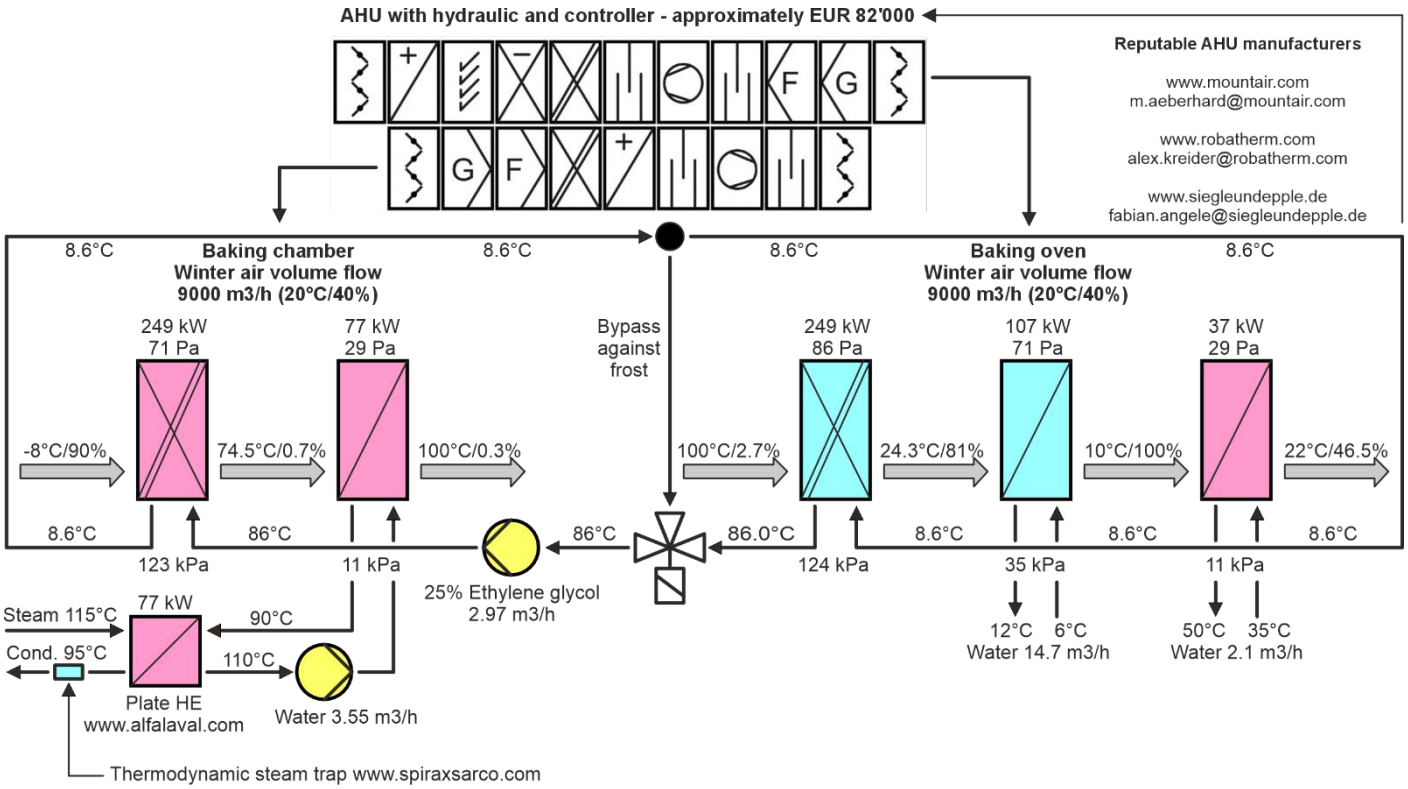
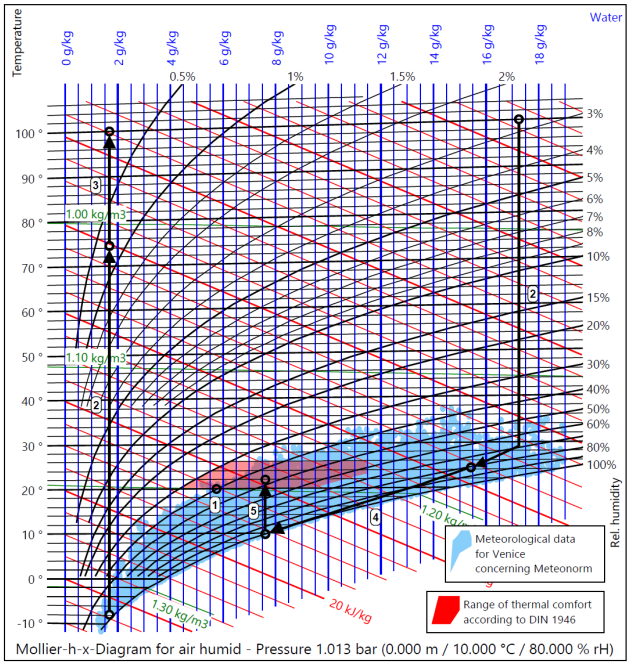
Energy recovery in bakery

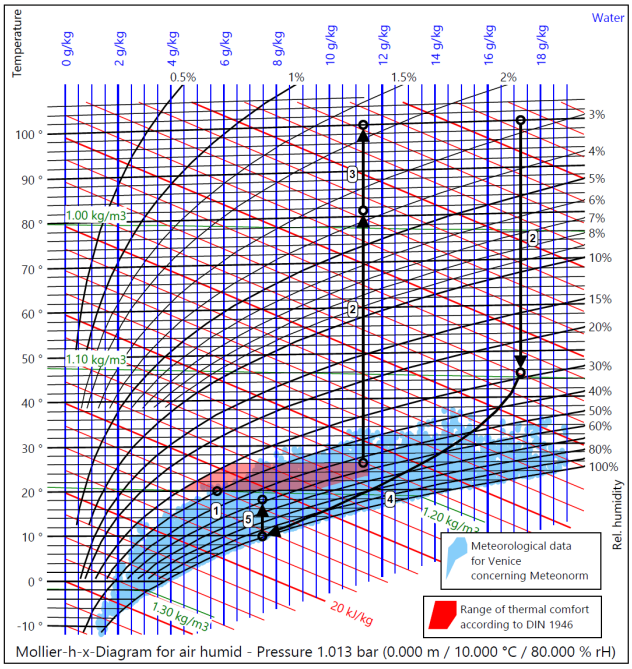
In order to heat a baking chamber and cool an backing oven at the same time, an energy recovery system must be used, which achieves a temperature efficiency of 76.4% in winter. It is recommended to operate the reheater in the baking chamber with hot water of 110/90°C and not directly with steam of 115°C, as such heat exchangers corrode quickly due to accumulation of the condensate. Plate exchangers from Alfa Laval are better suited for this.



Mollier-HX-Chart for winter



Mollier-HX-Chart for summer



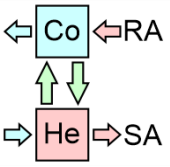
The following calculations was done with the software CCSB in high level language C#. 40 different fin coil exchanger geometries are calculated in less than 1 second for comparison purposes.

CC-System in winter		SAHe	RACo	Definition
Height over sea level	m			0.000
Pressure	hPa			1013.250
Efficiency	%	76.430	70.115	
Capacity sensible	kW	248.793	234.441	
Capacity latent	kW	0.000	14.352	
Capacity frost	kW	---	0.000	
Capacity total	kW	248.793	248.793	
Surface reserve	%	0.238	0.484	
Present surface	m²	503.869	503.869	

SAHe		Inlet	Outlet	Definition
Temp.	°C	-8.000	74.544	20.000
Rel. humidity	%	90.000	0.737	40.000
Abs. humidity	g/kg	1.708	1.708	5.783
Volume flow humid	m³/h	8087.568	10605.230	9000.000
Velocity	m/s	1.378	1.807	1.533
Pressure drop	Pa		70.686	

RACo		Inlet	Outlet	Definition
Temp.	°C	100.000	24.276	20.000
Rel. humidity	%	2.710	81.390	40.000
Abs. humidity	g/kg	17.285	15.493	5.783
Volume flow humid	m³/h	11665.865	9272.504	9000.000
Velocity	m/s	1.987	1.580	1.533
Pressure drop	Pa		86.004	

25 V% Et.glycol			SAHe	RACo
Temp.	in	°C	86.000	8.600
Temp.	out	°C	8.600	86.000
Volume flow		m³/h	2.967	2.968
Velocity		m/s	0.958	0.958
Reynolds		---	11308.577	11106.637
Pressure drop		kPa	123.366	123.886



Company
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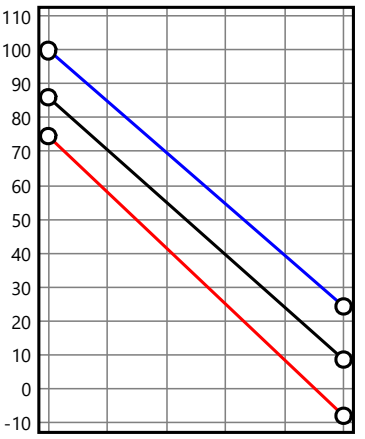
18-04-2026

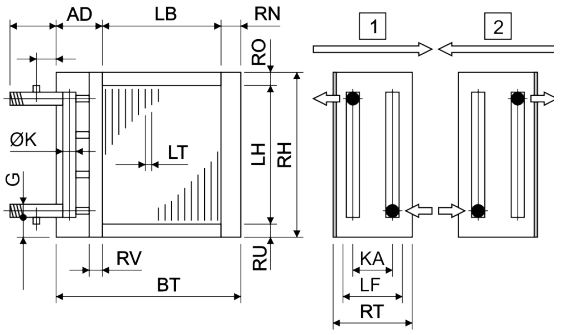
Representative

Plant
Object
Position

Temperature (°C)



Technical data			SAHe	RACo			
Tubes total		Piece	480	480	Tubes:	Cu	Cu
Tubes blank		Piece	0	0	Tubes:	smooth	smooth
Int. vent./drains		Piece	5	5	Tubes:	staggered	staggered
Tube rows on the depth		Piece	12	12	Tubes:	circular	circular
Tube rows on the height		Piece	40	40	Collectors:	Cu	Cu
Tube coupling in series		Piece	60	60	Collectors:	1.01 m/s	1.01 m/s
Number of circuits (NC)		Piece	8	8	Connections:	Rg7	Rg7
Volume		l	71	71	Connections:	1.01 m/s	1.01 m/s
Weight		kg	251	251	Fins:	Al	Al
Connections	G	---	1 ¼"	1 ¼"	Fins:	Wave structure	Wave structure
Frame height	RH	mm	1400	1400	Frame:	AISI304	AISI304
Frame width	BT	mm	1400	1400	Frame:	2.00 m/s	2.00 mm
Frame depth	RT	mm	390	390	Protection:	without	without
Finned height	LH	mm	1333	1333	Protection:	---	---
Finned width	LB	mm	1223	1223			
Finned depth	LF	mm	346	346			
Frame on top	RO	mm	33	33			
Frame on bottom	RU	mm	34	34			
Frame in front	RV	mm	30	30			
Frame on back	RN	mm	53	53			
Collector-Diameter	K	mm	35	35			
Collector covering	AD	mm	124	124			
Collector distance	KA	mm	328	328			
Fin spacing	LT	mm	2.500	2.500			
Fin thickness	LD	mm	0.200	0.200			
Tube diameter	DA	mm	12.400	12.400			
Tube diameter	da	mm	12.400	12.400			
Tube thickness	S	mm	0.350	0.350			
Tube interval on the height	S1	mm	33.333	33.333			
Tube interval on the width	S2	mm	28.867	28.867			



SAHe: 33/29/12-12R-40T-1223A-2.5PA-8C-Cu/Al/AISI304 — **SAHe: EUR 4457.00**

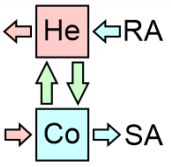
RACo: 33/29/12-12R-40T-1223A-2.5PA-8C-Cu/Al/AISI304 — **RACo: EUR 4457.00**

CC-System in summer		RAHe	SACo	Definition
Height over sea level	m			0.000
Pressure	hPa			1013.250
Efficiency	%	74.760	73.851	
Capacity sensible	kW	169.873	169.872	
Capacity latent	kW	0.000	0.000	
Capacity frost	kW	---	0.000	
Capacity total	kW	169.873	169.872	
Surface reserve	%	0.077	0.369	
Present surface	m²	503.869	503.869	

RAHe		Inlet	Outlet	Definition
Temp.	°C	26.000	81.322	20.000
Rel. humidity	%	54.000	3.637	40.000
Abs. humidity	g/kg	11.313	11.313	5.783
Volume flow humid	m³/h	9265.096	10978.451	9000.000
Velocity	m/s	1.578	1.870	1.533
Pressure drop	Pa		78.746	

SACo		Inlet	Outlet	Definition
Temp.	°C	100.000	45.350	20.000
Rel. humidity	%	2.710	28.200	40.000
Abs. humidity	g/kg	17.285	17.285	5.783
Volume flow humid	m³/h	11665.865	9957.391	9000.000
Velocity	m/s	1.987	1.696	1.533
Pressure drop	Pa		86.117	

25 V% Et.glycol			RAHe	SACo
Temp.	in	°C	89.131	36.408
Temp.	out	°C	36.408	89.131
Volume flow		m³/h	2.967	2.967
Velocity		m/s	0.958	0.958
Reynolds		---	14821.837	14626.621
Pressure drop		kPa	116.409	116.766



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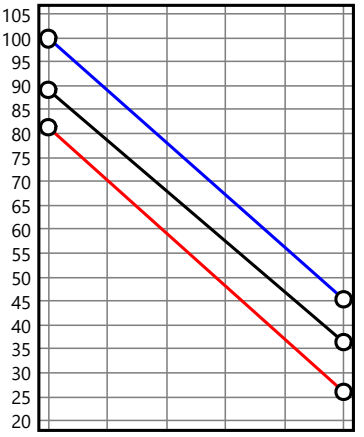
18-04-2026

Representative

Plant
Object
Position

Temperature (°C)



Technical data			SAHe	RACo			
Tubes total		Piece	480	480	Tubes:	Cu	Cu
Tubes blank		Piece	0	0	Tubes:	smooth	smooth
Int. vent./drains		Piece	5	5	Tubes:	staggered	staggered
Tube rows on the depth		Piece	12	12	Tubes:	circular	circular
Tube rows on the height		Piece	40	40	Collectors:	Cu	Cu
Tube coupling in series		Piece	60	60	Collectors:	1.01 m/s	1.01 m/s
Number of circuits (NC)		Piece	8	8	Connections:	Rg7	Rg7
Volume		l	71	71	Connections:	1.01 m/s	1.01 m/s
Weight		kg	251	251	Fins:	Al	Al
Connections	G	---	1 ¼"	1 ¼"	Fins:	Wave structure	Wave structure
Frame height	RH	mm	1400	1400	Frame:	AISI304	AISI304
Frame width	BT	mm	1400	1400	Frame:	2.00 m/s	2.00 mm
Frame depth	RT	mm	390	390	Protection:	without	without
Finned height	LH	mm	1333	1333	Protection:	---	---
Finned width	LB	mm	1223	1223			
Finned depth	LF	mm	346	346			
Frame on top	RO	mm	33	33			
Frame on bottom	RU	mm	34	34			
Frame in front	RV	mm	30	30			
Frame on back	RN	mm	53	53			
Collector-Diameter	K	mm	35	35			
Collector covering	AD	mm	124	124			
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Fin spacing	LT	mm	2.500	2.500			
Fin thickness	LD	mm	0.200	0.200			
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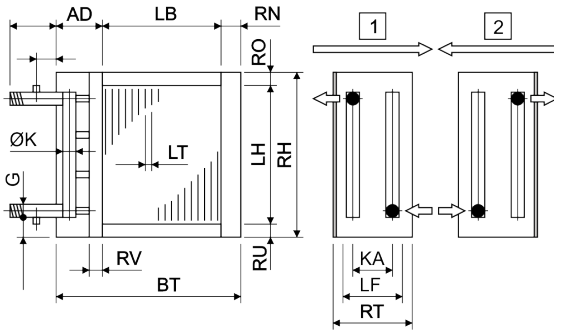

RAHe: 33/29/12-12R-40T-1223A-2.5PA-8C-Cu/Al/AISI304 **RAHe: EUR 4457.00**

SACo: 33/29/12-12R-40T-1223A-2.5PA-8C-Cu/Al/AISI304 **SACo: EUR 4457.00**

Energy recovery / Year (Service at 100% Air flow = 2080 Hours

No	Outside air		CCSB		Return air		Exhaust air		Efficiency	Capacity	Energy
	°C	%	°C	%	°C	%	°C	%	%	kW	MWh
1	-0.4	68.0	75.8	1.0	100.0	2.7	32.0	49.5	75.92	230.17	11.97
2	3.6	63.4	76.5	1.2	100.0	2.7	33.8	46.2	75.66	220.46	11.46
3	4.9	63.2	76.8	1.3	100.0	2.7	34.4	45.2	75.58	217.28	11.30
4	5.7	64.0	76.9	1.4	100.0	2.7	34.8	44.7	75.52	215.48	11.21
5	6.4	63.8	77.0	1.5	100.0	2.7	35.0	44.3	75.47	213.89	11.12
6	7.0	64.4	77.1	1.5	100.0	2.7	35.2	44.1	75.42	212.47	11.05
7	7.5	66.5	77.2	1.6	100.0	2.7	35.5	43.6	75.37	211.10	10.98
8	8.1	64.6	77.3	1.6	100.0	2.7	35.8	43.1	75.34	209.88	10.91
9	8.6	66.1	77.4	1.7	100.0	2.7	36.0	42.7	75.30	208.70	10.85
10	9.1	64.4	77.5	1.7	100.0	2.7	36.3	42.3	75.27	207.48	10.79
11	9.6	64.9	77.6	1.8	100.0	2.7	36.5	42.0	75.23	206.33	10.73
12	10.1	65.8	77.7	1.9	100.0	2.7	36.7	41.6	75.19	205.17	10.67
13	10.6	64.4	77.8	1.9	100.0	2.7	36.9	41.3	75.15	203.94	10.60
14	11.1	63.8	77.9	1.9	100.0	2.7	37.1	41.1	75.11	202.65	10.54
15	11.8	61.4	78.0	2.0	100.0	2.7	37.4	40.7	75.08	201.02	10.45
16	12.4	64.7	78.1	2.1	100.0	2.7	37.7	40.3	75.02	199.55	10.38
17	13.0	64.8	78.2	2.2	100.0	2.7	38.0	39.7	74.98	198.18	10.31
18	13.7	65.5	78.4	2.3	100.0	2.7	38.3	39.2	74.93	196.68	10.23
19	14.4	65.5	78.5	2.4	100.0	2.7	38.6	38.7	74.88	195.14	10.15
20	14.9	65.7	78.6	2.5	100.0	2.7	38.9	38.3	74.84	193.83	10.08
21	15.5	64.1	78.7	2.5	100.0	2.7	39.1	37.9	74.81	192.53	10.01
22	16.0	65.3	78.8	2.6	100.0	2.7	39.4	37.5	74.76	191.36	9.95
23	16.6	66.5	78.9	2.8	100.0	2.7	39.7	37.0	74.72	190.04	9.88
24	17.2	67.3	79.0	2.9	100.0	2.7	40.0	36.6	74.67	188.65	9.81
25	17.9	67.3	79.2	3.0	100.0	2.7	40.3	36.2	74.63	187.18	9.73
26	18.5	67.4	79.3	3.1	100.0	2.7	40.6	35.6	74.59	185.81	9.66
27	19.1	66.5	79.4	3.2	100.0	2.7	41.0	35.0	74.56	184.42	9.59
28	19.6	65.6	79.5	3.2	100.0	2.7	41.2	34.6	74.54	183.28	9.53
29	20.2	66.4	79.7	3.4	100.0	2.7	41.6	34.1	74.50	182.01	9.46
30	20.9	64.8	79.8	3.4	100.0	2.7	42.0	33.4	74.49	180.54	9.39
31	21.5	64.1	80.0	3.5	100.0	2.7	42.4	32.8	74.47	179.06	9.31
32	22.3	62.9	80.1	3.6	100.0	2.7	42.9	31.9	74.45	177.45	9.23
33	23.0	61.8	80.3	3.6	100.0	2.7	43.5	31.0	74.43	175.71	9.14
34	23.8	61.2	80.5	3.7	100.0	2.7	44.0	30.1	74.40	173.98	9.05
35	24.6	60.4	80.7	3.8	100.0	2.7	44.6	29.3	74.38	172.29	8.96
36	25.4	59.6	80.9	3.9	100.0	2.7	45.1	28.4	74.35	170.55	8.87
37	26.4	58.0	81.1	4.0	100.0	2.7	45.8	27.4	74.33	168.38	8.76
38	27.4	57.3	81.3	4.2	100.0	2.7	46.6	26.4	74.29	166.04	8.63
39	28.9	52.7	81.7	4.1	100.0	2.7	47.6	25.0	74.30	162.84	8.47
40	31.7	47.6	82.4	4.3	100.0	2.7	49.7	22.6	74.25	156.45	8.14

Air (%)	Service (h/a)
100.00	2080
0.00	0
0.00	0
▼	▼
100.00	2080

EU: Energy recovery: Heat energy	MWh	401.34	EUR	24080.00	(60.00 EUR/MWh)
EU: Energy recovery: Cold energy	MWh	0.00	EUR	0.00	(80.00 EUR/MWh)
EU: 2 Fan + Glycol pump	MWh	-2.12	EUR	-212.00	(100.00 EUR/MWh)
EU: Energy recovery: Net useful ratio / Year	MWh	399.21	EUR	23868.00	(59.79 EUR/MWh)
EU: Need of energy total / Year	MWh	558.61	EUR	34178.99	(61.19 EUR/MWh)
EU: Net useful ratio / Year	%	71.47	%	69.83	TWG = 76.43%
CH: Guidelines from associations such as SIA and SWKI: TWG>70.00% & JNG>75.00% & ETV>15.00					JNG = 73.65%
					ETV = 189.09

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20.4.2026
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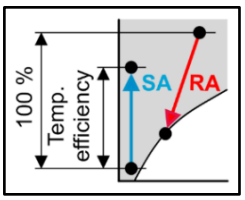
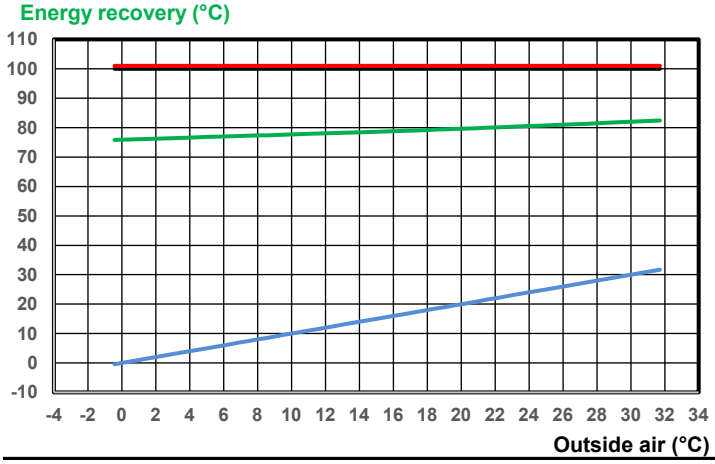
Plant
Object
Position



Software by www.zcs.ch

Outside air (°C) Return air (°C) Supply air (°C)
Energy recovery (°C)



Station		Trieste (I)
Height over sea level	m	0.00
Pressure	hPa	1013.25
Outside air	m3/h	9000.00
Return air	m3/h	9000.00
Adiabatic return air cooling	h/a	0.00
Service at 100% Air flow	h/a	2080.00
Capital interest	%	1.00
Energy increase	%	1.00
Inflation	%	1.00
Support costs	%	5.00
Costs without CC-System	EUR	47000.00
Costs with CC-System	EUR	82000.00
Additional costs	EUR	35000.00
BEP (Break even point) after	Years	1.60