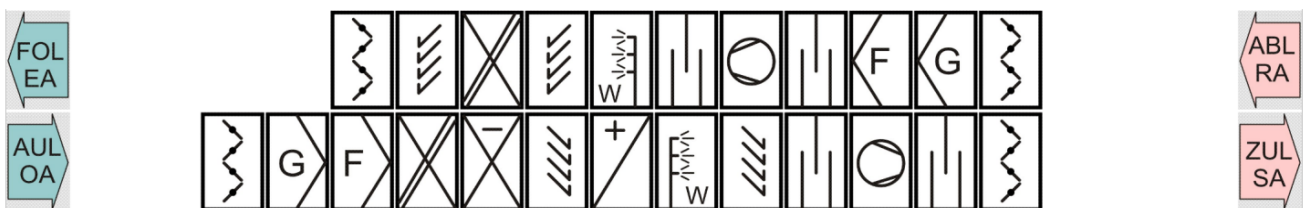
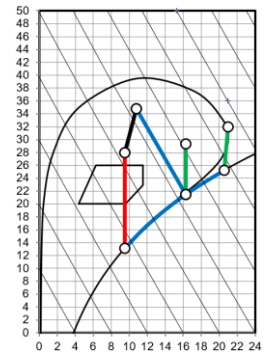




# A simplified cooling load calculation

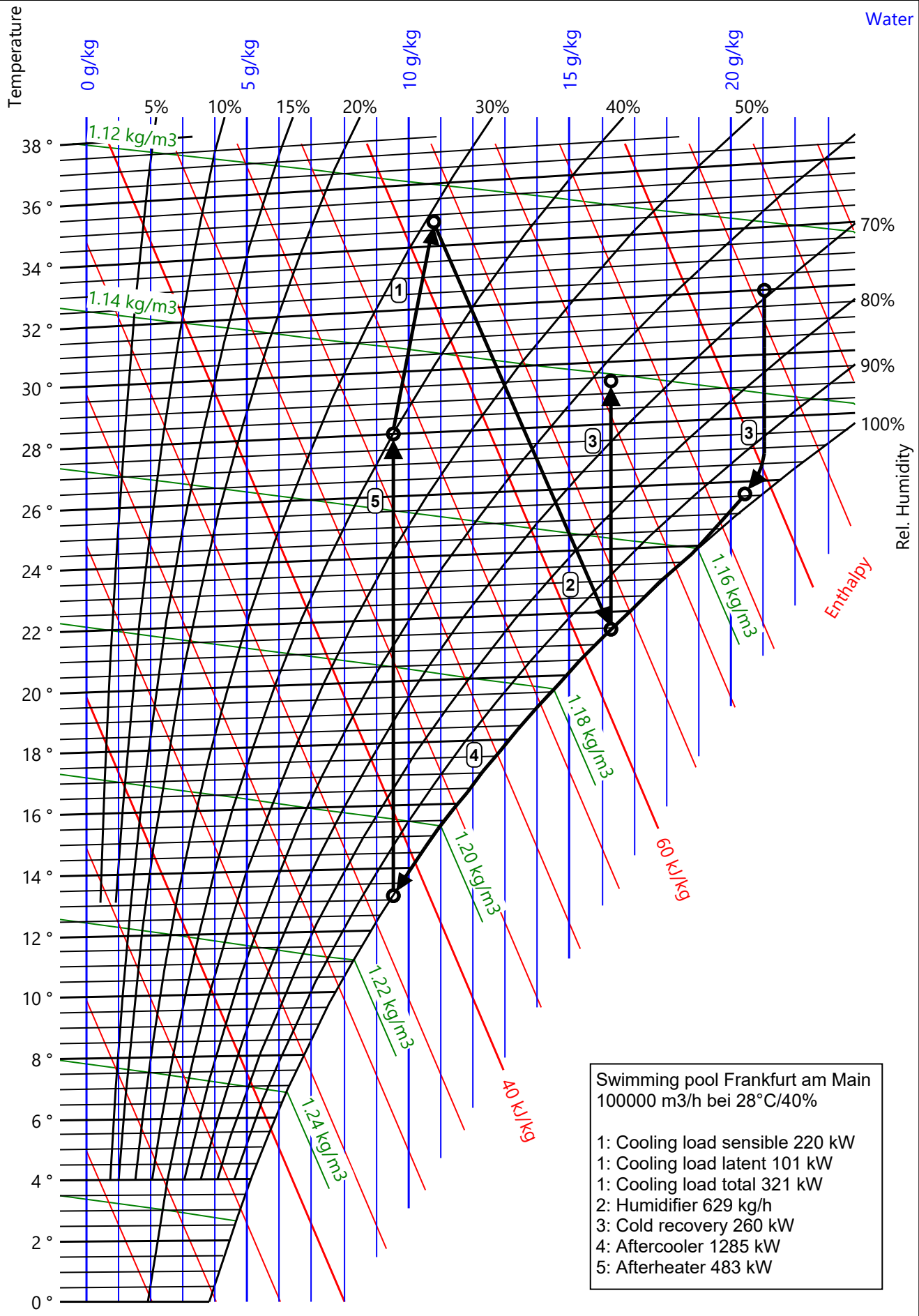
The present method is a simplification and therefore only suitable for long-standing experienced experts on the subject. An example follows. The guideline VDI 2078 is taken as a basis for the cooling load calculation for planning an air conditioning system. This is issued by the VDI. It contains recommendations and rules and thus represents the state of the art. All parameters that influence the thermal room behavior in any way are taken into account.

Anyone who enters 32°C/40% out of habit should not be surprised if the cooler is underperforming in midsummer. Look at the sloping enthalpy lines and choose 32°C/69%. Of course, a large part of the cooling requirement can be reduced with cold recovery.



Air-Handling Unit ( H x W = 2773 x 5416 mm )	Length	Weight	Pressure drop	Price
Outside air ( 100000 m <sup>3</sup> /h - Filter 1.99 )	mm	kg	Pa	EUR
Outside air			100.00	
Empty part little with flaps	350.00	270.00	30.00	4550.00
Filter G	450.00	380.00	124.00	5810.00
Filter F	650.00	560.00	164.00	8640.00
CC-System	650.00	1910.00	89.00	29260.00
Cooler	400.00	960.00	63.00	15310.00
Droplet separator	150.00	190.00	99.00	3290.00
Heater	200.00	590.00	23.00	9630.00
Humidifier water	1300.00	770.00	99.00	12120.00
Droplet separator	150.00	190.00	99.00	3290.00
Sound absorber	1300.00	770.00	60.00	12120.00
Fan - Efficiency 70.00 % - Capacity 53.13 kW	4100.00	3340.00	99.00	51980.00
Sound absorber	1300.00	770.00	60.00	12120.00
Empty part little with flaps	350.00	270.00	30.00	4550.00
Supply air			200.00	
<b>Total</b>	<b>11350.00</b>	<b>10970.00</b>	<b>1339.00</b>	<b>172670.00</b>

Air-Handling Unit ( H x W = 2773 x 5416 mm )	Length	Weight	Pressure drop	Price
Return air ( 100000 m <sup>3</sup> /h - Filter 1.99 )	mm	kg	Pa	EUR
Return air			200.00	
Empty part little with flaps	350.00	270.00	30.00	4550.00
Filter G	450.00	380.00	124.00	5810.00
Filter F	650.00	560.00	164.00	8640.00
Sound absorber	1300.00	770.00	60.00	12120.00
Fan - Efficiency 70.00 % - Capacity 49.72 kW	4100.00	3340.00	99.00	51980.00
Sound absorber	1300.00	770.00	60.00	12120.00
Humidifier water	1300.00	770.00	99.00	12120.00
Droplet separator	150.00	190.00	99.00	3290.00
CC-System	650.00	1910.00	89.00	29260.00
Droplet separator	150.00	190.00	99.00	3290.00
Empty part little with flaps	350.00	270.00	30.00	4550.00
Exhaust air			100.00	
<b>Total</b>	<b>10750.00</b>	<b>9420.00</b>	<b>1253.00</b>	<b>147730.00</b>



Mollier-h-x-Diagram for air humid - Pressure 1.001 bar (106.000 m / 10.000 °C / 80.000 % rH)

## Cooling load calculation of rooms in midsummer

Location	Frankfurt am Main		
Height above sea	H	m	106.000
Air pressure	p	mbar	1000.564
Room air temperature	t	°C	28.000
Room humidity	rf	%	40.000
Room humidity	af	g/kg	9.516
Room air vapor partial pressure	pd	mbar	15.072

Room type	Schwimmhalle		
Room width	B	m	25.000
Room length	L	m	40.000
Room height	H	m	5.000
Room volume	V	m <sup>3</sup>	5000.000
Air change rate	n	1/h	20.000
Amount of outside air	VI	m <sup>3</sup> /h	100000.000

Water pool	Evaporation amount according to VDI 2089		
Water pool use	Leisure pool		
Evaporation coefficient	ε	g/(mbar m <sup>2</sup> h)	28.000
Pool width	b	m	10.000
Pool length	l	m	25.000
Water pool surface	A	m <sup>2</sup>	250.000
Temperature of the water	tw	°C	26.000
Saturation vapor pressure of water	ps	mbar	33.514
Amount of evaporation	W <sub>1</sub>	g/h	129096.310

Persons	Evaporation amount according to DIN EN ISO 7730		
Activity level IV	Heavy physical activity		
Number of people in the room	m	Anzahl	100
Evaporative emission per person	W <sub>p</sub>	g/h	146.676
Evaporative emission of all persons	W <sub>2</sub>	g/h	14667.600

Room	Rough estimate of cooling needs		
Room volume	V	m <sup>3</sup>	5000.000
Cooling demand	H <sub>r</sub>	W/m <sup>3</sup>	60.000
Cooling demand	H <sub>1</sub>	W	300000.000

Persons	Heat emission according to DIN EN ISO 7730		
Activity level IV	Heavy physical activity		
Number of people in the room	m	Anzahl	100
Heat output per person	H <sub>p</sub>	W	177.934
Heat dissipation of all people	H <sub>2</sub>	W	17793.352

Total amount of evaporation	W	g/h	143763.910
Amount of outside air	VI	m <sup>3</sup> /h	100000.000
Outside air temperature	t	°C	32.000
Relative outside air humidity	rf	%	69.000
Absolute outside air humidity	af	g/kg	21.018
Evaporation per m <sup>3</sup>	w	g/m <sup>3</sup>	1.438
Air density	d	kg/m <sup>3</sup>	1.151
Evaporation per kg	w	g/kg	1.249
Heat of vaporization	Ro	J/kg	2500500.000
Heat emission latent	Wl	W	3124.211
Heat emission sensitive	Ws	W	317793.352
Total heat emission	Wt	W	320917.563

Cooling and dehumidification	VI	m <sup>3</sup> /h	95056.374
Temperature	t	°C	13.112
Relative humidity	rf	%	100.000
Absolute humidity	af	g/kg	9.516

Air handling unit to room	VI	m <sup>3</sup> /h	100000.008
Temperature	t	°C	28.000
Relative humidity	rf	%	40.000
Absolute humidity	af	g/kg	9.516

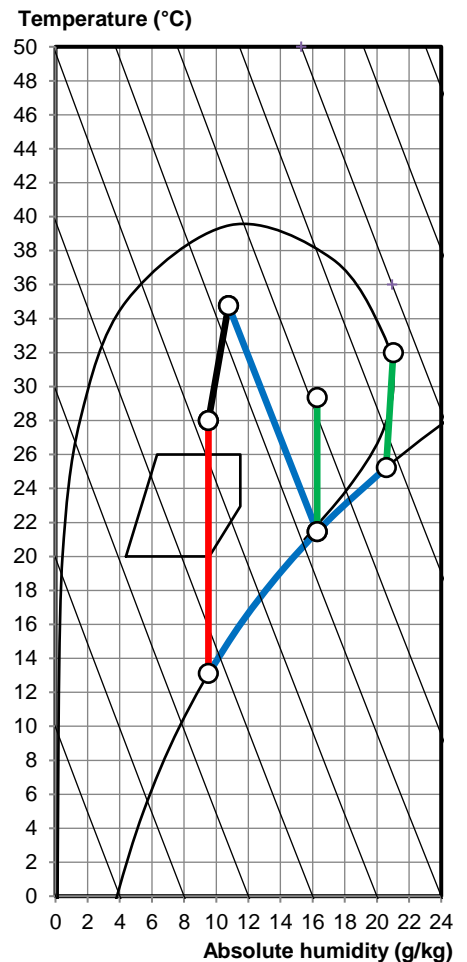
The present method is a simplification and therefore only suitable for long-standing experienced experts on the subject. The guideline VDI 2078 is taken as a basis for the cooling load calculation for planning an air conditioning system. This is issued by the VDI. It contains recommendations and rules and thus represents the state of the art. All parameters that influence the thermal room behavior in any way are taken into account.

$$W_1 = \varepsilon A (p_s - p_d)$$

$$W_2 = m W_p$$

$$H_1 = V H_r$$

$$H_2 = m H_p$$



**Total heat emission = Cooling load!**

**Cooling load = 320.918 kW**

**Exhaust air temperature 34.764 °C**

**Relative humidity 30.778 %**

**Absolute humidity 10.766 g/kg**

**Compensation of the cooling load**

**Exhaust air humidification 628.776 kg/h**

**Cold recovery 259.627 kW**

**Air cooler 1285.041 kW**

**Air heater 482.854 kW**

CC-System in summer		RA-Hy	SA-Co	Definition
Height over sea level	m			106.000
Pressure	hPa			1000.564
Efficiency	%	75.104	62.329	
Capacity sensible	kW	260.000	217.431	
Capacity latent	kW	0.000	42.569	
Capacity frost	kW	---	0.000	
Capacity total	kW	260.000	260.000	
Surface reserve	%	3.004	3.070	
Present surface	m2	6641.575	6641.575	



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Plant

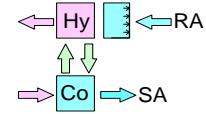
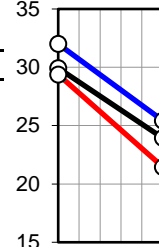
Object

Position

RA-Hy ( ff = 0.00005 m2K/W )		Inlet	Outlet	Definition
Temp.	°C	21.457	29.375	28.000
Rel. humidity	%	100.000	62.536	40.000
Abs. humidity	g/kg	16.282	16.282	9.516
Volume flow humid	m3/h	98874.941	101532.412	100000.000
Velocity	m/s	2.041	2.095	2.064
Pressure drop	Pa		183.378	

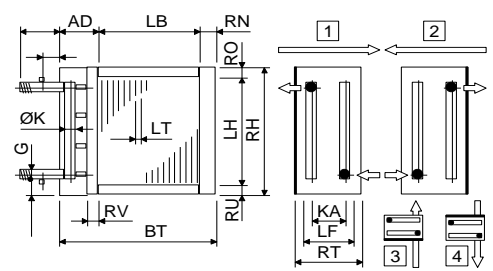
SA-Co ( ff = 0.00005 m2K/W )		Inlet	Outlet	Definition
Temp.	°C	32.000	25.429	28.000
Rel. humidity	%	69.000	98.460	40.000
Abs. humidity	g/kg	21.018	20.492	9.516
Volume flow humid	m3/h	103172.942	100868.713	100000.000
Velocity	m/s	2.129	2.082	2.064
Pressure drop wet	Pa		200.149	

34 V% Et.glycol ( ff = 0.00005 / 0.00005 m2K/W )		RA-Hy	SA-Co	
Temp.	in °C	29.935	23.933	
Temp.	out °C	23.933	29.935	
Volume flow	m3/h	41.360	41.371	
Velocity	m/s	1.002	1.002	
Reynolds	---	8026.387	7903.054	
Pressure drop	kPa	143.910	144.518	



Software by www.zcs.ch

Technical data		RA-Hy	SA-Co	RA-Hy	SA-Co
Tubes total	Piece	1200	1200	Tubes:	Cu
Tubes blank	Piece	0	0	Tubes:	smooth
Int. vent./drains	Piece	9	9	Tubes:	staggered
Tube rows on the depth	Piece	20	20	Tubes:	circular
Tube rows on the height	Piece	60	60	Collectors:	Cu
Tube coupling in series	Piece	20	20	Collectors:	1.38 m/s
Number of circuits (NC)	Piece	60	60	Connections:	Rg7
Volume	l	1361	1361	Connections:	1.38 m/s
Weight	kg	3351	3351	Fins:	Al
Connections	G	---	4"	Fins:	smooth
Frame height	RH	mm	2480	Frame:	AISI 304
Frame width	BT	mm	5900	Air flow direction:	horizontal
Frame depth	RT	mm	870	Protection:	without
Finned height	LH	mm	2400	Protection:	---
Finned width	LB	mm	5608		
Finned depth	LF	mm	693		
Frame on top	RO	mm	40		
Frame on bottom	RU	mm	40		
Frame in front	RV	mm	30		
Frame on back (-69/69mm)	RN	mm	69		
Collector-Diameter	K	mm	108		
Collector covering	AD	mm	223		
Collector distance	KA	mm	734		
Fin spacing	LT	mm	2.500		
Fin thickness	LD	mm	0.200		
Tube diameter	DA	mm	16.400		
Tube diameter	da	mm	16.400		
Tube thickness	S	mm	0.400		
Tube interval on the height	S1	mm	40.000		
Tube interval on the depth	S2	mm	34.641		



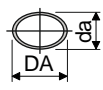
Delivery: 5-6 weeks  
Validity: 12 weeks  
Condit.: net, prepaid address  
Payment: 30 days net

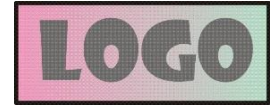
RA-Hy: 40/35/16-20R-60T-5608A-2.5PA-60C-Cu/Al/AISI 304

RA-Hy: EUR 43741.00

SA-Co: 40/35/16-20R-60T-5608A-2.5PA-60C-Cu/Al/AISI 304

SA-Co: EUR 43741.00





Capacity	kW	1284.513	----- sensible:	399.376
Surface reserve	%	3.747	latent:	885.137
Present surface	m2	4493.093	frost:	0.000
Required surface	m2	4330.833		
k-coeff.	W/m2K	46.266		
Average temp. diff. ( 98.76 % )	K	6.411		

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Air humid ( ff = 0.00005 m2K/W )		Inlet	Outlet	Definition
Height over sea level	m			106.000
Pressure	hPa			1000.564
Temp.	°C	25.428	13.113	28.000
Rel. humidity	%	98.461	100.000	40.000
Abs. humidity	g/kg	20.492	9.517	9.516
Density humid	kg/m3	1.153	1.210	1.151
Enthalpy humid	kJ/kg	77.794	37.223	52.470
Volume flow humid	m3/h	100868.475	95056.906	100000.000
Mass flow dry	kg/h	113978.530	113978.530	113978.530
Condensate flow	kg/h		1250.903	
Surface temperature	°C	22.904	7.918	
Velocity	m/s	2.073	1.953	2.055
Pressure drop (dry 149 Pa)	Pa		219.926	

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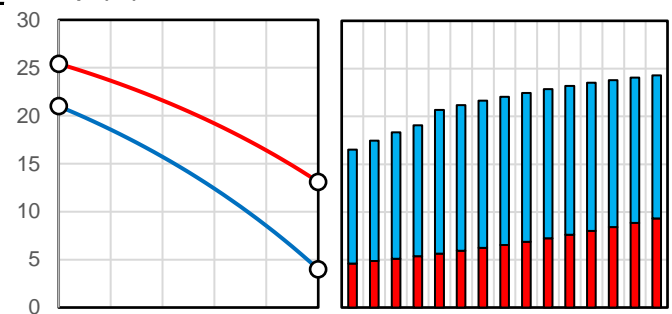
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Plant  
Object  
Position

25 V% Et.glycol ( ff = 0.00005 m2K/W )

Temp. Inlet	°C	4.000
Temp. Outlet	°C	21.000
Temp. Selection	°C	10.205
Density	kg/m3	1040.937
Spec. heat	kJ/kgK	3.706
Heat cond.	W/mK	0.462
Viscosity	Pas	2.475E-03
Volume flow	m3/h	70.511
Velocity	m/s	0.854
Reynolds	---	5602.871
Pressure drop ( T/C = 2.430 )	kPa	60.870

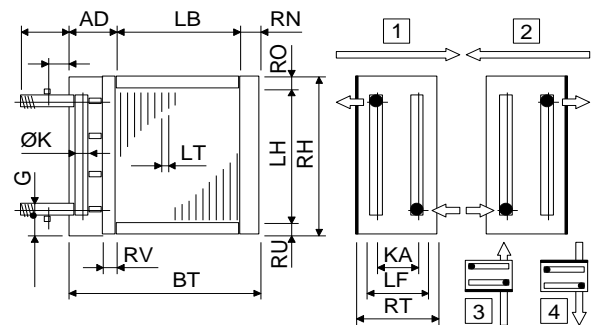
Temp. (°C)



Technical data

Tubes total	Piece	960
Tubes blank	Piece	0
Int. vent./drains	Piece	0
Tube rows on the depth	Piece	16
Tube rows on the height	Piece	60
Tube coupling in series	Piece	8
Number of circuits (NC)	Piece	120
Volume	l	1102
Weight	kg	2469
Connections	G	4"
Frame height	RH	mm 2480
Frame width	BT	mm 5900
Frame depth	RT	mm 660
Finned height	LH	mm 2400
Finned width	LB	mm 5632
Finned depth	LF	mm 554
Frame on top	RO	mm 40
Frame on bottom	RU	mm 40
Frame in front	RV	mm 30
Frame on back (~69mm)	RN	mm 69
Collector-Diameter	K	mm 108
Collector covering	AD	mm 199
Collector distance	KA	mm 520
Fin spacing	LT	mm 3.000
Fin thickness	LD	mm 0.200
Tube diameter	DA	mm 16.400
Tube diameter	da	mm 16.400
Tube thickness	S	mm 0.400
Tube interval on the height	S1	mm 40.000
Tube interval on the depth	S2	mm 34.641

Tubes:	Cu
Tubes:	smooth
Tubes:	staggered
Tubes:	circular
Collectors:	2.35 m/s Cu
Connections:	2.35 m/s Rg7
Fins:	Al
Fins:	smooth
Circulations:	2 Parallel
Frame:	3.0 mm AISI 304
Protection:	without
Protection:	---
Air flow direction:	horizontal



Delivery:	5-6 weeks
Validity:	12 weeks
Condit.:	net, prepaid address
Payment:	30 days net
Price net:	EUR 33261.00





Capacity	kW	482.853	----- sensible:	482.853
Surface reserve	%	5.506	latent:	0.000
Present surface	m2	561.637		
Required surface	m2	532.329		
k-coeff.	W/m2K	32.025		
Average temp. diff.	K	28.324		

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Street  
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Phone: xxxxxxxxxx  
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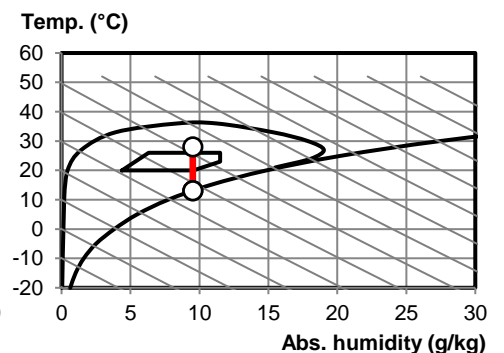
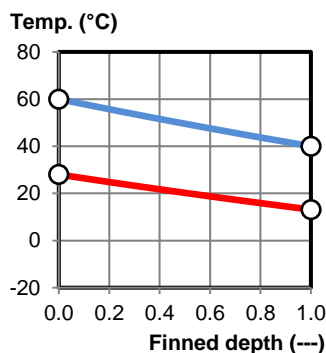
City, 19.12.2022  
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Plant  
Object  
Position

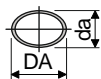
Air humid (ff=0.00005 m2K/W)		Inlet	Outlet	Definition
Height over sea level	m			106.000
Pressure	hPa			1000.564
Temp.	°C	13.112	28.000	28.000
Rel. humidity	%	100.000	40.000	40.000
Abs. humidity	g/kg	9.516	9.516	9.516
Density humid	kg/m3	1.210	1.151	1.151
Enthalpy humid	kJ/kg	37.219	52.470	52.470
Volume flow humid	m3/h	95056.394	100000.012	100000.000
Mass flow dry	kg/h	113978.530	113978.530	113978.530
Velocity	m/s	1.953	2.055	2.055
Pressure drop dry	Pa		17.015	
Pressure drop wet	Pa		17.015	
Evaporation total	kg/h		0.000	(15.000 °C)

Water (ff=0.00005 m2K/W)			
Temp. in	°C	60.000	
Temp. out	°C	40.000	
Density	kg/m3	988.065	
Spec. heat	kJ/kgK	4.180	
Heat cond.	W/mK	0.643	
Viscosity	Pas	5.477E-04	
Volume flow	m3/h	21.046	
Velocity	m/s	0.510	
Pressure drop ( T/C = 1.709 )	kPa	4.527	

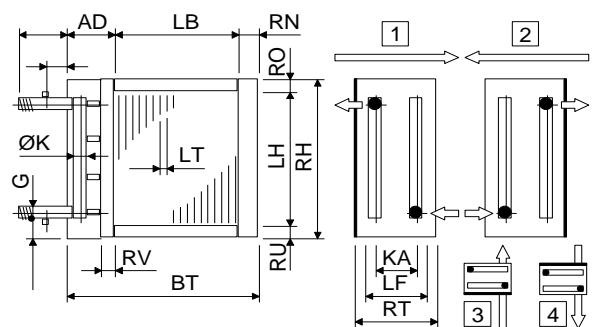


Technical data

Tubes total	Piece	120
Tubes blank	Piece	0
Int. vent./drains	Piece	0
Tube rows on the depth	Piece	2
Tube rows on the height	Piece	60
Tube coupling in series	Piece	2
Number of circuits (NC)	Piece	60
Volume	l	175
Weight	kg	463
Connections	G	4"
Frame height	RH	mm 2480
Frame width	BT	mm 5900
Frame depth	RT	mm 270
Finned height	LH	mm 2400
Finned width	LB	mm 5632
Finned depth	LF	mm 69
Frame on top	RO	mm 40
Frame on bottom	RU	mm 40
Frame in front	RV	mm 30
Frame on back (~69mm)	RN	mm 69
Collector-Diameter	K	mm 108
Collector covering	AD	mm 199
Collector distance	KA	mm 128
Fin spacing	LT	mm 3.000
Fin thickness	LD	mm 0.200
Tube diameter	DA	mm 16.400
Tube diameter	da	mm 16.400
Tube thickness	S	mm 0.400
Tube interval on the height	S1	mm 40.000
Tube interval on the depth	S2	mm 34.641



Tubes:	Cu
Tubes:	smooth
Tubes:	staggered
Tubes:	circular
Collectors:	0.71 m/s Cu
Connections:	0.71 m/s Rg7
Fins:	Al
Fins:	smooth
Frame:	3.00 mm AISI 304
Circulations:	1 Default
Protection:	without
Protection:	---
Air flow direction:	horizontal



Delivery:	5-6 weeks
Validity:	12 weeks
Condit.:	net, prepaid address
Payment:	30 days net
Price net:	EUR 6204.00