Air heater with multi-stage steam

4 different systems can be calculated with the same software.

HPC: High-pressure steam in a maximum of 4 heat exchangers with vertical tubes.

MPC: Medium pressure steam in a maximum of 4 heat exchangers with vertical tubes.

LPC: Low-pressure steam in 1 heat exchanger with vertical or horizontal tubes.

LPS: Condensate cooler in 1 heat exchanger with vertical or horizontal tubes.

The following is System 4 as an example:

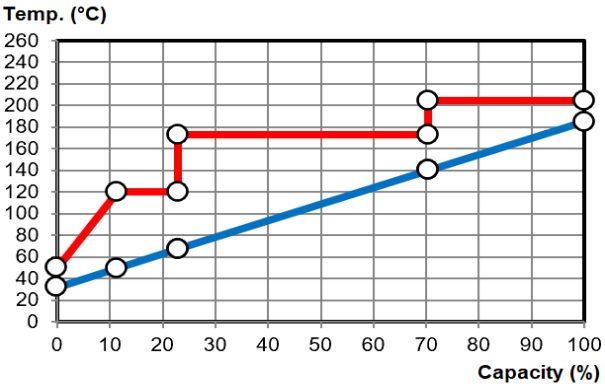
High pressure steam of 17.00 bar = 204.31°C
Mass flow = 2'440.96 kg/h
Capacity = 1'303.68 kW

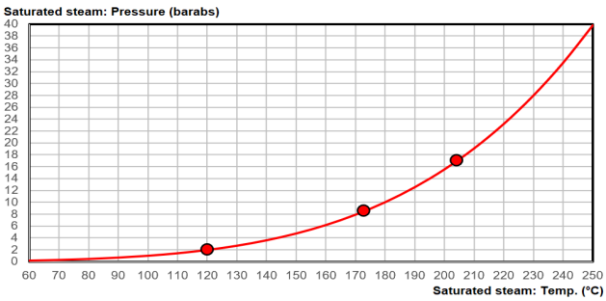
Medium pressure steam of 8.50 bar = 172.95°C
Mass flow = 3'694.22 kg/h
Capacity = 2'092.10 kW

Low pressure steam of 2.00 bar = 120.22°C
Mass flow = 6'135.18 kg/h
Capacity = 506.40 kW

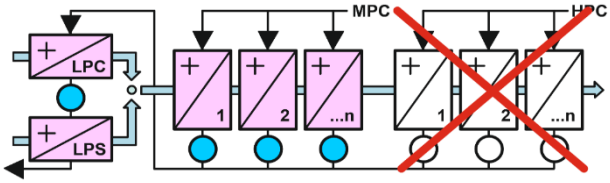
Condensate cooler from 120.22°C to 50.00°C
Mass flow = 6'135.18 kg/h
Capacity = 503.52 kW

Air volume = 100,000 kg/h at 1.00 bar
Temperature from 32°C/40% to 185°C/0.17%
Total pressure drop = 175.88 Pa
Total capacity = 4'405.71 kW

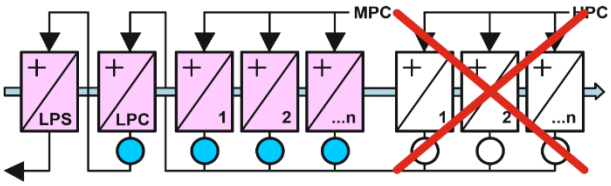




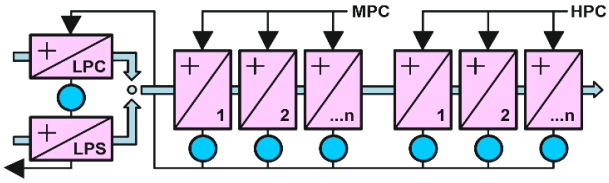
System 1



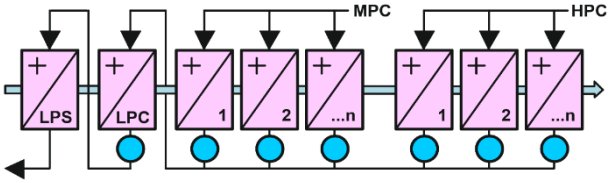
System 2

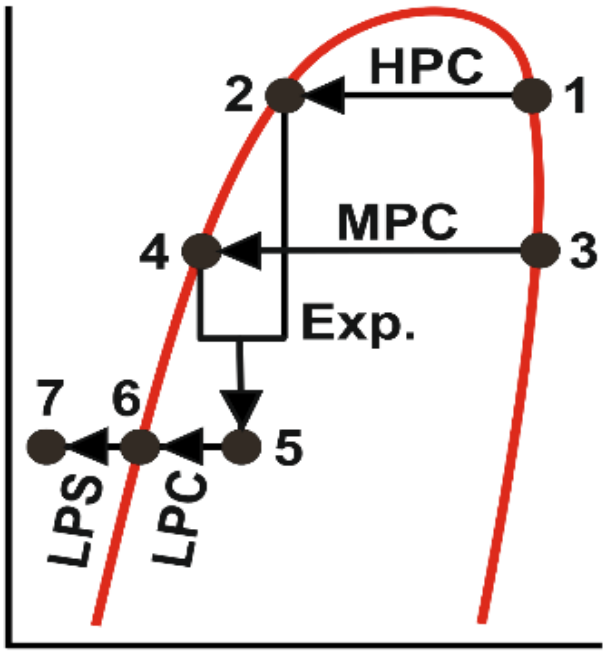


System 3



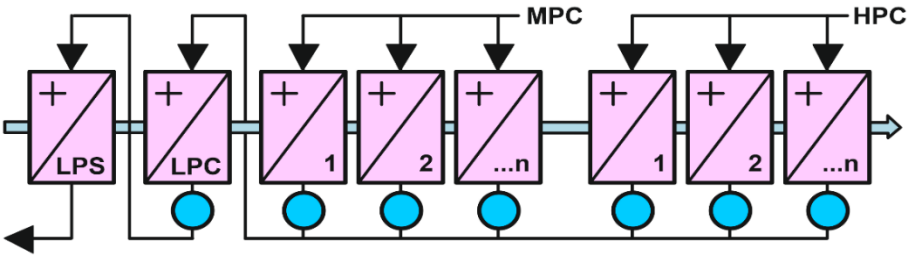
System 4



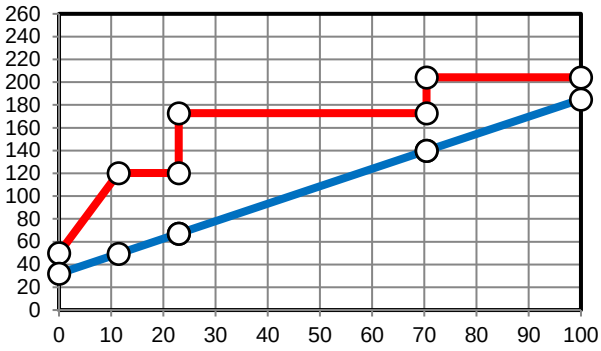


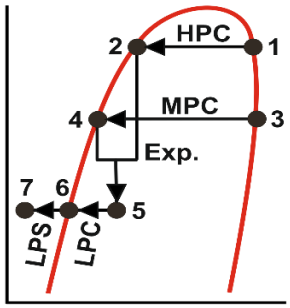
Flash gas (point 5), combined from the high pressure and medium pressure stage = 13.50%.

Air heater with steam



Temp. (°C)





Flash gas (Point 5) = 13.50 %

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Air humid		Point 7	Point 6	Point 5	Point 4	Point 3	Point 2	Point 1
Pressure	bar	1.00						
Temp.	°C	32.00	49.60	67.27	67.27	140.00	140.00	185.00
Rel. humidity	%	40.00	15.75	6.88	6.88	0.52	0.52	0.17
Abs. humidity	g/kg	12.02	12.02	12.02	12.02	12.02	12.02	12.02
Density humid	kg/m3	1.13	1.07	1.02	1.02	0.84	1.02	0.75
Enthalpy humid	kJ/kg	62.98	81.11	99.34	99.34	174.65	99.34	221.58
Volume flow humid	m3/h	89303.86	94453.66	99626.71	99626.71	120909.63	99626.71	134078.70
Mass flow dry	kg/h	100000.00	100000.00	100000.00	100000.00	100000.00	100000.00	100000.00

Steam 17.00 / 8.50 / 2.00 bar		Point 7	Point 6	Point 5	Point 4	Point 3	Point 2	Point 1
Temp.	°C	50.00	120.22	120.22	172.95	172.95	204.31	204.31
Density	kg/m3	988.02	942.93	8.30	894.41	4.41	859.58	8.57
Enthalpy	kJ/kg	209.29	504.74	801.89	732.02	2770.76	871.75	2794.47
Mass flow	kg/h	6135.18	6135.18	6135.18	3694.22	3694.22	2440.96	2440.96
Volume flow	m3/h	6.21	6.51	738.82	4.13	837.92	2.84	284.78

Technical data		**Total**	**LPS (H)**	**LPC (V)**	**MPC (V)**	**HPC (V)**
Capacity	kW	4405.71	503.52	506.40	2092.10	1303.68
Surface reserve	%	3.96	5.24	4.60	3.71	3.25
Present surface	m2	2063.25	428.59	221.41	706.63	706.63
Required surface	m2	1984.64	407.25	211.68	681.34	684.37
Air humid: Pressure drop	Pa	175.88	30.43	18.39	58.69	68.37
Water: Volume	l	747	115	76	291	265
Weight empty	kg	3433	609	471	1194	1159
Inlet	mm	76	60	140	140	76
Outlet	mm	60	60	60	48	42
Tube rows on the depth	Piece	11	2	1	4	4
Finned height	mm	4000	3996	4000	4000	4000
Finned width	mm	2520	2520	2520	2520	2520
Fin spacing	mm	---	3.00	2.90	3.70	3.70
Fin thickness	mm	---	0.50	0.50	0.50	0.50
Tube diameter	mm	---	16.40	16.40	16.40	16.40
Tube thickness	mm	---	1.00	1.00	1.00	1.00
Tube interval on the height	mm	---	36.00	36.00	36.00	36.00
Tube interval on the depth	mm	---	36.00	36.00	36.00	36.00
Price	**EUR**	**79050.00**	**13517.00**	**10563.00**	**27894.00**	**27076.00**

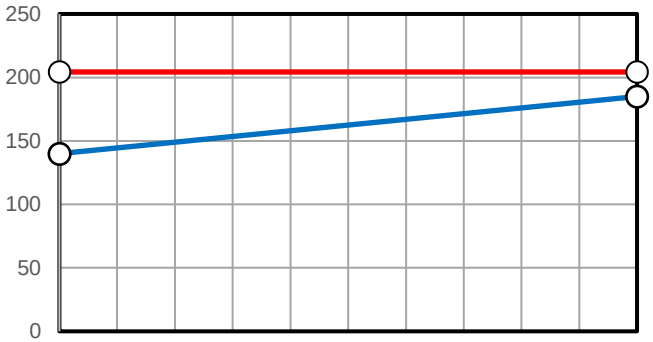
HPC-Condenser: 36/36/16-4T-70B-4000H

Capacity	kW	1303.685
Surface reserve	%	3.252
Present surface	m2	706.626
Required surface	m2	684.372
k-coeff.	W/m2K	51.083
Fouling outside	m2K/W	5.000E-05
Fouling inside	m2K/W	1.000E-04
Average temp. diff. (99.88 %)	K	37.291

Air humid		Inlet	Outlet
Pressure	bar	1.000	
Temp.	°C	140.000	185.000
Rel. humidity	%	0.523	0.168
Abs. humidity	g/kg	12.020	12.020
Density humid	kg/m3	0.837	0.755
Enthalpy humid	kJ/kg	174.652	221.585
Volume flow humid	m3/h	120909.633	134078.705
Mass flow dry	kg/h	100000.000	100000.000
Velocity	m/s	3.332	3.695
Pressure drop	Pa		68.371

Steam 17.00 bar		
Condensation	°C	204.310
Enthalpy difference	kJ/kg	1922.716
Mass flow	kg/h	2440.956
Density''	kg/m3	8.571
Volume flow''	m3/h	284.782
Velocity''	m/s	1.735
Density'	kg/m3	859.579
Volume flow'	m3/h	2.840
Velocity'	m/s	0.017
Pressure drop	bar	0.070
Pressure drop	K	0.200

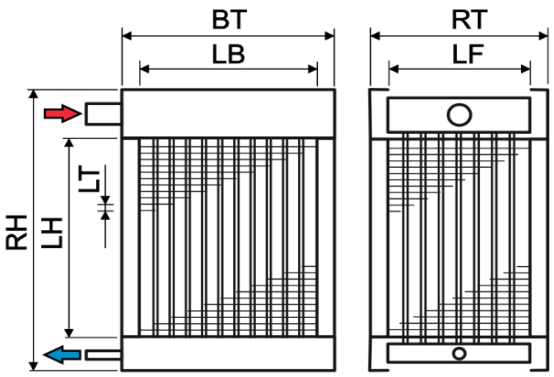
Temp. (°C)



Technical data

Tubes total		Piece	280
Tube rows on the depth		Piece	4
Tube rows on the width		Piece	70
Finned depth	LF	mm	144
Finned width	LB	mm	2520
Finned height	LH	mm	4000
Steam connection		mm	76.100
Cond. connection		mm	42.400
Frame on top		mm	130
Frame on bottom		mm	95
Frame left		mm	50
Frame right		mm	50
Frame depth	RT	mm	244
Frame width	BT	mm	2620
Frame height	RH	mm	4225
Volume		l	265
Weight		kg	1159
Fin spacing	LT	mm	3.700
Fin thickness		mm	0.500
Tube diameter		mm	16.400
Tube thickness		mm	1.000
Tube interval on the width		mm	36.000
Tube interval on the depth		mm	36.000

Tubes:	smooth	AISI 304
	in line	
Collectors:		AISI 304
Connections:		AISI 304
Fins:	smooth	Al
Frame:	2.0 mm	AISI 304
Circulations:	1	Default
Protection:		without



Delivery:	5-6 weeks
Validity:	12 weeks
Condit.:	net, prepaid address
Payment:	30 days net
Price net:	**EUR 27076.00**

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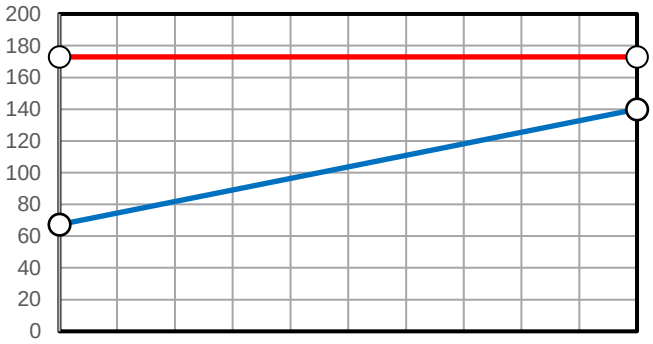
MPC-Condenser: 36/36/16-4T-70B-4000H

Capacity	kW	2092.101
Surface reserve	%	3.711
Present surface	m2	706.626
Required surface	m2	681.338
k-coeff.	W/m2K	49.292
Fouling outside	m2K/W	5.000E-05
Fouling inside	m2K/W	1.000E-04
Average temp. diff. (99.93 %)	K	62.293

Air humid		Inlet	Outlet
Pressure	bar	1.000	
Temp.	°C	67.274	140.000
Rel. humidity	%	6.882	0.523
Abs. humidity	g/kg	12.020	12.020
Density humid	kg/m3	1.016	0.837
Enthalpy humid	kJ/kg	99.336	174.652
Volume flow humid	m3/h	99626.714	120909.633
Mass flow dry	kg/h	100000.000	100000.000
Velocity	m/s	2.745	3.332
Pressure drop	Pa		58.690

Steam 8.50 bar		
Condensation	°C	172.950
Enthalpy difference	kJ/kg	2038.742
Mass flow	kg/h	3694.221
Density''	kg/m3	4.409
Volume flow''	m3/h	837.923
Velocity''	m/s	5.104
Density'	kg/m3	894.415
Volume flow'	m3/h	4.130
Velocity'	m/s	0.025
Pressure drop	bar	0.041
Pressure drop	K	0.200

Temp. (°C)



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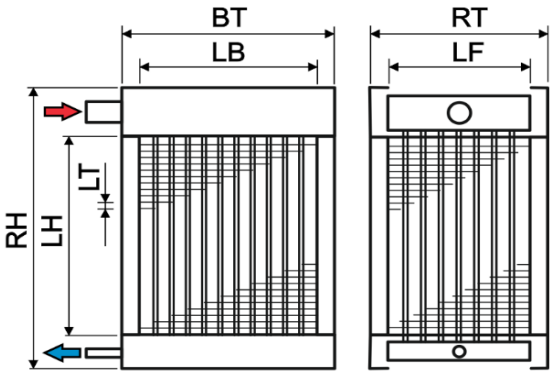
Technical data

Tubes total		Piece	280
Tube rows on the depth		Piece	4
Tube rows on the width		Piece	70
Finned depth	LF	mm	144
Finned width	LB	mm	2520
Finned height	LH	mm	4000
Steam connection		mm	139.700
Cond. connection		mm	48.300
Frame on top		mm	190
Frame on bottom		mm	100
Frame left		mm	50
Frame right		mm	50
Frame depth	RT	mm	244
Frame width	BT	mm	2620
Frame height	RH	mm	4290
Volume		l	291
Weight		kg	1194
Fin spacing	LT	mm	3.700
Fin thickness		mm	0.500
Tube diameter		mm	16.400
Tube thickness		mm	1.000
Tube interval on the width		mm	36.000
Tube interval on the depth		mm	36.000

Tubes:	smooth	AISI 304
	in line	
Collectors:		AISI 304
Connections:		AISI 304
Fins:	smooth	Al
Frame:	2.0 mm	AISI 304
Circulations:	1	Default
Protection:		without



Delivery:	5-6 weeks
Validity:	12 weeks
Condit.:	net, prepaid address
Payment:	30 days net
Price net:	**EUR 27894.00**

LPC-Condenser: 36/36/16-1T-70B-4000H

Capacity	kW	506.400
Surface reserve	%	4.596
Present surface	m2	221.410
Required surface	m2	211.680
k-coeff.	W/m2K	39.052
Fouling outside	m2K/W	5.000E-05
Fouling inside	m2K/W	1.000E-04
Average temp. diff. (99.98 %)	K	61.260

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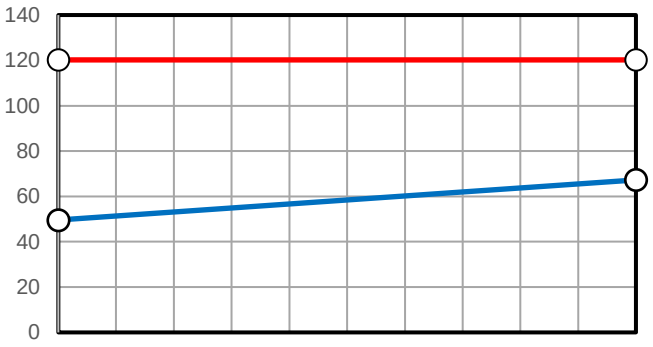
Air humid	Inlet	Outlet
Pressure bar	1.000	
Temp. °C	49.597	67.274
Rel. humidity %	15.746	6.882
Abs. humidity g/kg	12.020	12.020
Density humid kg/m3	1.071	1.016
Enthalpy humid kJ/kg	81.106	99.336
Volume flow humid m3/h	94453.660	99626.714
Mass flow dry kg/h	100000.000	100000.000
Velocity m/s	2.603	2.745
Pressure drop Pa		18.389

Steam 2.00 bar	
Condensation °C	120.220
Enthalpy difference kJ/kg	297.145
Mass flow kg/h	6135.177
Density'' kg/m3	8.304
Volume flow'' m3/h	738.816
Velocity'' m/s	18.002
Density' kg/m3	942.931
Volume flow' m3/h	6.506
Velocity' m/s	0.159
Pressure drop bar	0.013
Pressure drop K	0.200

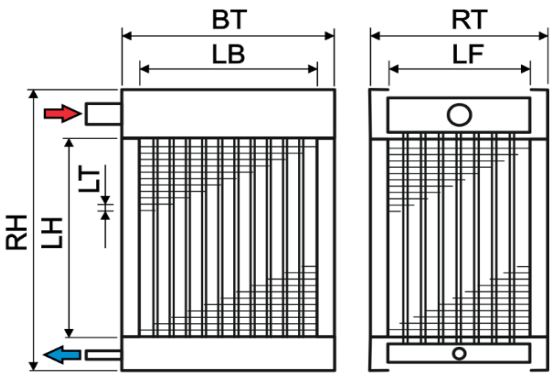
Temp. (°C)



Technical data

Tubes total		Piece	70
Tube rows on the depth		Piece	1
Tube rows on the width		Piece	70
Finned depth	LF	mm	36
Finned width	LB	mm	2520
Finned height	LH	mm	4000
Steam connection		mm	139.700
Cond. connection		mm	60.300
Frame on top		mm	190
Frame on bottom		mm	115
Frame left		mm	50
Frame right		mm	50
Frame depth	RT	mm	136
Frame width	BT	mm	2620
Frame height	RH	mm	4305
Volume		l	76
Weight		kg	471
Fin spacing	LT	mm	2.900
Fin thickness		mm	0.500
Tube diameter		mm	16.400
Tube thickness		mm	1.000
Tube interval on the width		mm	36.000
Tube interval on the depth		mm	36.000

Tubes:	smooth	AISI 304
	in line	
Collectors:		AISI 304
Connections:		AISI 304
Fins:	smooth	Al
Frame:	2.0 mm	AISI 304
Circulations:	1	Default
Protection:		without



Delivery:		5-6 weeks
Validity:		12 weeks
Condit.:		net, prepaid address
Payment:		30 days net
Price net:	**EUR**	**10563.00**

LPS-Heater: 36/36/16-2T-111H-2520B

Capacity	kW	503.522
Surface reserve	%	5.241
Present surface	m2	428.591
Required surface	m2	407.249
k-coeff.	W/m2K	35.695
Fouling outside	m2K/W	5.000E-05
Fouling inside	m2K/W	1.000E-04
Average temp. diff. (89.98 %)	K	34.638

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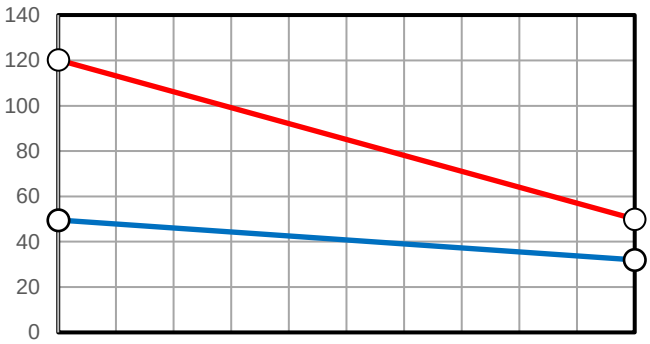
Air humid	Inlet	Outlet
Pressure bar	1.000	
Temp. °C	32.000	49.597
Rel. humidity %	40.000	15.746
Abs. humidity g/kg	12.020	12.020
Density humid kg/m3	1.133	1.071
Enthalpy humid kJ/kg	62.979	81.106
Volume flow humid m3/h	89303.862	94453.660
Mass flow dry kg/h	100000.000	100000.000
Velocity m/s	2.463	2.605
Pressure drop Pa		30.430

Condensate			
Temp.	in	°C	120.220
Temp.	out	°C	50.000
Spec. heat		kJ/kgK	4.208
Mass flow		kg/h	6135.177
Density		kg/m3	968.342
Volume flow		m3/h	6.336
Velocity		m/s	0.292
Pressure drop		kPa	4.778

Temp. (°C)



Technical data

Tubes total		Piece	222	Tubes:	smooth	AISI 304
Tubes blank		Piece	0		in line	
Int. vent./drains		Piece	0	Collectors:	0.82 m/s	AISI 304
Tube rows on the depth		Piece	2	Connections:	0.82 m/s	AISI 304
Tube rows on the height		Piece	111	Fins:	smooth	Al
Tube coupling in series		Piece	6	Frame:	2.00 mm	AISI 304
Number of circuits (NC)		Piece	37	Circulations:	1	Default
Volume		l	115	Protection:		without
Weight		kg	609			---
Connections	G	mm	60			
Frame height	RH	mm	4076			
Frame width	BT	mm	2740			
Frame depth	RT	mm	170			
Finned height	LH	mm	3996			
Finned width	LB	mm	2520			
Finned depth	LF	mm	72			
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	60			
Collector covering	AD	mm	151			
Collector distance	KA	mm	81			
Fin spacing	LT	mm	3.000			
Fin thickness	LD	mm	0.500	Delivery:		5-6 weeks
Tube diameter	DA	mm	16.400	Validity:		12 weeks
Tube thickness	S	mm	1.000	Condit.:		net, prepaid address
Tube interval on the height	S1	mm	36.000	Payment:		30 days net
Tube interval on the depth	S2	mm	36.000	**Price net:**	**EUR**	**13517.00**