



# Dehumidification in the hot and humid summer

The method of dehumidification in the hot and humid summer, for example in an open-plan office or in a hospital, must not be considered on its own. Rather, when designing the air condition unit, you have to take into account the outdoor air conditions throughout the year.

Theoretically, it can be used to dehumidify very well in the hot and humid summer and heat in winter. As a result of increasing **leakage** of the rotors, this type of air condition unit is not allowed in hospitals. If the exhaust fan is not positioned in the exhaust air (FOL), but far too often in the return air (ABL), far too much **exhaust air is forced into the supply air** as a result of the pressure conditions. The regeneration of the **adsorbent** is limited by the cycle and is not renewable, which is why these very expensive desiccant rotors have to be replaced at regular intervals. The drag heat on the desiccant rotors is another problem.

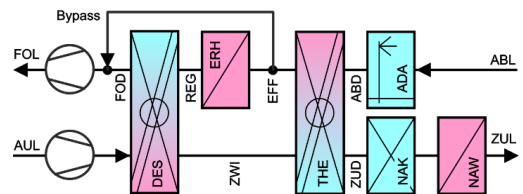
Water-soluble **lithium chloride** is often used as a liquid **adsorbent**, which must be continuously regenerated and concentrated with high energy consumption. We call this an **add-on to air condition units**, as it does not cover all the other necessary functions of an air condition unit. **Request to Alfa Laval (USA):** KATHABAR system, open-plan office, Bern 540 m, outside air 25,000 m<sup>3</sup>/h, 32°C/40%, supply air 16°C/70%. **Offer:** As a rule, an open-plan office is not the best application for us, as the **equipment is somewhat exaggerated in terms of precision and price**. FV1200 and FP6 device, price US\$ 400,000, delivery time 6 months. My conclusion: Desiccant processes with liquid adsorbent really have no place in the air conditioning industry!

Many industrial processes rely on dry air, otherwise the products to be manufactured 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 adiabatically pre-cooled**. The rest must be cooled with cold water of 6/12°C, for example.

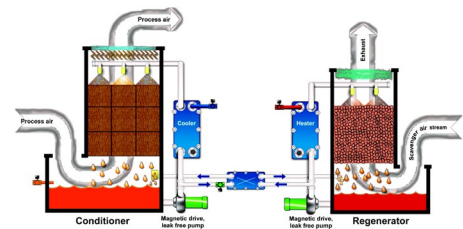
Both coolers must have smooth fins that allow the condensate to drain well. The thickness of the fins should be at least 0.2 mm to generate large condensate droplets. These are combined into even larger droplets in the upstream demister and separated in the downstream droplet separator. Droplet separators must have a pressure drop of at least 100 Pa to ensure a high fractional separation efficiency. If this advice is not followed, you should not be surprised, if the air heater in the cold recovery system does not reach the required air outlet temperature and the air outlet humidity is far too high. The cause is mainly due to the totally insufficient condensate separation efficiency. Some of the condensate gets into the air heater, which is really not the point.

Counterflow in finned heat exchangers only exists in the imagination of a few producers, who do not care whether the temperature efficiency of heat recovery systems is only achieved at 50% instead of the promised 70%! It is hoped, that no remeasurements will be taken. Correct procedure is described below and has been confirmed by measurements in the laboratory. When it comes to cooling humid air, opinions about the latent power differ widely. Only those who calculate the cooling process with finite elements can determine exactly how the cooling process works. For the moist air and coolant, the Reynolds number goes down and Prandtl number goes up during the cooling process. Therefore, the k-value decreases. However, as soon as condensate forms, the k-value increases. **This can only be determined and taken into account by finite elements.** The beautiful exponential temperature gradients must be forgotten, because at the beginning only sensitive capacity can be dissipated and only towards the end latent capacity can be dissipated. The temperature gradients deform. Since the temperature difference  $\Delta t_m$  must be understood as the area between the two temperature gradients, this reduces the  $\Delta t_m$  extremely, even in the counter-current, of course! In thermodynamic process technology, the pinch point is defined as the smallest temperature difference between the two media. Conclusion: **Latent capacity reduces the average temperature difference!**

## Air condition unit with solid adsorbent



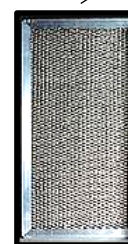
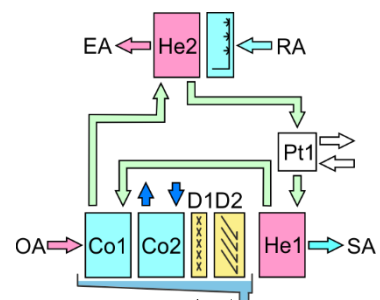
## Auxiliary devices with liquid adsorbent



## Air condition unit with CCSF HR-System

- RA: Return air
- EA: Exhaust air
- OA: Outside air with 17 g/kg
- SA: Supply air with 8 g/kg (Option with 4 g/kg)
- He1: Air heater
- He2: Air heater
- Co1: Air cooler
- Co2: Air cooler

- D1: Demister
- D2: Droplet separator



What the CCSF HR-System can do throughout the year, please see the following pages.

CC-System in summer		SA-Co1	SA-Co2	SA-He	RA-Hy
Capacity	kW	119.277	225.649	43.461	75.816
Surface reserve	%	0.016	1.769	1.183	0.351
Present surface	m2	1560.699	783.001	308.831	1560.699
Temp. in ( 26.000 )	°C	32.000	20.710	10.519	18.780
Rel. humidity in ( 51.420 )	%	54.000	96.443	100.000	100.000
Abs. humidity in ( 11.500 )	g/kg	17.228	15.793	8.439	14.502
Temp. out	°C	20.710	10.519	16.000	28.234
Rel. humidity out	%	96.443	100.000	70.000	56.631
Abs. humidity out	g/kg	15.793	8.439	8.439	14.502
Velocity	m/s	1.905	1.853	1.798	1.881
Pressure drop	Pa	190.620	99.673	29.808	164.645
Moistening temperature	°C				15.000



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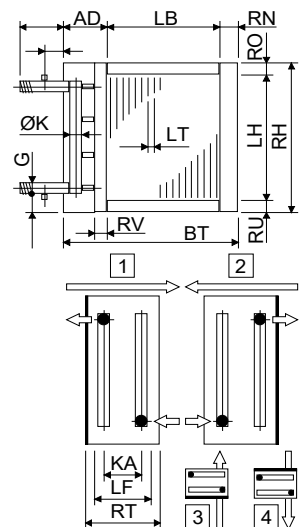
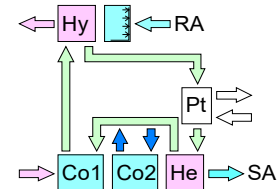
Plant  
Object  
Position

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	25000.000
Return air	m3/h	25000.000
<b>25 V% Et.glycol</b>		
Temp. in	°C	16.200
Temp. out	°C	29.400
Volume flow	m3/h	8.396
Pressure drop total	kPa	324.154
<b>Water</b>		
SA-Co2		
Temp. in	°C	6.000
Temp. out	°C	12.000
Volume flow	m3/h	32.282
Pressure drop	kPa	35.150



Technical data		SA-Co1	SA-Co2	SA-He	RA-Hy
Tubes blank	Piece	12	0	0	12
Int. vent./drains	Piece	7	0	1	7
Tube rows on the depth	Piece	16	10	4	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	14	48	24	14
Volume	l	279	201	77	279
Weight	kg	770	470	200	770
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	450	210	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1941	1972	1972
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	3.100	3.200	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	in line	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	12533.00	7940.00	3347.00	12533.00

Software by www.zcs.ch



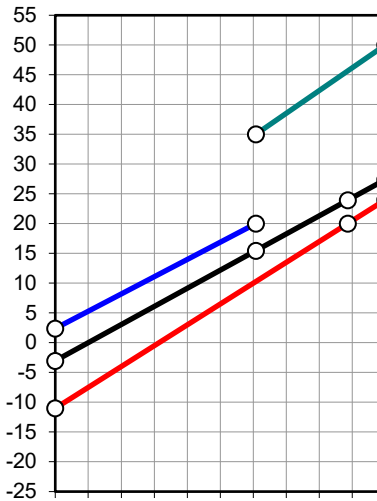
Delivery: 5-6 weeks  
Validity: 12 weeks  
Condit.: net, prepaid address  
Payment: 30 days net

CC-System in winter		SA-He1	SA-Co	SA-He2	RA-Hy
Capacity	kW	242.863		31.106	166.433
Surface reserve	%	0.000		0.409	0.291
Present surface	m2	1560.699	783.001	308.831	1560.699
Temp. in	°C	-11.000		20.028	20.000
Rel. humidity in	%	90.000		9.083	40.000
Abs. humidity in	g/kg	1.394		1.394	6.175
Temp. out	°C	20.028		24.000	2.395
Rel. humidity out	%	9.083		7.134	99.228
Abs. humidity out	g/kg	1.394		1.394	4.765
Velocity	m/s	1.724	1.724	1.833	1.777
Pressure drop	Pa	145.944	70.946	30.298	170.974

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	25000.000
Return air	m3/h	25000.000

25 V% Et.glycol		
Temp. in	°C	27.396
Temp. out	°C	-3.032
Volume flow	m3/h	8.396
Pressure drop total	kPa	361.692

Water		
Temp. in	°C	---
Temp. out	°C	---
Volume flow	m3/h	---
Pressure drop	kPa	---



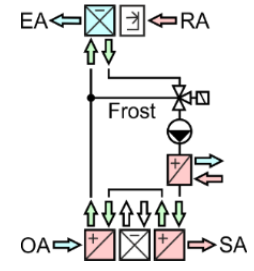
Technical data		SA-He1	SA-Co	SA-He2	RA-Hy
Tubes blank	Piece	12	0	0	12
Int. vent./drains	Piece	7	0	1	7
Tube rows on the depth	Piece	16	10	4	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	14	48	24	14
Volume	l	279	201	77	279
Weight	kg	770	470	200	770
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	450	210	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1941	1972	1972
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	3.100	3.200	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	in line	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	---	---	---	---	---
<b>Price</b>	<b>EUR</b>	<b>12533.00</b>	<b>7940.00</b>	<b>3347.00</b>	<b>12533.00</b>



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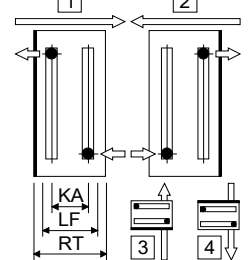
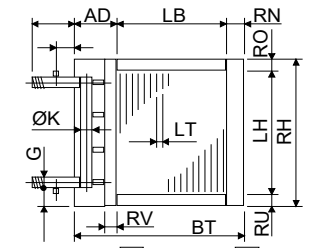
Plant  
Object  
Position



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### Heat exchanger (Pt)

Capacity	kW	107.537
in	°C	50.000
out	°C	35.000
in	°C	15.453
out	°C	27.396



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	164.213		21.148	185.301
Surface reserve	%	0.351		0.305	0.315
Present surface	m <sup>2</sup>	1560.699	783.001	308.831	1560.699
Temp. in	°C	-11.000		9.983	20.000
Rel. humidity in	%	90.000		17.313	40.000
Abs. humidity in	g/kg	1.394		1.394	6.175
Temp. out	°C	9.983		12.684	1.140
Rel. humidity out	%	17.313		14.483	99.404
Abs. humidity out	g/kg	1.394		1.394	4.362
Velocity	m/s	1.693	1.693	1.766	1.773
Pressure drop	Pa	142.210	70.946	29.081	175.104

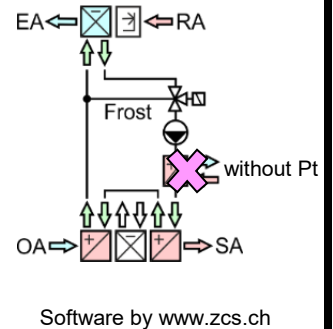


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Position



### Definition

Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m <sup>3</sup> /h	25000.000
Return air	m <sup>3</sup> /h	25000.000

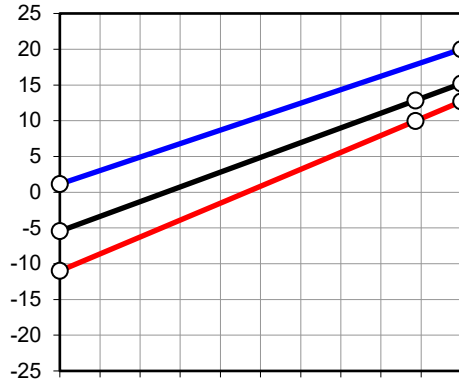
### 25 V% Et.glycol

Temp. in	°C	15.198
Temp. out	°C	-5.450
Volume flow	m <sup>3</sup> /h	8.396
Pressure drop total	kPa	372.591

### Water

Temp. in	°C	---
Temp. out	°C	---
Volume flow	m <sup>3</sup> /h	---
Pressure drop	kPa	---

Efficiency: Supply air = 76.400 %  
Efficiency: Return air = 60.839 %

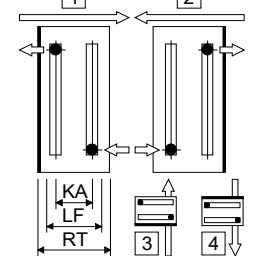
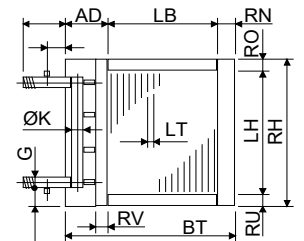


Technical data		SA-He1-Red	SA-Co-Red	SA-He2-Red	RA-Hy-Red
Tubes blank	Piece	12	0	0	12
Int. vent./drains	Piece	7	0	1	7
Tube rows on the depth	Piece	16	10	4	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	14	48	24	14
Volume	l	279	201	77	279
Weight	kg	770	470	200	770
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	450	210	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1941	1972	1972
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	3.100	3.200	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	in line	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	---	---	---	---	---
<b>Price</b>	<b>EUR</b>	<b>12533.00</b>	<b>7940.00</b>	<b>3347.00</b>	<b>12533.00</b>



### Heat exchanger (Pt)

Capacity	kW	0.000
in	°C	---
out	°C	---
in	°C	15.198
out	°C	15.198

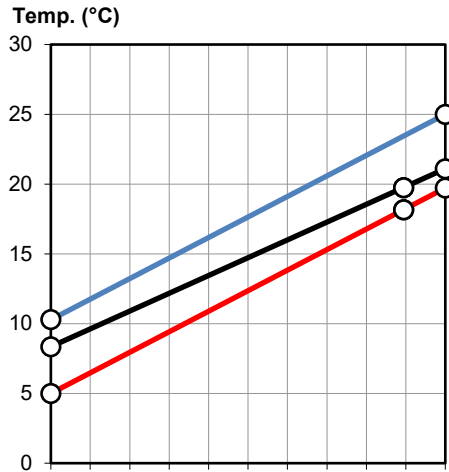


Delivery: 5-6 weeks  
Validity: 12 weeks  
Condit.: net, prepaid address  
Payment: 30 days net

CC-System ( DIN EN 308 )		SA-He1	SA-Co	SA-He2	RA-Hy
Capacity	kW	102.762		12.185	114.945
Surface reserve	%	0.059		1.147	1.969
Present surface	m2	1560.699	783.001	308.831	1560.699
Temp. in	°C	5.000		18.160	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	18.160		19.720	10.283
Rel. humidity out	%	0.000		0.000	0.000
Abs. humidity out	g/kg	0.000		0.000	0.000
Velocity	m/s	1.764	1.764	1.810	1.801
Pressure drop	Pa	150.812	70.946	29.845	155.391
Temp. efficiency	%	73.600			

Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	25000.000
Return air	m3/h	25000.000

25 V% Et.glycol		
Temp. in	°C	21.102
Temp. out	°C	8.348
Volume flow	m3/h	8.396
Pressure drop total	kPa	341.016



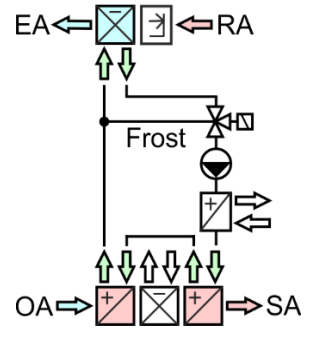
Technical data		SA-He1	SA-Co	SA-He2	RA-Hy
Tubes blank	Piece	12	0	0	12
Int. vent./drains	Piece	7	0	1	7
Tube rows on the depth	Piece	16	10	4	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	14	48	24	14
Volume	l	279	201	77	279
Weight	kg	770	470	200	770
Connections	G	2"	4"	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	450	210	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1941	1972	1972
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	3.100	3.200	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	in line	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	12533.00	7940.00	3347.00	12533.00



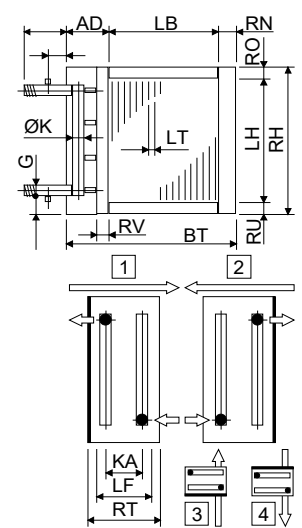
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Delivery: 5-6 weeks  
Validity: 12 weeks  
Condit.: net, prepaid address  
Payment: 30 days net

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



No	Outside air		CCSB		Return air		Exhaust air		Efficiency %	Capacity kW	Energy MWh
	°C	%	°C	%	°C	%	°C	%			
1	-8.7	84.0	13.9	15.4	21.1	34.5	2.0	94.6	75.89	176.79	25.05
2	-3.3	78.4	15.0	21.3	21.2	35.0	4.8	89.4	74.64	143.42	20.32
3	-1.4	79.2	15.4	24.5	21.3	35.4	5.9	87.8	74.24	132.42	18.76
4	-0.2	78.5	15.8	26.3	21.4	35.9	6.6	86.8	74.05	125.75	17.82
5	0.8	76.3	16.1	27.1	21.5	36.3	7.2	85.9	73.90	120.08	17.01
6	1.6	79.2	16.4	29.4	21.6	36.7	7.7	85.2	73.77	115.81	16.41
7	2.4	77.1	16.6	29.7	21.7	37.2	8.2	84.7	73.67	111.91	15.85
8	3.0	77.3	16.9	30.7	21.8	37.6	8.7	84.4	73.61	108.81	15.42
9	3.6	76.2	17.1	31.0	21.9	38.1	9.1	84.0	73.56	105.97	15.01
10	4.2	75.3	17.3	31.5	22.0	38.5	9.4	83.8	73.51	103.36	14.64
11	4.7	75.9	17.5	32.5	22.2	39.0	9.8	83.5	73.45	100.74	14.27
12	5.3	73.8	17.7	32.4	22.3	39.4	10.2	83.2	73.41	98.13	13.90
13	5.9	75.2	18.0	34.0	22.4	39.9	10.6	82.7	73.34	95.13	13.48
14	6.5	72.4	18.2	33.6	22.5	40.3	11.0	82.2	73.28	92.01	13.04
15	7.1	73.7	18.4	35.1	22.6	40.7	11.4	81.7	73.23	89.31	12.65
16	7.7	72.1	18.7	35.2	22.7	41.2	11.8	81.2	73.19	86.62	12.27
17	8.3	73.0	18.9	36.7	22.8	41.6	12.3	80.4	73.14	83.43	11.82
18	9.0	73.9	19.2	38.3	22.9	42.1	12.8	79.5	73.11	80.25	11.37
19	9.6	73.3	19.4	39.1	23.0	42.5	13.3	78.2	73.10	77.09	10.92
20	10.3	71.7	19.7	39.2	23.1	43.0	13.7	77.2	73.11	74.21	10.51
21	10.9	72.5	19.7	40.7	23.2	43.4	14.2	76.0	73.10	69.71	9.88
22	11.5	68.9	19.6	39.7	23.3	43.9	14.7	74.8	73.12	63.39	8.98
23	12.3	68.7	19.4	40.9	23.4	44.3	15.3	73.4	73.11	56.46	8.00
24	13.1	69.7	19.3	42.9	23.5	44.7	15.9	71.8	73.09	49.26	6.98
25	13.7	67.7	19.1	42.8	23.6	45.2	16.4	70.7	73.10	42.95	6.09
26	14.3	69.5	19.0	45.0	23.8	45.6	16.9	69.8	73.08	37.29	5.28
27	14.9	71.2	18.9	47.3	23.9	46.1	17.3	68.8	73.06	31.12	4.41
28	15.5	71.6	18.7	48.7	24.0	46.5	17.8	67.9	73.05	25.39	3.60
29	16.1	71.0	18.6	49.4	24.1	47.0	18.3	67.0	73.04	19.44	2.75
30	16.7	67.3	18.4	48.0	24.2	47.4	18.8	66.1	73.06	13.38	1.90
31	17.4	64.6	18.3	47.3	24.3	47.9	19.2	65.1	73.08	7.30	1.03
32	18.0	64.9	18.1	48.6	24.4	48.3	19.7	64.2	73.07	1.18	0.17
33	18.6	63.9	17.5	68.6	17.1	100.0	18.2	93.2	73.20	8.99	1.27
34	19.3	64.2	17.8	70.6	17.3	100.0	18.8	91.1	73.18	11.96	1.69
35	20.1	64.5	18.2	73.0	17.4	100.0	19.4	88.4	73.16	15.75	2.23
36	21.0	60.2	18.5	70.3	17.6	100.0	20.1	85.5	73.19	20.05	2.84
37	22.0	62.1	18.9	75.3	17.7	100.0	20.9	82.4	73.13	24.90	3.53
38	23.2	60.1	19.3	76.2	17.9	100.0	21.8	78.7	73.12	30.95	4.38
39	24.8	56.4	19.9	76.0	18.1	100.0	23.0	74.0	73.11	39.23	5.56
40	28.3	50.1	21.0	77.7	18.2	100.0	25.6	63.9	73.07	58.95	8.35

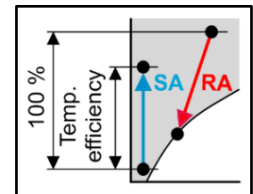
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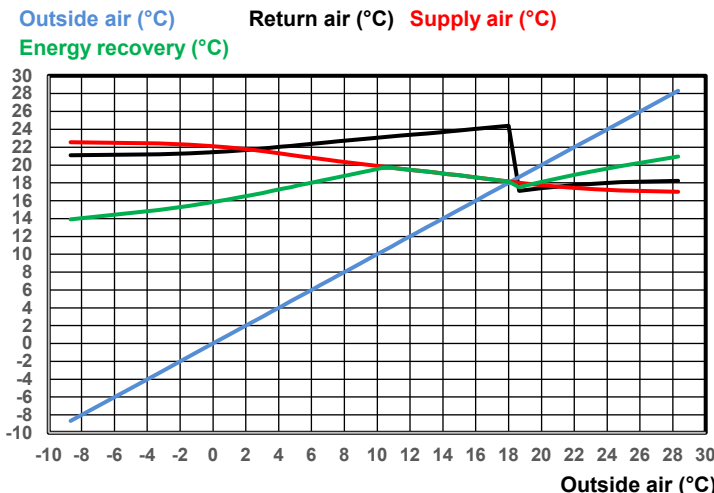
Plant  
Object  
Position



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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	359.57	EUR	21574.00	( 60.00 EUR/MWh )
EU: Energy recovery: Cold energy	MWh	29.86	EUR	2389.00	( 80.00 EUR/MWh )
EU: 2 Fan + Glycol pump	MWh	-32.92	EUR	-3292.00	( 100.00 EUR/MWh )
EU: Energy recovery: Net useful ratio / Year	MWh	356.51	EUR	20671.00	( 57.98 EUR/MWh )
EU: Need of energy total / Year	MWh	616.08	EUR	42911.96	( 69.65 EUR/MWh )
EU: Net useful ratio / Year	%	57.87	%	48.17	TWG = 76.40%
CH: Guidelines from associations such as SIA and SWKI: TWG>70.00% & JNG>75.00% & ETV>15.00					JNG = 73.21%
					ETV = 13.65



Station		Bern (CH)
Height over sea level	m	540.00
Pressure	hPa	949.65
Outside air	m3/h	25000.00
Return air	m3/h	25000.00
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	75000.00
Costs with CC-System	EUR	139000.00
Additional costs	EUR	64000.00
BEP (Break even point) after	Years	3.69

CC-System in summer		SA-Co1	SA-Co2	SA-He	RA-Hy
Capacity	kW	193.668	317.214	118.049	75.618
Surface reserve	%	0.590	2.669	3.136	7.402
Present surface	m2	1560.699	566.565	1170.524	1560.699
Temp. in ( 26.000 )	°C	32.000	17.800	1.000	18.780
Rel. humidity in ( 51.420 )	%	54.000	96.957	100.000	100.000
Abs. humidity in ( 11.500 )	g/kg	17.228	13.198	4.344	14.502
Temp. out	°C	17.800	1.000	16.000	28.209
Rel. humidity out	%	96.957	100.000	36.268	56.712
Abs. humidity out	g/kg	13.198	4.344	4.344	14.502
Velocity	m/s	1.892	1.834	1.757	1.881
Pressure drop	Pa	220.336	85.023	112.576	164.636
Moistening temperature	°C				15.000



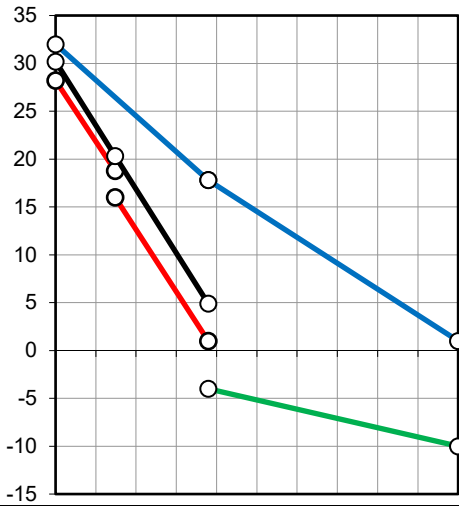
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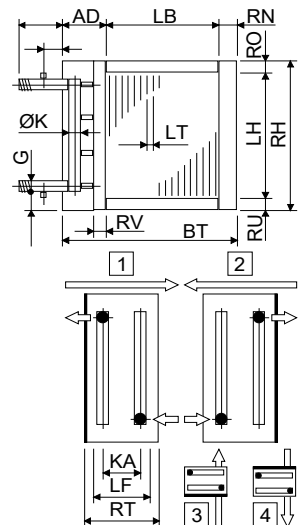
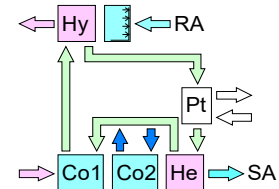
Plant  
Object  
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Definition		
Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m3/h	25000.000
Return air	m3/h	25000.000
<b>25 V% Et.glycol</b>		
Temp. in	°C	4.900
Temp. out	°C	30.200
Volume flow	m3/h	7.121
Pressure drop total	kPa	425.846
<b>25 V% Et.glycol SA-Co2</b>		
Temp. in	°C	-10.000
Temp. out	°C	-4.000
Volume flow	m3/h	49.714
Pressure drop	kPa	57.258



Technical data		SA-Co1	SA-Co2	SA-He	RA-Hy
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	7	0	5	7
Tube rows on the depth	Piece	16	6	12	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	12	48	16	12
Volume	l	279	153	212	279
Weight	kg	770	390	587	770
Connections	G	2"	NW125	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	340	490	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1909	1972	1972
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	226	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	in line	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	12523.00	6700.00	9539.00	12523.00

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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-Co	SA-He2	RA-Hy
Capacity	kW	146.050		127.920	184.472
Surface reserve	%	0.000		0.010	0.015
Present surface	m2	1560.699	566.565	1170.524	1560.699
Temp. in	°C	-11.000		7.662	20.000
Rel. humidity in	%	90.000		20.243	40.000
Abs. humidity in	g/kg	1.394		1.394	6.175
Temp. out	°C	7.662		24.000	1.250
Rel. humidity out	%	20.243		7.134	98.970
Abs. humidity out	g/kg	1.394		1.394	4.377
Velocity	m/s	1.686	1.686	1.794	1.773
Pressure drop	Pa	141.352	64.294	116.051	175.002

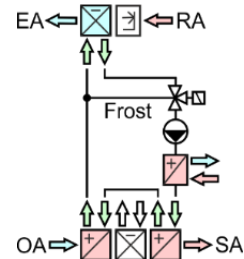


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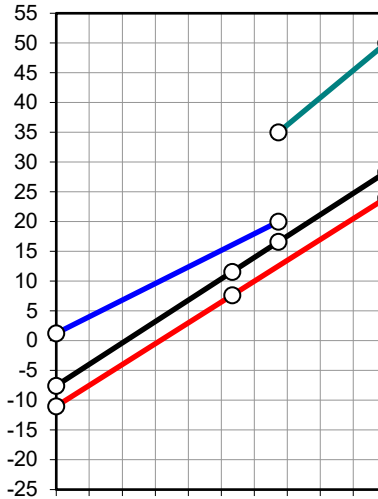
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Position



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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	25000.000
Return air	m3/h	25000.000



25 V% Et.glycol		
Temp. in	°C	28.353
Temp. out	°C	-7.545
Volume flow	m3/h	7.121
Pressure drop total	kPa	482.469

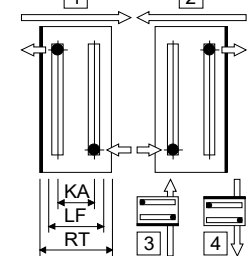
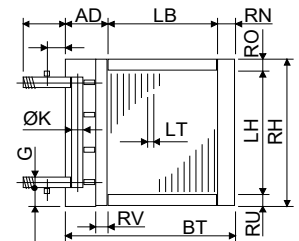
25 V% Et.glycol		
Temp. in	°C	---
Temp. out	°C	---
Volume flow	m3/h	---
Pressure drop	kPa	---

Technical data		SA-He1	SA-Co	SA-He2	RA-Hy
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	7	0	5	7
Tube rows on the depth	Piece	16	6	12	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	12	48	16	12
Volume	l	279	153	212	279
Weight	kg	770	390	587	770
Connections	G	2"	NW125	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	340	490	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1909	1972	1972
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	226	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	in line	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	---	---	---	---	---
<b>Price</b>	<b>EUR</b>	<b>12523.00</b>	<b>6700.00</b>	<b>9539.00</b>	<b>12523.00</b>



### Heat exchanger (Pt)

Capacity	kW	89.498
in	°C	50.000
out	°C	35.000
in	°C	16.626
out	°C	28.353



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	102.698		88.003	190.249
Surface reserve	%	0.396		0.457	0.692
Present surface	m2	1560.699	566.565	1170.524	1560.699
Temp. in	°C	-11.000		2.123	20.000
Rel. humidity in	%	90.000		29.756	40.000
Abs. humidity in	g/kg	1.394		1.394	6.175
Temp. out	°C	2.123		13.366	0.833
Rel. humidity out	%	29.756		13.853	99.063
Abs. humidity out	g/kg	1.394		1.394	4.251
Velocity	m/s	1.668	1.668	1.744	1.772
Pressure drop	Pa	139.309	64.294	111.471	176.241

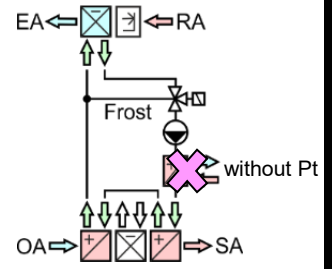


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Position



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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	25000.000
Return air	m3/h	25000.000

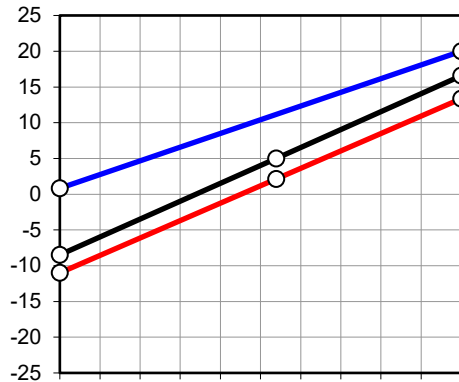
### 25 V% Et.glycol

Temp. in	°C	16.572
Temp. out	°C	-8.480
Volume flow	m3/h	7.121
Pressure drop total	kPa	492.510

### 25 V% Et.glycol

Temp. in	°C	---
Temp. out	°C	---
Volume flow	m3/h	---
Pressure drop	kPa	---

Efficiency: Supply air = 78.600 %  
Efficiency: Return air = 61.830 %

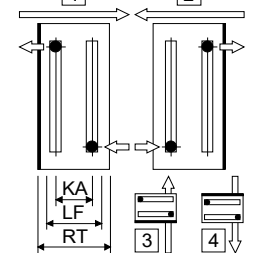
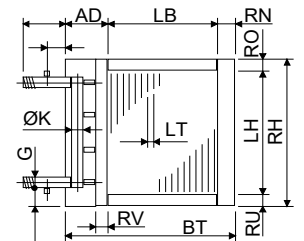


Technical data		SA-He1-Red	SA-Co-Red	SA-He2-Red	RA-Hy-Red
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	7	0	5	7
Tube rows on the depth	Piece	16	6	12	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	12	48	16	12
Volume	l	279	153	212	279
Weight	kg	770	390	587	770
Connections	G	2"	NW125	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	340	490	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1909	1972	1972
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	226	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	in line	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	---	---	---	---	---
<b>Price</b>	<b>EUR</b>	<b>12523.00</b>	<b>6700.00</b>	<b>9539.00</b>	<b>12523.00</b>



### Heat exchanger (Pt)

Capacity	kW	0.000
in	°C	---
out	°C	---
in	°C	16.572
out	°C	16.572



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

CC-System ( DIN EN 308 )		SA-He1	SA-Co	SA-He2	RA-Hy
Capacity	kW	66.681		53.421	120.101
Surface reserve	%	0.019		0.389	0.648
Present surface	m <sup>2</sup>	1560.699	566.565	1170.524	1560.699
Temp. in	°C	5.000		13.540	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	13.540		20.380	9.623
Rel. humidity out	%	0.000		0.000	0.000
Abs. humidity out	g/kg	0.000		0.000	0.000
Velocity	m/s	1.750	1.750	1.797	1.799
Pressure drop	Pa	149.078	64.294	116.361	155.141

Temp. efficiency	%	76.900
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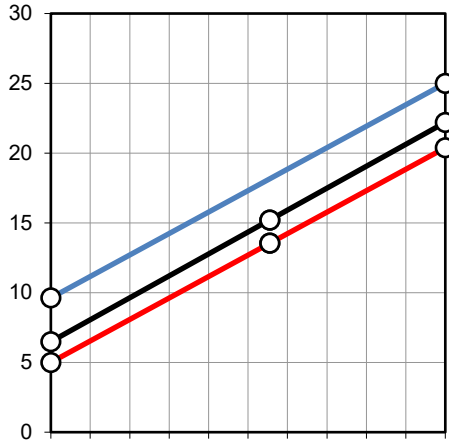
#### Definition

Height over sea level	m	540.000
Pressure	hPa	949.653
Temp.	°C	20.000
Rel. humidity	%	40.000
Supply air	m <sup>3</sup> /h	25000.000
Return air	m <sup>3</sup> /h	25000.000

#### 25 V% Et.glycol

Temp. in	°C	22.201
Temp. out	°C	6.487
Volume flow	m <sup>3</sup> /h	7.121
Pressure drop total	kPa	444.212

Temp. (°C)



Technical data		SA-He1	SA-Co	SA-He2	RA-Hy
Tubes blank	Piece	0	0	0	0
Int. vent./drains	Piece	7	0	5	7
Tube rows on the depth	Piece	16	6	12	16
Tube rows on the height	Piece	48	48	48	48
Number of circuits (NC)	Piece	12	48	16	12
Volume	l	279	153	212	279
Weight	kg	770	390	587	770
Connections	G	2"	NW125	2"	2"
Frame height	RH	2000	2000	2000	2000
Frame width	BT	2200	2200	2200	2200
Frame depth	RT	630	340	490	630
Finned height	LH	1920	1920	1920	1920
Finned width	LB	1972	1909	1972	1972
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	226	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	in line	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	---	---	---	---	---
<b>Price</b>	<b>EUR</b>	<b>12523.00</b>	<b>6700.00</b>	<b>9539.00</b>	<b>12523.00</b>

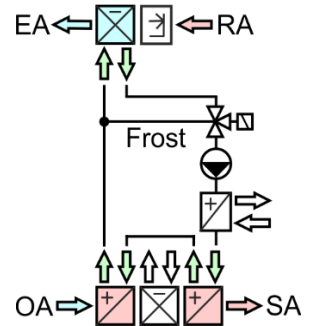


Company  
Branch  
Street  
Country / ZIP / City  
Phone: xxxxxxxxxx  
Fax: xxxxxxxxxx  
E-Mail  
Homepage

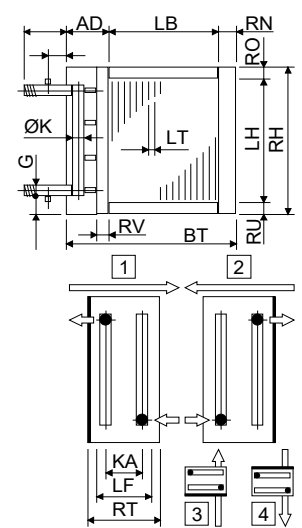
City, 15.1.2025  
With the compliments of

Representative  
Direct dialing  
xxxxxxxxxx

Plant  
Object  
Position



Software by www.zcs.ch



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		CCSB		Return air		Exhaust air		Efficiency %	Capacity kW	Energy MWh
	°C	%	°C	%	°C	%	°C	%			
1	-8.7	84.0	14.3	15.0	21.1	34.5	1.8	95.1	77.04	179.48	25.43
2	-3.3	78.4	15.3	20.9	21.2	35.0	4.6	90.0	75.79	145.63	20.63
3	-1.4	79.2	15.7	24.1	21.3	35.4	5.7	88.3	75.38	134.46	19.05
4	-0.2	78.5	16.0	25.9	21.4	35.9	6.4	87.4	75.18	127.68	18.09
5	0.8	76.3	16.3	26.7	21.5	36.3	7.1	86.5	75.03	121.92	17.27
6	1.6	79.2	16.6	29.0	21.6	36.7	7.6	85.8	74.90	117.59	16.66
7	2.4	77.1	16.9	29.3	21.7	37.2	8.1	85.3	74.80	113.63	16.10
8	3.0	77.3	17.1	30.3	21.8	37.6	8.5	85.0	74.72	110.46	15.65
9	3.6	76.2	17.3	30.6	21.9	38.1	8.9	84.7	74.67	107.57	15.24
10	4.2	75.3	17.5	31.1	22.0	38.5	9.3	84.4	74.63	104.93	14.87
11	4.7	75.9	17.7	32.1	22.2	39.0	9.7	84.1	74.57	102.27	14.49
12	5.3	73.8	17.9	32.0	22.3	39.4	10.1	83.8	74.52	99.61	14.11
13	5.9	75.2	18.2	33.6	22.4	39.9	10.5	83.3	74.44	96.56	13.68
14	6.5	72.4	18.4	33.3	22.5	40.3	10.9	82.9	74.38	93.39	13.23
15	7.1	73.7	18.6	34.7	22.6	40.7	11.3	82.4	74.32	90.64	12.84
16	7.7	72.1	18.8	34.9	22.7	41.2	11.7	81.9	74.27	87.91	12.45
17	8.3	73.0	19.1	36.4	22.8	41.6	12.2	81.2	74.21	84.66	11.99
18	9.0	73.9	19.3	37.9	22.9	42.1	12.6	80.2	74.18	81.43	11.54
19	9.6	73.3	19.6	38.7	23.0	42.5	13.1	79.0	74.17	78.22	11.08
20	10.3	71.7	19.8	38.9	23.1	43.0	13.6	77.9	74.18	75.30	10.67
21	10.9	72.5	19.7	40.4	23.2	43.4	14.1	76.7	74.17	69.71	9.88
22	11.5	68.9	19.6	39.4	23.3	43.9	14.6	75.4	74.18	63.39	8.98
23	12.3	68.7	19.4	40.6	23.4	44.3	15.2	73.9	74.18	56.46	8.00
24	13.1	69.7	19.3	42.6	23.5	44.7	15.8	72.3	74.16	49.26	6.98
25	13.7	67.7	19.1	42.5	23.6	45.2	16.3	71.2	74.17	42.95	6.09
26	14.3	69.5	19.0	44.7	23.8	45.6	16.8	70.3	74.15	37.29	5.28
27	14.9	71.2	18.9	47.1	23.9	46.1	17.3	69.2	74.12	31.12	4.41
28	15.5	71.6	18.7	48.4	24.0	46.5	17.7	68.3	74.11	25.39	3.60
29	16.1	71.0	18.6	49.2	24.1	47.0	18.2	67.4	74.11	19.44	2.75
30	16.7	67.3	18.4	47.8	24.2	47.4	18.7	66.4	74.13	13.38	1.90
31	17.4	64.6	18.3	47.1	24.3	47.9	19.2	65.4	74.14	7.30	1.03
32	18.0	64.9	18.1	48.4	24.4	48.3	19.7	64.4	74.13	1.18	0.17
33	18.6	63.9	17.5	68.7	17.1	100.0	18.2	93.1	74.27	9.13	1.29
34	19.3	64.2	17.8	70.6	17.3	100.0	18.8	90.9	74.25	12.13	1.72
35	20.1	64.5	18.1	73.1	17.4	100.0	19.4	88.3	74.23	15.98	2.26
36	21.0	60.2	18.5	70.5	17.6	100.0	20.1	85.4	74.25	20.34	2.88
37	22.0	62.1	18.8	75.5	17.7	100.0	20.9	82.2	74.20	25.26	3.58
38	23.2	60.1	19.3	76.4	17.9	100.0	21.8	78.5	74.19	31.40	4.45
39	24.8	56.4	19.8	76.4	18.1	100.0	23.0	73.7	74.18	39.80	5.64
40	28.3	50.1	20.8	78.2	18.2	100.0	25.7	63.5	74.13	59.81	8.47

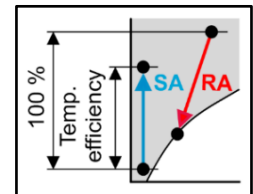
Company  
Branch  
Street  
Country / ZIP / City

Phone: xxxxxxxxx  
Fax: xxxxxxxxx  
E-Mail  
Homepage

City, 15.1.2025  
With the compliments of

Representative  
Direct dialing  
xxxxxxxxx

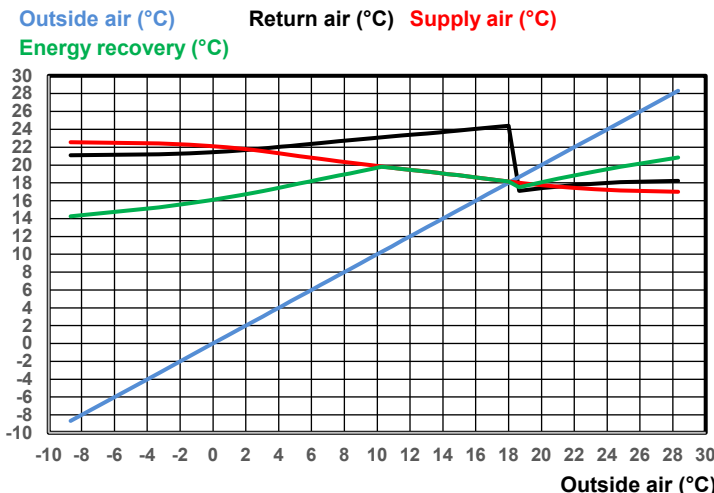
Plant  
Object  
Position



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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	364.11	EUR	21847.00	( 60.00 EUR/MWh )
EU: Energy recovery: Cold energy	MWh	30.29	EUR	2424.00	( 80.00 EUR/MWh )
EU: 2 Fan + Glycol pump	MWh	-37.33	EUR	-3733.00	( 100.00 EUR/MWh )
EU: Energy recovery: Net useful ratio / Year	MWh	357.08	EUR	20538.00	( 57.52 EUR/MWh )
EU: Need of energy total / Year	MWh	616.33	EUR	42936.96	( 69.67 EUR/MWh )
EU: Net useful ratio / Year	%	57.94	%	47.83	TWG = 78.60%
CH: Guidelines from associations such as SIA and SWKI: TWG>70.00% & JNG>75.00% & ETV>15.00					JNG = 73.23%
					ETV = 12.19



Station		Bern (CH)
Height over sea level	m	540.00
Pressure	hPa	949.65
Outside air	m3/h	25000.00
Return air	m3/h	25000.00
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	75000.00
Costs with CC-System	EUR	144000.00
Additional costs	EUR	69000.00
BEP (Break even point) after	Years	4.06