical data		SA-Co1	SA-Co2	SA-He	RA-Hy
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	11	0	1	11
Tube rows on the depth	Piece	24	8	4	24
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	18	48	16	18
Volume	l	491	194	89	491
Weight	kg	1346	498	258	1346
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2600	2600	2600	2600
Frame depth	RT	910	380	210	910
Finned height	LH	1920	1920	1920	1920
Finned width	LB	2372	2341	2372	2372
Frame on top	RO	40	40	40	40
Frame on bottom	RU	40	40	40	40
Frame in front	RV	30	30	30	30
Frame on back (~65/65/65/65)	RN	65	65	65	65
Collector covering	AD	163	194	163	163
Fin spacing	LT	2.500	2.500	2.500	2.500
Fin thickness	LD	0.200	0.200	0.200	0.200
Tube diameter	DA	15.400	15.400	15.400	15.400
Tube diameter	da	15.400	15.400	15.400	15.400
Tube thickness	S	0.400	0.400	0.400	0.400
Tube interval on the height	S1	40.000	40.000	40.000	40.000
Tube interval on the depth	S2	35.000	35.000	35.000	35.000
Tubes	---	Cu	Cu	Cu	Cu
Tubes	---	smooth	smooth	smooth	smooth
Tubes	---	staggered	staggered	staggered	staggered
Tubes	Type	circular	circular	circular	circular
Collector	---	Cu	Cu	Cu	Cu
Connections	---	Rg7	Rg7	Rg7	Rg7
Fins	---	Al	Al	Al	Al
Fins	---	ribbed	ribbed	ribbed	ribbed
Frame	---	AISI 304	AISI 304	AISI 304	AISI 304
Protection	---	without	without	without	without
Protection	---	---	---	---	---
Price	**EUR**	**21643.00**	**8057.00**	**4072.00**	**21643.00**



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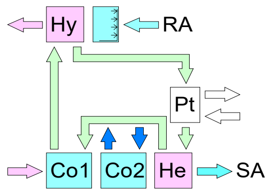

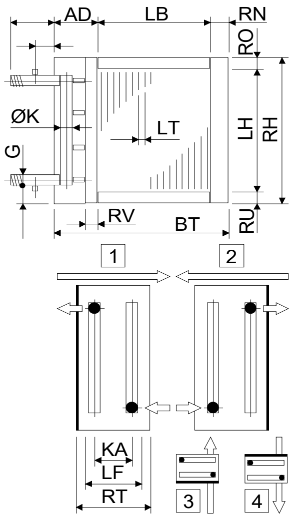

Delivery:	5-6 weeks
Validity:	12 weeks
Condit.:	net, prepaid address
Payment:	30 days net

CC-System in winter		SA-He1	SA-Co2	SA-He2	RA-Hy
Capacity	kW	288.983		39.781	231.342
Surface reserve	%	0.000		0.145	0.193
Present surface	m2	2785.209	916.270	464.202	2785.209
Temp. in	°C	-11.000		19.767	20.000
Rel. humidity in	%	90.000		9.231	40.000
Abs. humidity in	g/kg	1.394		1.394	6.174
Temp. out	°C	19.767		24.000	0.600
Rel. humidity out	%	9.231		7.134	99.876
Abs. humidity out	g/kg	1.394		1.394	4.214
Velocity	m/s	1.719	1.719	1.828	1.767
Pressure drop	Pa	175.856	111.383	32.619	211.913

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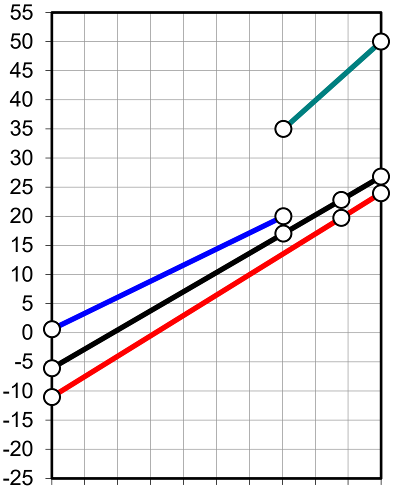
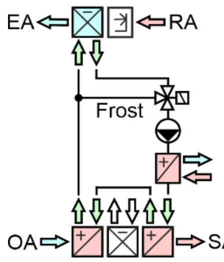
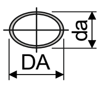
Plant
Object
Position

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	30000.000
Return air	m3/h	30000.000
25 V% Et.glycol		
Temp. in	°C	26.825
Temp. out	°C	-6.075
Volume flow	m3/h	9.324
Pressure drop total	kPa	423.168
Water		
Temp. in	°C	---
Temp. out	°C	---
Volume flow	m3/h	---
Pressure drop	kPa	---





Technical data		SA-He1	SA-Co2	SA-He2	RA-Hy
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	11	0	1	11
Tube rows on the depth	Piece	24	8	4	24
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	18	48	16	18
Volume	l	491	194	89	491
Weight	kg	1346	498	258	1346
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2600	2600	2600	2600
Frame depth	RT	910	380	210	910
Finned height	LH	1920	1920	1920	1920
Finned width	LB	2372	2341	2372	2372
Frame on top	RO	40	40	40	40
Frame on bottom	RU	40	40	40	40
Frame in front	RV	30	30	30	30
Frame on back (~65/65/65/65)	RN	65	65	65	65
Collector covering	AD	163	194	163	163
Fin spacing	LT	2.500	2.500	2.500	2.500
Fin thickness	LD	0.200	0.200	0.200	0.200
Tube diameter	DA	15.400	15.400	15.400	15.400
Tube diameter	da	15.400	15.400	15.400	15.400
Tube thickness	S	0.400	0.400	0.400	0.400
Tube interval on the height	S1	40.000	40.000	40.000	40.000
Tube interval on the depth	S2	35.000	35.000	35.000	35.000
Tubes	---	Cu	Cu	Cu	Cu
Tubes	---	smooth	smooth	smooth	smooth
Tubes	---	staggered	staggered	staggered	staggered
Tubes	Type	circular	circular	circular	circular
Collector	---	Cu	Cu	Cu	Cu
Connections	---	Rg7	Rg7	Rg7	Rg7
Fins	---	Al	Al	Al	Al
Fins	---	ribbed	ribbed	ribbed	ribbed
Frame	---	AISI 304	AISI 304	AISI 304	AISI 304
Protection	---	without	without	without	without
Protection	---	---	---	---	---
Price	**EUR**	**21643.00**	**8057.00**	**4072.00**	**21643.00**



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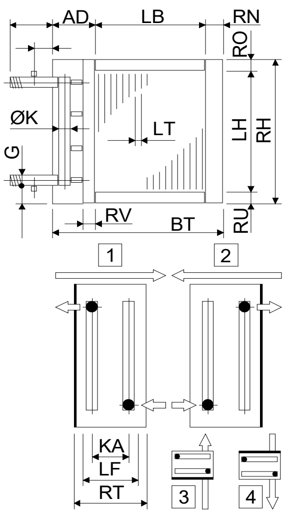
Heat exchanger (Pt)		
Capacity	kW	97.421
in	°C	50.000
out	°C	35.000
in	°C	17.076
out	°C	26.825



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

CC-System in winter without Pt		SA-He1-Red	SA-Co-Red	SA-He2-Red	RA-Hy-Red
Capacity	kW	212.101		29.991	242.233
Surface reserve	%	0.329		0.216	0.216
Present surface	m2	2785.209	916.270	464.202	2785.209
Temp. in	°C	-11.000		11.584	20.000
Rel. humidity in	%	90.000		15.568	40.000
Abs. humidity in	g/kg	1.394		1.394	6.174
Temp. out	°C	11.584		14.777	-0.050
Rel. humidity out	%	15.568		12.646	100.000
Abs. humidity out	g/kg	1.394		1.394	4.014
Velocity	m/s	1.694	1.694	1.774	1.764
Pressure drop	Pa	172.242	111.383	31.292	214.164

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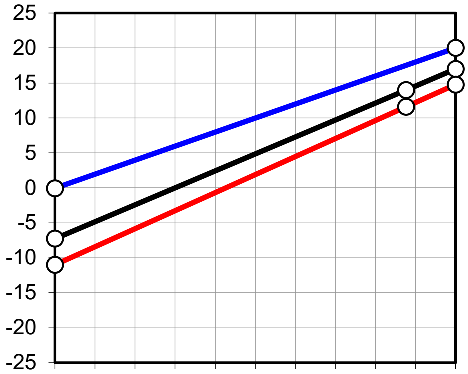
Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	30000.000
Return air	m3/h	30000.000
25 V% Et.glycol		
Temp. in	°C	17.007
Temp. out	°C	-7.274
Volume flow	m3/h	9.324
Pressure drop total	kPa	433.974
Water		
Temp. in	°C	---
Temp. out	°C	---
Volume flow	m3/h	---
Pressure drop	kPa	---

Efficiency: Supply air = 83.150 %
Efficiency: Return air = 64.677 %



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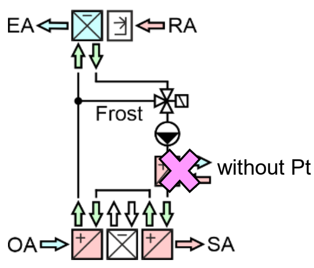
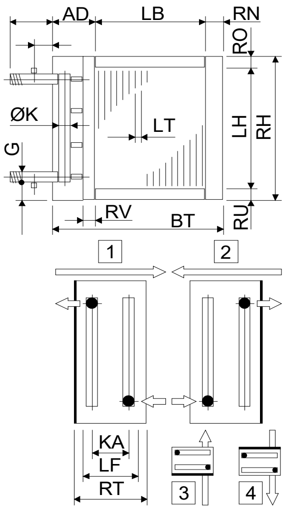


Software by www.zcs.ch

Technical data		SA-He1-Red	SA-Co-Red	SA-He2-Red	RA-Hy-Red
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	11	0	1	11
Tube rows on the depth	Piece	24	8	4	24
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	18	48	16	18
Volume	l	491	194	89	491
Weight	kg	1346	498	258	1346
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2600	2600	2600	2600
Frame depth	RT	910	380	210	910
Finned height	LH	1920	1920	1920	1920
Finned width	LB	2372	2341	2372	2372
Frame on top	RO	40	40	40	40
Frame on bottom	RU	40	40	40	40
Frame in front	RV	30	30	30	30
Frame on back (~65/65/65/65)	RN	65	65	65	65
Collector covering	AD	163	194	163	163
Fin spacing	LT	2.500	2.500	2.500	2.500
Fin thickness	LD	0.200	0.200	0.200	0.200
Tube diameter	DA	15.400	15.400	15.400	15.400
Tube diameter	da	15.400	15.400	15.400	15.400
Tube thickness	S	0.400	0.400	0.400	0.400
Tube interval on the height	S1	40.000	40.000	40.000	40.000
Tube interval on the depth	S2	35.000	35.000	35.000	35.000
Tubes	---	Cu	Cu	Cu	Cu
Tubes	---	smooth	smooth	smooth	smooth
Tubes	---	staggered	staggered	staggered	staggered
Tubes	Type	circular	circular	circular	circular
Collector	---	Cu	Cu	Cu	Cu
Connections	---	Rg7	Rg7	Rg7	Rg7
Fins	---	Al	Al	Al	Al
Fins	---	ribbed	ribbed	ribbed	ribbed
Frame	---	AISI 304	AISI 304	AISI 304	AISI 304
Protection	---	without	without	without	without
Protection	---	---	---	---	---
Price	**EUR**	**21643.00**	**8057.00**	**4072.00**	**21643.00**

Heat exchanger (Pt)		
Capacity	kW	0.000
in	°C	---
out	°C	---
in	°C	17.007
out	°C	17.007



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

CC-System in winter		SA-He1	SA-Co2	SA-He2	RA-Hy
Capacity	kW	288.983		39.781	212.554
Surface reserve	%	0.000		0.145	0.077
Present surface	m2	2785.209	916.270	464.202	2785.209
Temp. in	°C	-11.000		19.767	20.000
Rel. humidity in	%	90.000		9.231	40.000
Abs. humidity in	g/kg	1.394		1.394	6.174
Temp. out	°C	19.767		24.000	1.600
Rel. humidity out	%	9.231		7.134	100.000
Abs. humidity out	g/kg	1.394		1.394	4.535
Velocity	m/s	1.719	1.719	1.828	1.770
Pressure drop	Pa	175.856	111.383	32.619	208.166

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Plant
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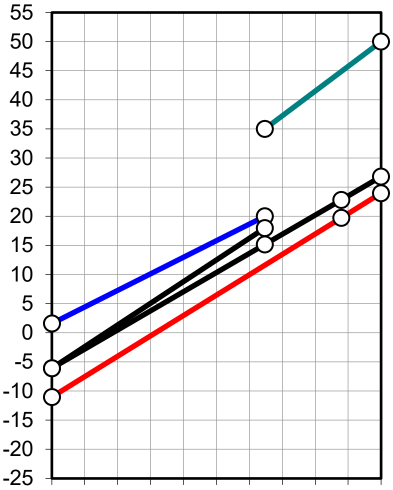
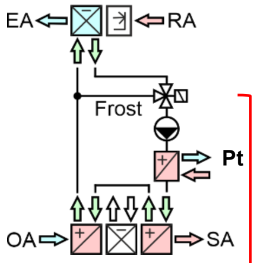
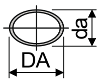
Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	30000.000
Return air	m3/h	30000.000
25 V% Et.glycol		
Temp. in	°C	26.825
Temp. out	°C	-6.075
Volume flow	m3/h	9.324
Pressure drop total	kPa	384.582
Water		
Temp. in	°C	---
Temp. out	°C	---
Volume flow	m3/h	---
Pressure drop	kPa	---



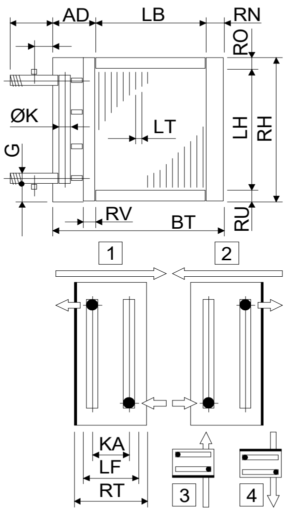


Technical data		SA-He1	SA-Co2	SA-He2	RA-Hy
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	11	0	1	11
Tube rows on the depth	Piece	24	8	4	24
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	18	48	16	18
Volume	l	491	194	89	491
Weight	kg	1346	498	258	1346
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2600	2600	2600	2600
Frame depth	RT	910	380	210	910
Finned height	LH	1920	1920	1920	1920
Finned width	LB	2372	2341	2372	2372
Frame on top	RO	40	40	40	40
Frame on bottom	RU	40	40	40	40
Frame in front	RV	30	30	30	30
Frame on back (~65/65/65/65)	RN	65	65	65	65
Collector covering	AD	163	194	163	163
Fin spacing	LT	2.500	2.500	2.500	2.500
Fin thickness	LD	0.200	0.200	0.200	0.200
Tube diameter	DA	15.400	15.400	15.400	15.400
Tube diameter	da	15.400	15.400	15.400	15.400
Tube thickness	S	0.400	0.400	0.400	0.400
Tube interval on the height	S1	40.000	40.000	40.000	40.000
Tube interval on the depth	S2	35.000	35.000	35.000	35.000
Tubes	---	Cu	Cu	Cu	Cu
Tubes	---	smooth	smooth	smooth	smooth
Tubes	---	staggered	staggered	staggered	staggered
Tubes	Type	circular	circular	circular	circular
Collector	---	Cu	Cu	Cu	Cu
Connections	---	Rg7	Rg7	Rg7	Rg7
Fins	---	Al	Al	Al	Al
Fins	---	ribbed	ribbed	ribbed	ribbed
Frame	---	AISI 304	AISI 304	AISI 304	AISI 304
Protection	---	without	without	without	without
Protection	---	---	---	---	---
Price	**EUR**	**21643.00**	**8057.00**	**4072.00**	**21643.00**



Software by www.zcs.ch

Heat exchanger (Pt)		
Capacity	kW	116.209
in	°C	50.000
out	°C	35.000
in	°C	15.196
out	°C	26.825



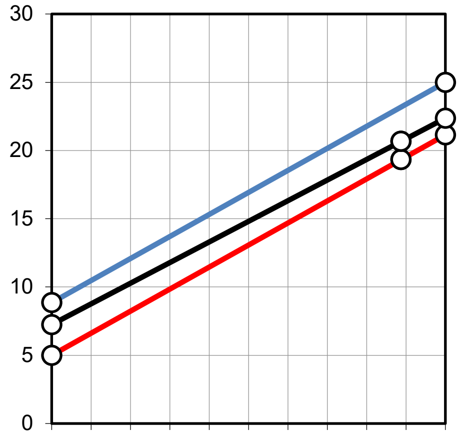
Delivery:	5-6 weeks
Validity:	12 weeks
Condit.:	net, prepaid address
Payment:	30 days net

CC-System (DIN EN 308)		SA-He1	SA-Co2	SA-He2	RA-Hy
Capacity	kW	134.280		17.022	151.301
Surface reserve	%	0.060		0.137	0.356
Present surface	m2	2785.209	916.270	464.202	2785.209
Temp. in	°C	5.000		19.330	25.000
Rel. humidity in	%	0.000		0.000	0.000
Abs. humidity in	g/kg	0.000		0.000	0.000
Temp. out	°C	19.330		21.146	8.856
Rel. humidity out	%	0.000		0.000	0.000
Abs. humidity out	g/kg	0.000		0.000	0.000
Velocity	m/s	1.763	1.763	1.813	1.793
Pressure drop	Pa	182.256	79.472	32.273	186.524

Temp. efficiency	%	80.730

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	30000.000
Return air	m3/h	30000.000

25 V% Et.glycol		
Temp. in	°C	22.368
Temp. out	°C	7.252
Volume flow	m3/h	9.324
Pressure drop total	kPa	393.787



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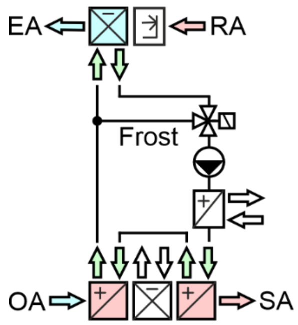

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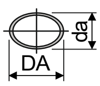
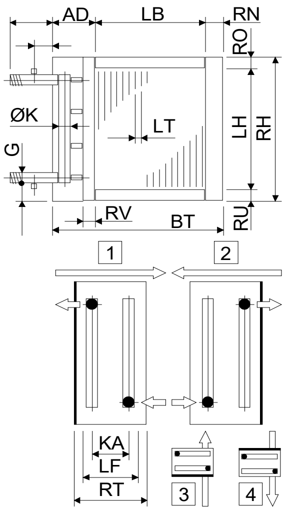
Technical data		SA-He1	SA-Co2	SA-He2	RA-Hy
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	11	0	1	11
Tube rows on the depth	Piece	24	8	4	24
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	18	48	16	18
Volume	l	491	194	89	491
Weight	kg	1346	498	258	1346
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2600	2600	2600	2600
Frame depth	RT	910	380	210	910
Finned height	LH	1920	1920	1920	1920
Finned width	LB	2372	2341	2372	2372
Frame on top	RO	40	40	40	40
Frame on bottom	RU	40	40	40	40
Frame in front	RV	30	30	30	30
Frame on back (~65/65/65/65)	RN	65	65	65	65
Collector covering	AD	163	194	163	163
Fin spacing	LT	2.500	2.500	2.500	2.500
Fin thickness	LD	0.200	0.200	0.200	0.200
Tube diameter	DA	15.400	15.400	15.400	15.400
Tube diameter	da	15.400	15.400	15.400	15.400
Tube thickness	S	0.400	0.400	0.400	0.400
Tube interval on the height	S1	40.000	40.000	40.000	40.000
Tube interval on the depth	S2	35.000	35.000	35.000	35.000
Tubes	---	Cu	Cu	Cu	Cu
Tubes	---	smooth	smooth	smooth	smooth
Tubes	---	staggered	staggered	staggered	staggered
Tubes	Type	circular	circular	circular	circular
Collector	---	Cu	Cu	Cu	Cu
Connections	---	Rg7	Rg7	Rg7	Rg7
Fins	---	Al	Al	Al	Al
Fins	---	ribbed	ribbed	ribbed	ribbed
Frame	---	AISI 304	AISI 304	AISI 304	AISI 304
Protection	---	without	without	without	without
Protection	---	---	---	---	---
Price	**EUR**	**21643.00**	**8057.00**	**4072.00**	**21643.00**





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

Energy recovery / Year (Service at 100% Air flow = 5667 Hours

No	Outside air °C	Outside air %	CCSB °C	CCSB %	Return air °C	Return air %	Exhaust air °C	Exhaust air %	Efficiency %	Capacity kW	Energy MWh
1	-8.7	84.0	15.6	13.8	21.1	34.5	1.0	96.6	81.70	228.39	32.35
2	-3.3	78.4	16.4	19.5	21.2	35.0	3.9	91.7	80.39	185.35	26.26
3	-1.4	79.2	16.7	22.6	21.3	35.4	5.0	90.2	79.95	171.13	24.24
4	-0.2	78.5	17.0	24.3	21.4	35.9	5.7	89.3	79.69	162.41	23.01
5	0.8	76.3	17.3	25.2	21.5	36.3	6.4	88.6	79.51	155.04	21.96
6	1.6	79.2	17.5	27.4	21.6	36.7	6.9	88.1	79.37	149.53	21.18
7	2.4	77.1	17.7	27.7	21.7	37.2	7.5	87.5	79.27	144.51	20.47
8	3.0	77.3	17.9	28.7	21.8	37.6	7.9	87.2	79.19	140.48	19.90
9	3.6	76.2	18.1	29.1	21.9	38.1	8.3	86.9	79.12	136.77	19.38
10	4.2	75.3	18.3	29.6	22.0	38.5	8.7	86.7	79.05	133.38	18.89
11	4.7	75.9	18.5	30.6	22.2	39.0	9.1	86.5	78.97	129.97	18.41
12	5.3	73.8	18.7	30.6	22.3	39.4	9.5	86.3	78.90	126.57	17.93
13	5.9	75.2	18.9	32.1	22.4	39.9	9.9	85.8	78.81	122.67	17.38
14	6.5	72.4	19.1	31.9	22.5	40.3	10.3	85.4	78.72	118.61	16.80
15	7.1	73.7	19.3	33.3	22.6	40.7	10.7	85.0	78.64	115.09	16.30
16	7.7	72.1	19.5	33.5	22.7	41.2	11.1	84.6	78.56	111.58	15.81
17	8.3	73.0	19.7	35.0	22.8	41.6	11.6	83.9	78.47	107.42	15.22
18	9.0	73.9	19.9	36.6	22.9	42.1	12.1	83.2	78.39	103.27	14.63
19	9.6	73.3	20.0	37.4	23.0	42.5	12.6	81.9	78.38	98.01	13.88
20	10.3	71.7	19.8	37.6	23.1	43.0	13.1	80.6	78.38	90.90	12.88
21	10.9	72.5	19.7	39.1	23.2	43.4	13.6	79.3	78.37	83.65	11.85
22	11.5	68.9	19.6	38.3	23.3	43.9	14.1	77.9	78.38	76.07	10.78
23	12.3	68.7	19.4	39.5	23.4	44.3	14.7	76.2	78.38	67.75	9.60
24	13.1	69.7	19.3	41.5	23.5	44.7	15.3	74.4	78.36	59.11	8.37
25	13.7	67.7	19.1	41.5	23.6	45.2	15.9	73.1	78.36	51.55	7.30
26	14.3	69.5	19.0	43.7	23.8	45.6	16.4	72.1	78.34	44.75	6.34
27	14.9	71.2	18.9	46.0	23.9	46.1	16.9	70.9	78.32	37.34	5.29
28	15.5	71.6	18.7	47.4	24.0	46.5	17.4	69.9	78.30	30.47	4.32
29	16.1	71.0	18.6	48.2	24.1	47.0	17.9	68.8	78.30	23.33	3.30
30	16.7	67.3	18.4	46.9	24.2	47.4	18.4	67.7	78.32	16.06	2.28
31	17.4	64.6	18.3	46.3	24.3	47.9	18.9	66.6	78.33	8.76	1.24
32	18.0	64.9	18.1	47.7	24.4	48.3	19.4	65.5	78.32	1.41	0.20
33	18.6	63.9	17.4	68.9	17.1	100.0	18.3	92.7	78.48	11.57	1.64
34	19.3	64.2	17.7	71.0	17.3	100.0	18.9	90.4	78.46	15.38	2.18
35	20.1	64.5	18.0	73.7	17.4	100.0	19.5	87.7	78.44	20.25	2.87
36	21.0	60.2	18.3	71.1	17.6	100.0	20.3	84.6	78.46	25.79	3.65
37	22.0	62.1	18.7	76.4	17.7	100.0	21.1	81.3	78.40	32.03	4.54
38	23.2	60.1	19.1	77.5	17.9	100.0	22.1	77.4	78.39	39.81	5.64
39	24.8	56.4	19.5	77.7	18.1	100.0	23.3	72.4	78.38	50.46	7.15
40	28.3	50.1	20.4	80.2	18.2	100.0	26.1	61.9	78.32	75.82	10.74

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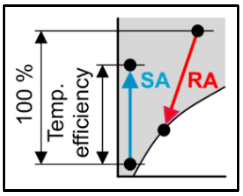

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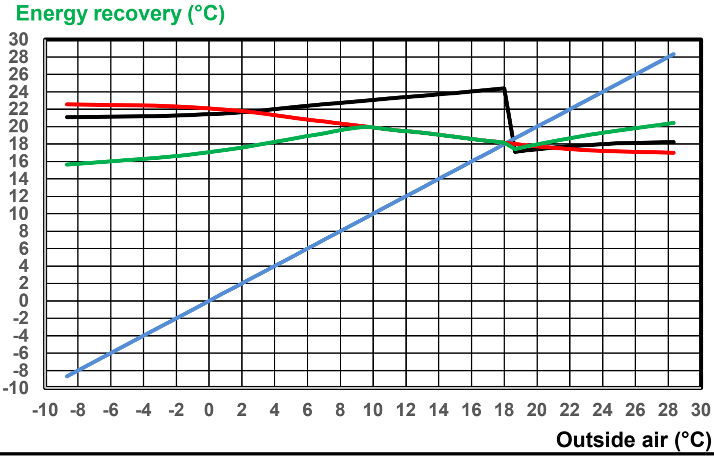
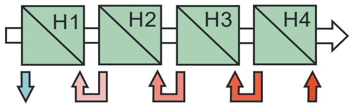
Air (%)	Service (h/a)
100.00	4000
66.67	2000
33.33	1000
▼	▼
100.00	5667

EU: Energy recovery: Heat energy	MWh	457.77	EUR	27466.00	(60.00 EUR/MWh)
EU: Energy recovery: Cold energy	MWh	38.41	EUR	3072.00	(80.00 EUR/MWh)
EU: 2 Fan + Glycol pump	MWh	-47.32	EUR	-4732.00	(100.00 EUR/MWh)
EU: Energy recovery: Net useful ratio / Year	MWh	448.85	EUR	25806.00	(57.49 EUR/MWh)
EU: Need of energy total / Year	MWh	739.58	EUR	51523.21	(69.67 EUR/MWh)
EU: Net useful ratio / Year	%	60.69	%	50.09	TWG = 83.15%
CH: Guidelines from associations such as SIA and SWKI: TWG>70.00% & JNG>75.00% & ETV>15.00					JNG = 76.65%
					ETV = 12.09



Station		Bern (CH)
Height over sea level	m	540.00
Pressure	hPa	949.65
Outside air	m3/h	30000.00
Return air	m3/h	30000.00
Adiabatic return air cooling	h/a	1133.33
Service at 100% Air flow	h/a	5666.65
Capital interest	%	1.00
Energy increase	%	1.00
Inflation	%	1.00
Support costs	%	5.00
Costs without CC-System	EUR	86000.00
Costs with CC-System	EUR	182000.00
Additional costs	EUR	96000.00
BEP (Break even point) after	Years	4.59

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Air humid	m3/h	30000.000
25 V% Et.glycol	m3/h	9.332



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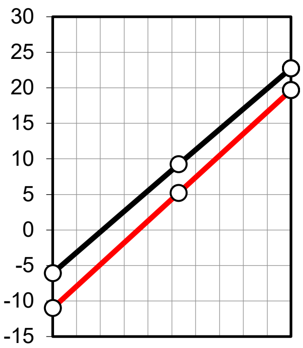
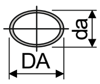
Air humid		Heater 1	Heater 2	Heater 3	Heater 4
Temp. Inlet	°C	-11.000	5.230	19.668	19.668
Rel. humidity Inlet	%	90.000	23.924	9.288	9.288
Temp. Outlet	°C	5.230	19.668	19.668	19.668
Rel. humidity Outlet	%	23.924	9.288	9.288	9.288
Pressure drop (100.67 %)	Pa	85.110	91.925	0.000	0.000

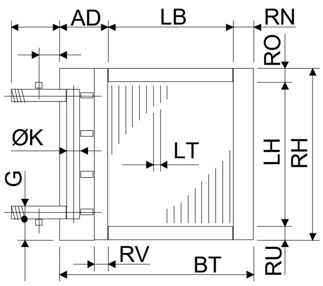
25 V% Et.glycol		Heater 1	Heater 2	Heater 3	Heater 4
Temp. Inlet	°C	9.244	22.739	22.739	22.739
Temp. Outlet	°C	-6.075	9.244	22.739	22.739
Pressure drop (104.20 %)	kPa	99.424	90.575	0.000	0.000

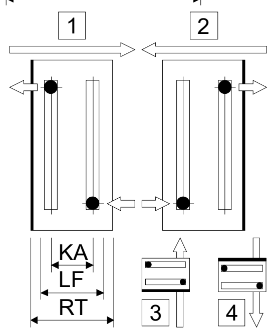
Heat exchanger		Heater 1	Heater 2	Heater 3	Heater 4
Capacity	kW	152.413	135.637	0.000	0.000
Surface reserve	%	0.473	0.391	0.000	0.000
Present surface	m2	1392.605	1392.605	0.000	0.000
Required surface	m2	1386.046	1387.186	0.000	0.000
k-coeff.	W/m2K	26.083	29.758	0.000	0.000
Average temp. diff.	K	4.216	3.286	0.000	0.000
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	5	5	0	0
Tube rows on the depth	Piece	12	12	0	0
Tube rows on the height	Piece	48	48	0	0
Number of circuits (NC)	Piece	18	18	0	0
Volume	l	250	250	0	0
Weight	kg	693	693	0	0
Connections	G	2"	2"	0	0
Frame height	RH	2000	2000	0	0
Frame width	BT	2600	2600	0	0
Frame depth	RT	490	490	0	0
Finned height	LH	1920	1920	0	0
Finned width	LB	2372	2372	0	0
Frame on top	RO	40	40	0	0
Frame on bottom	RU	40	40	0	0
Frame in front	RV	30	30	0	0
Frame on back (~65/65/0/0)	RN	65	65	0	0
Collector covering	AD	163	163	0	0





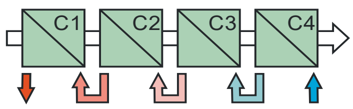
Tubes	Type	circular	circular	---	---
Tubes	DA / da	15.40 / 15.40	15.40 / 15.40	---	---
Tubes	S1 / S2	40.00 / 35.00	40.00 / 35.00	---	---
Tubes	---	staggered	staggered	---	---
Tubes	---	Cu	Cu	---	---
Tubes	---	smooth	smooth	---	---
Collector	---	Cu	Cu	---	---
Connections	---	Rg7	Rg7	---	---
Fins	LT / LD	2.50 / 0.20	2.50 / 0.20	---	---
Fins	---	Al	Al	---	---
Fins	---	ribbed	ribbed	---	---
Frame	---	AISI 304	AISI 304	---	---
Protection	---	without	without	---	---
Protection	---	---	---	---	---
Air flow direction	---	horizontal	horizontal	---	---





Heater 1: 40/35/15-12R-48T-2372A-2.5PA-18C-Cu/Al/AISI 304	EUR	11101.00	Delivery:	5-6 weeks
Heater 2: 40/35/15-12R-48T-2372A-2.5PA-18C-Cu/Al/AISI 304	EUR	11101.00	Validity:	12 weeks
Heater 3: ---	EUR	0.00	Condit.:	net, prepaid address
Heater 4: ---	EUR	0.00	Payment:	30 days net
Total	**EUR**	**22202.00**		

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Air humid	m3/h	30000.000
25 V% Et.glycol	m3/h	9.345



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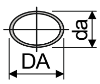
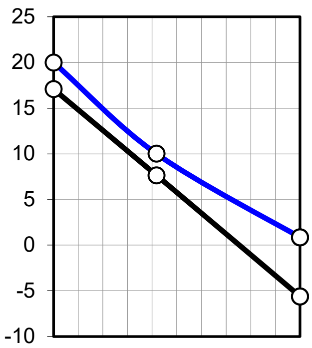
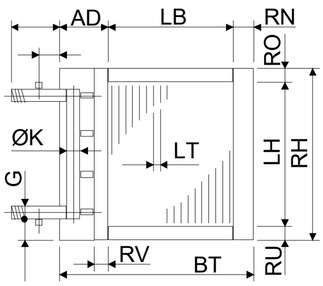
Air humid		Cooler 1	Cooler 2	Cooler 3	Cooler 4
Temp. Inlet	°C	20.000	10.007	0.862	0.862
Rel. humidity Inlet	%	40.000	75.986	100.000	100.000
Temp. Outlet	°C	10.007	0.862	0.862	0.862
Rel. humidity Outlet	%	75.986	100.000	100.000	100.000
Pressure drop	Pa	94.004	111.200	0.000	0.000

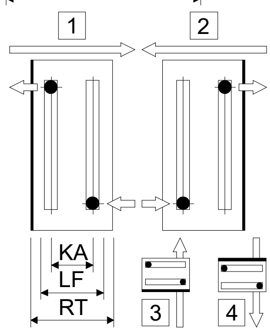
25 V% Et.glycol		Cooler 1	Cooler 2	Cooler 3	Cooler 4
Temp. Inlet	°C	7.653	-5.598	-5.598	-5.598
Temp. Outlet	°C	17.076	7.653	-5.598	-5.598
Pressure drop (103.59 %)	kPa	92.914	100.160	0.000	0.000

Heat exchanger		Cooler 1	Cooler 2	Cooler 3	Cooler 4
Capacity	kW	94.707	132.156	0.000	0.000
Surface reserve	%	0.222	0.332	0.000	0.000
Present surface	m2	1392.605	1392.605	0.000	0.000
Required surface	m2	1389.527	1387.998	0.000	0.000
k-coeff.	W/m2K	29.183	28.874	0.000	0.000
Average temp. diff.	K	2.336	3.298	0.000	0.000
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	5	5	0	0
Tube rows on the depth	Piece	12	12	0	0
Tube rows on the height	Piece	48	48	0	0
Number of circuits (NC)	Piece	18	18	0	0
Volume	l	250	250	0	0
Weight	kg	693	693	0	0
Connections	G	2"	2"	0	0
Frame height	RH	2000	2000	0	0
Frame width	BT	2600	2600	0	0
Frame depth	RT	490	490	0	0
Finned height	LH	1920	1920	0	0
Finned width	LB	2372	2372	0	0
Frame on top	RO	40	40	0	0
Frame on bottom	RU	40	40	0	0
Frame in front	RV	30	30	0	0
Frame on back (~65/65/0/0)	RN	65	65	0	0
Collector covering	AD	163	163	0	0
Tubes	Type	circular	circular	---	---
Tubes	DA / da	15.40 / 15.40	15.40 / 15.40	---	---
Tubes	S1 / S2	40.00 / 35.00	40.00 / 35.00	---	---
Tubes	---	staggered	staggered	---	---
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	---	ribbed	ribbed	---	---
Frame	---	AISI 304	AISI 304	---	---
Protection	---	without	without	---	---
Protection	---	---	---	---	---
Air flow direction	---	horizontal	horizontal	---	---



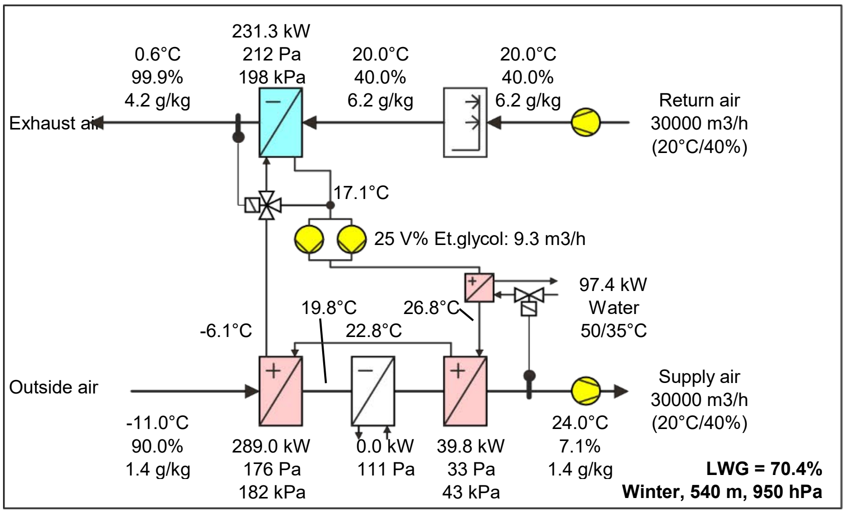


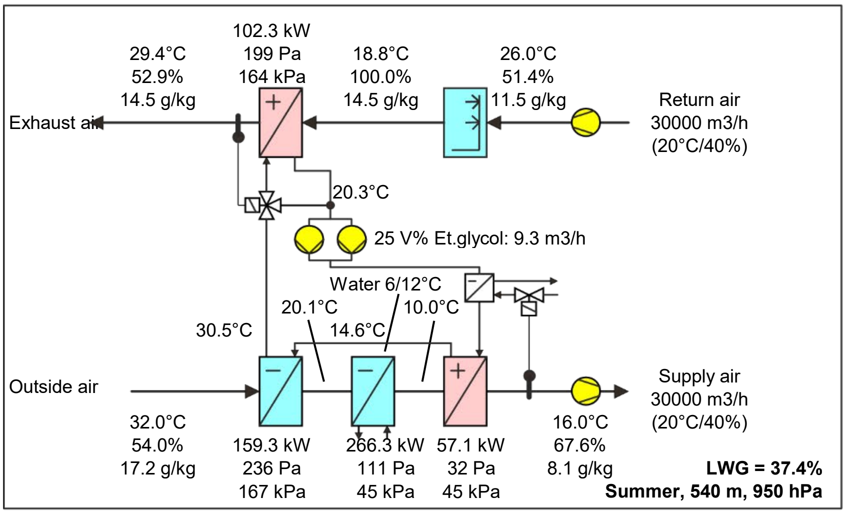


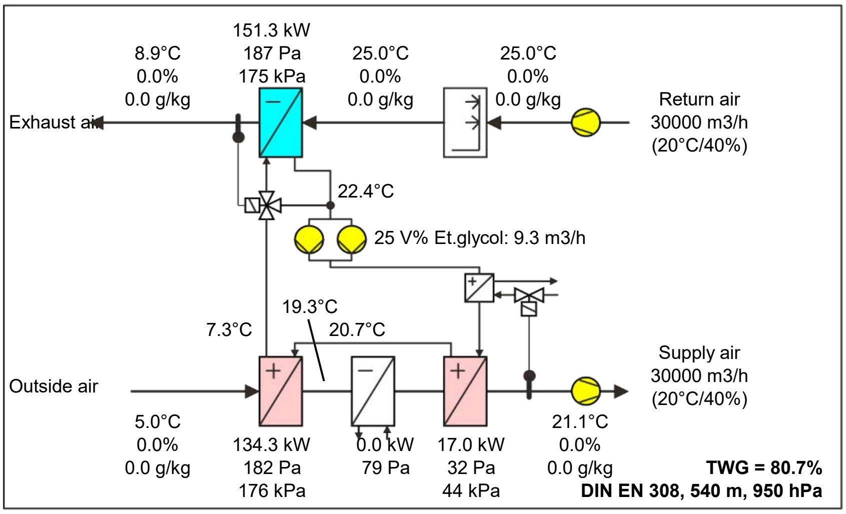


Cooler 1: 40/35/15-12R-48T-2372A-2.5PA-18C-Cu/Al/AISI 304	EUR	11101.00
Cooler 2: 40/35/15-12R-48T-2372A-2.5PA-18C-Cu/Al/AISI 304	EUR	11101.00
Cooler 3: ---	EUR	0.00
Cooler 4: ---	EUR	0.00
Total	**EUR**	**22202.00**

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







LOGO

Company
Branch
Street
Country / ZIP / City

Phone: xxxxxxxxxx
Fax: xxxxxxxxxx
E-Mail
Homepage

City, 14.10.2025
With the compliments of

Representative
Direct dialing
xxxxxxxxxx

Plant
Object
Position

Price total: EUR 56533.00

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

Conformity

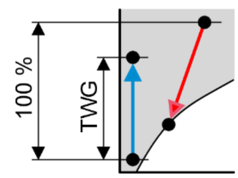
VDI 6022
VDI 3803-5

TÜV SÜD
Baumuster geprüft
Produktion überwacht
Basierend auf EN 308

Economy

EU: Net useful ratio / Year (MWh) 60.69%
EU: Net useful ratio / Year (EUR) 50.09%

CH: TWG = 83.15%
CH: JNG = 76.65%
CH: ETV = 12.09



Software by www.zcs.ch

Heat exchanger	---	---	ply air 1	ply air 2	urn air 1	urn air 2	Cooler	Heater
Tube rows	---	---	12	12	12	12	8	4
Volume	---	l	250	250	250	250	194	89
Weight	---	kg	693	693	693	693	498	258
Connections	G	---	2"	2"	2"	2"	4"	2"
Frame height	RH	mm	2000	2000	2000	2000	2000	2000
Frame width	BT	mm	2600	2600	2600	2600	2600	2600
Frame depth	RT	mm	490	490	490	490	380	210
Finned height	LH	mm	1920	1920	1920	1920	1920	1920
Finned width	LB	mm	2372	2372	2372	2372	2341	2372
Finned depth	LF	mm	420	420	420	420	280	140
Fin spacing	LT	mm	2.50	2.50	2.50	2.50	2.50	2.50
Fin thickness	LD	mm	0.20	0.20	0.20	0.20	0.20	0.20
Tube thickness	S	mm	0.40	0.40	0.40	0.40	0.40	0.40
Tubes	---	---	Cu	Cu	Cu	Cu	Cu	Cu
Collector	---	---	Cu	Cu	Cu	Cu	Cu	Cu
Fins	---	---	Al	Al	Al	Al	Al	Al
Frame	---	---	AISI 304	AISI 304	AISI 304	AISI 304	AISI 304	AISI 304
Price	---	EUR	11101.00	11101.00	11101.00	11101.00	8057.00	4072.00

Heat exchanger

Two-piece in the supply air
Two-piece in the exhaust air
One-piece in the supply air
One-piece in the supply air