



Co-current cooler

In air conditioning technology, 99% of fin coil heat exchangers are designed in multiple cross-counter-current-flow and thus achieve almost the values of counter-current-flow. However, if the hot outlet temperature is identical to the cold outlet temperature, the mean logarithmic temperature difference becomes $\Delta t_m = 0.000$ in pure direct co-current-flow, which means, that the fin coil heat exchanger can no longer provide any capacity. In practice, however, it will produce a very small capacity, because there will be a very small temperature difference y at the outlet.

Example

Temperature hot in = 20.000°C
 Temperature hot out = 18.000°C
 Temperature cold in = 15.000°C
 Temperature cold out = 17.999°C

Counter-current

$x = 20.000 - 17.999 = 2.001$
 $y = 18.000 - 15.000 = 3.000$
 $\Delta t_m = 2.467$

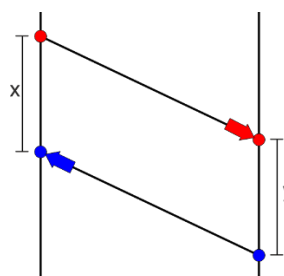
Co-current flow

$x = 20.000 - 15.000 = 5.000$
 $y = 18.000 - 17.999 = 0.001$
 $\Delta t_m = 0.587$

Hot out = cold out = 18.000
 Counter-current = $\Delta t_m = 2.466$
 Co-current flow $\Delta t_m = 0.000$

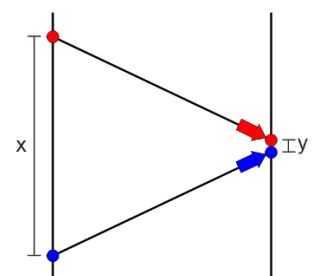
Counter-current

$$\Delta t_m = \frac{x-y}{\ln(x/y)}$$



Co-current-flow

$$\Delta t_m = \frac{x-y}{\ln(x/y)}$$



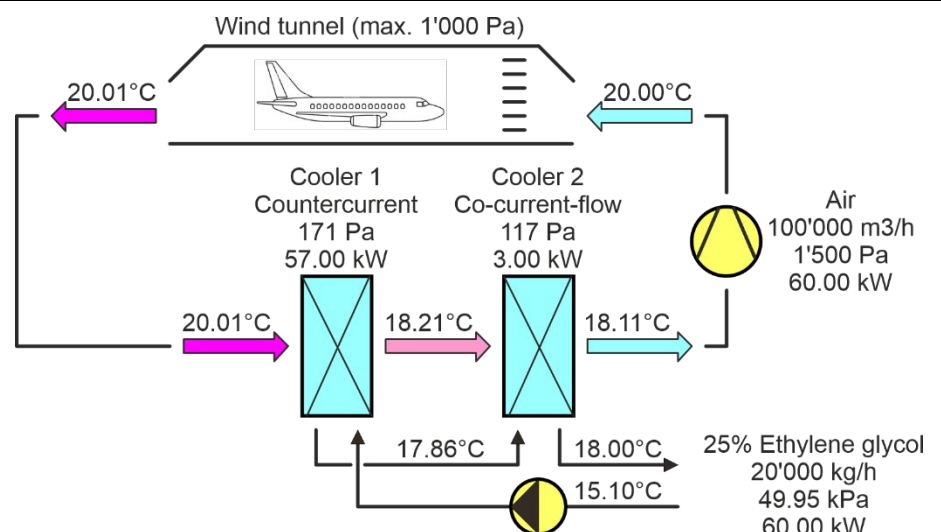
In the last 55 years, I have only been presented with such a special case 1 time, where a fin coil heat exchanger in co-current-flow was required. It was a wind tunnel, where various objects such as airplanes and model-sized cars were tested for flow resistance. At first, there was only one cooler in the counter-current, which, however, could not keep the air sufficiently stable at the entrance to the wind tunnel. Fluctuations during a measurement period of several minutes were therefore more than 1K, which was not accepted. The solution to the problem was a downstream second cooler in co-current-flow. Since its mean logarithmic temperature difference automatically tended towards 0.000K, the temperature was extremely stable with regard to the air at the entrance to the wind tunnel.

There was a requirement, that the temperature before entering the wind tunnel had to be an accuracy of less than 0.1K.

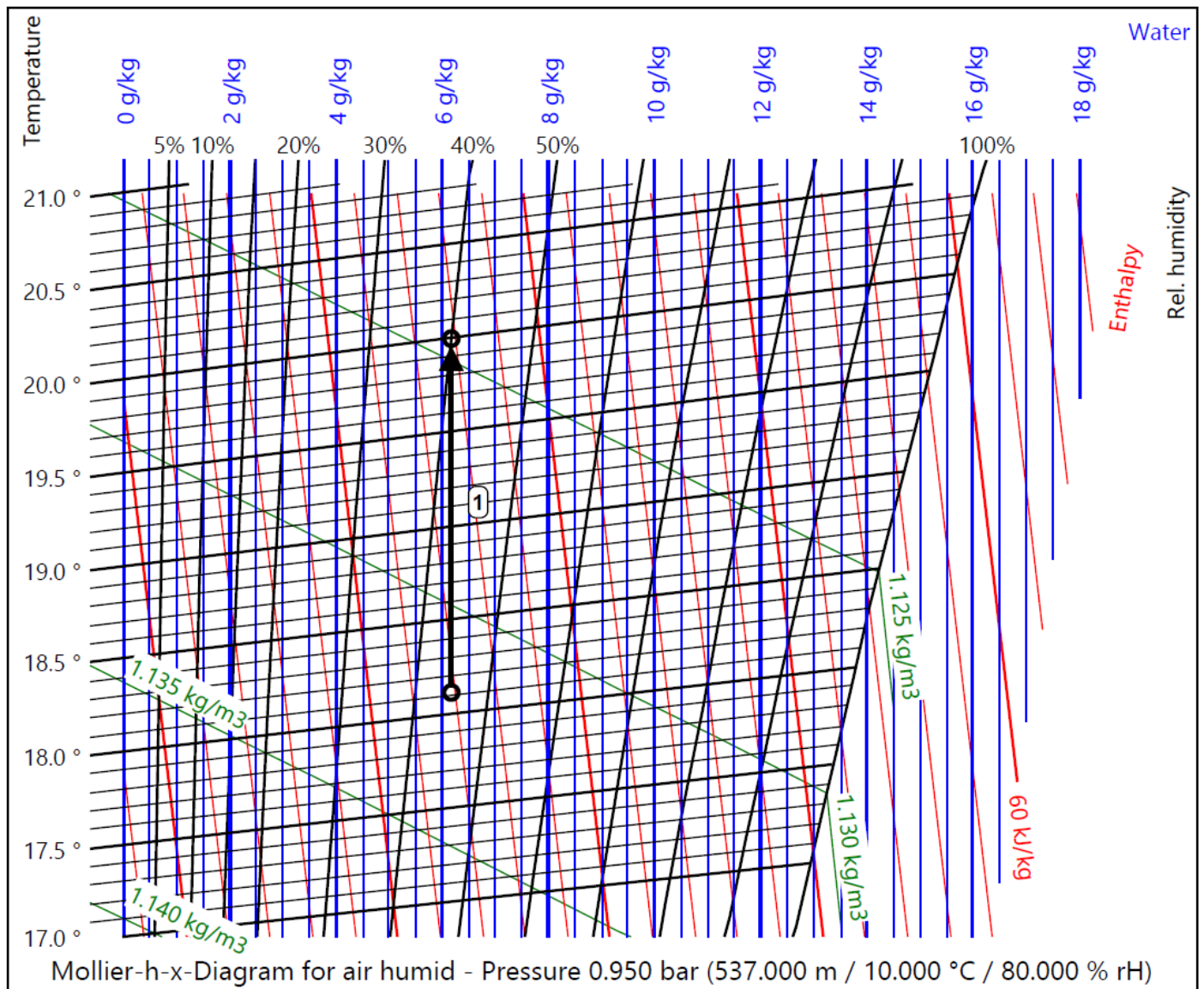
However, because the fan warmed up the air by 1.89K, which corresponded to an output of 60 kW, 2 coolers had to be used.

The first counter-current cooler had to produce 57 kW, i.e. 95%.

The second co-current cooler had to produce 3 kW, i.e. 5%.



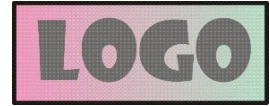
The air heating by the fan with an efficiency of about 70% is 1,886K, which corresponds a capacity of 60 kW and is shown in the Mollier-HX-Diagram with the software AHH (Air humid Handling). This includes 15 applications.



1) Fan Effect

Fan pressure total	Pa	1511.550
Fan efficiency total	%	70.000
Fan capacity	kW	60.000

		Air In	Air Out
Temperature	°C	18.114	20.000
Rel. humidity	%	44.980	40.000
Abs. humidity	g/kg	6.173	6.173
Density humid	kg/m ³	1.132	1.125
Enthalpy humid	kJ/kg	33.871	35.792
Volume flow humid	m ³ /h	100000.000	100647.522
Massflow dry	kg/h	112486.841	112486.841



Capacity	kW	57.000	----- sensible:	57.000
Surface reserve	%	0.635	latent:	0.000
Present surface	m2	568.679	frost:	0.000
Required surface	m2	565.091		
k-coeff.	W/m2K	40.441		
Average temp. diff. (95.74 %)	K	2.494		

Company
Branch
Street
Country / ZIP / City

Air humid (ff = 0.00005 m2K/W)		Inlet	Outlet	Definition
Height over sea level	m			537.000
Pressure	hPa			949.999
Temp.	°C	20.012	18.209	20.000
Rel. humidity	%	39.970	44.713	40.000
Abs. humidity	g/kg	6.171	6.171	6.171
Density humid	kg/m3	1.124	1.131	1.125
Enthalpy humid	kJ/kg	35.800	33.964	35.787
Volume flow humid	m3/h	100004.193	99389.044	100000.000
Mass flow dry	kg/h	111763.117	111763.117	111763.117
Condensate flow	kg/h		0.000	
Surface temperature	°C	18.713	16.371	
Velocity	m/s	4.961	4.930	4.960
Pressure drop (dry 171 Pa)	Pa		170.543	

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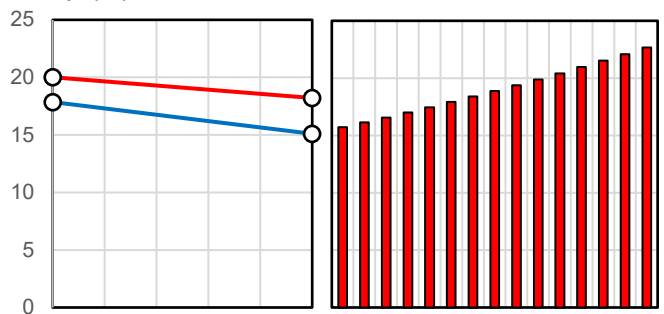
Representative
Direct dialing
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Plant
Object
Position

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

Temp. Inlet	°C	15.098
Temp. Outlet	°C	17.855
Temp. Selection	°C	16.104
Density	kg/m3	1039.005
Spec. heat	kJ/kgK	3.721
Heat cond.	W/mK	0.470
Viscosity	Pas	2.083E-03
Mass flow	kg/h	20000.000
Volume flow	m3/h	19.249
Velocity	m/s	0.968
Pressure drop (T/C = 2.928)	kPa	30.156

Temp. (°C)

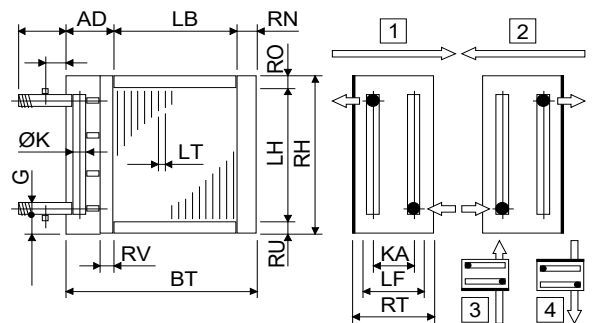


Technical data

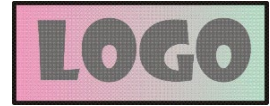
Tubes total	Piece	200
Tubes blank	Piece	2
Int. vent./drains	Piece	0
Tube rows on the depth	Piece	4
Tube rows on the height	Piece	50
Tube coupling in series	Piece	6
Number of circuits (NC)	Piece	33
Volume	l	116
Weight	kg	317
Connections	G	--- 2 1/2"
Frame height	RH	mm 2080
Frame width	BT	mm 3027
Frame depth	RT	mm 210
Finned height	LH	mm 2000
Finned width	LB	mm 2800
Finned depth	LF	mm 140
Frame on top	RO	mm 40
Frame on bottom	RU	mm 40
Frame in front	RV	mm 40
Frame on back (~65mm)	RN	mm 65
Collector-Diameter	K	mm 76
Covering (~162mm)	AD	mm 162
Collector distance	KA	mm 105
Fin spacing	LT	mm 2.500
Fin thickness	LD	mm 0.200
Tube diameter	DA	mm 15.400
Tube diameter	da	mm 15.400
Tube thickness	S	mm 0.400
Tube interval on the height	S1	mm 40.000
Tube interval on the depth	S2	mm 35.000



Tubes:	Cu
Tubes:	smooth
Tubes:	staggered
Tubes:	circular
Collectors:	1.31 m/s Cu
Connections:	1.31 m/s Rg7
Fin:	Al
Fin:	smooth
Circulations:	1 Default
Frame:	2.0 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 5048.00



Capacity	kW	3.000	----- sensible:	3.000
Surface reserve	%	1.925	latent:	0.000
Present surface	m ²	358.811	frost:	0.000
Required surface	m ²	352.034		
k-coeff.	W/m ² K	41.206		
Average temp. diff. (88.74 %)	K	0.207		

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Air humid (ff = 0.00005 m ² K/W)		Inlet	Outlet	Definition
Height over sea level	m			537.000
Pressure	hPa			949.999
Temp.	°C	18.209	18.114	20.000
Rel. humidity	%	44.713	44.980	40.000
Abs. humidity	g/kg	6.171	6.171	6.171
Density humid	kg/m ³	1.131	1.132	1.125
Enthalpy humid	kJ/kg	33.964	33.867	35.787
Volume flow humid	m ³ /h	99389.056	99356.675	100000.000
Mass flow dry	kg/h	111763.117	111763.117	111763.117
Condensate flow	kg/h		0.000	
Surface temperature	°C	17.987	18.043	
Velocity	m/s	4.930	4.928	4.960
Pressure drop (dry 117 Pa)	Pa		116.834	

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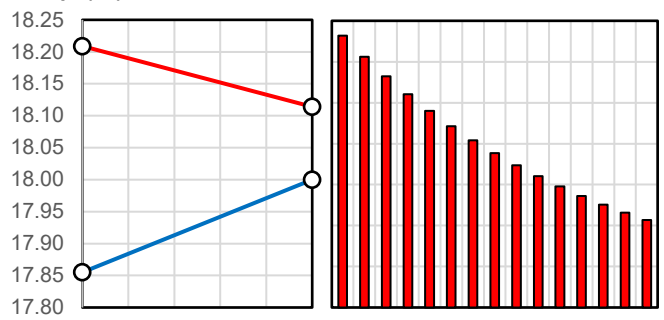
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Plant
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Position

25 V% Et.glycol (ff = 0.00005 m²K/W)

Temp. Inlet	°C	17.855
Temp. Outlet	°C	18.000
Temp. Selection	°C	17.908
Density	kg/m ³	1038.381
Spec. heat	kJ/kgK	3.726
Heat cond.	W/mK	0.472
Viscosity	Pas	1.981E-03
Mass flow	kg/h	20000.000
Volume flow	m ³ /h	19.261
Velocity	m/s	0.864
Pressure drop (T/C = 1.585)	kPa	19.795

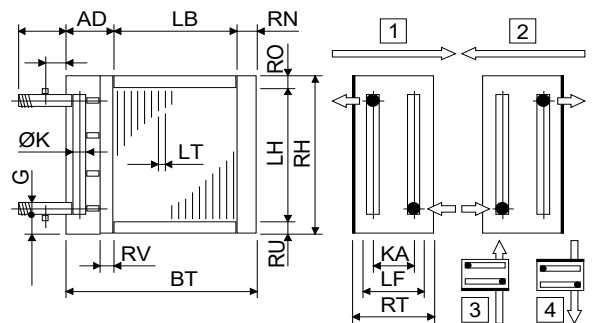
Temp. (°C)



Technical data

Tubes total	Piece	150
Tubes blank	Piece	2
Int. vent./drains	Piece	0
Tube rows on the depth	Piece	3
Tube rows on the height	Piece	50
Tube coupling in series	Piece	4
Number of circuits (NC)	Piece	37
Volume	l	92
Weight	kg	236
Connections	G	--- 2 1/2"
Frame height	RH	mm 2080
Frame width	BT	mm 3027
Frame depth	RT	mm 200
Finned height	LH	mm 2000
Finned width	LB	mm 2800
Finned depth	LF	mm 105
Frame on top	RO	mm 40
Frame on bottom	RU	mm 40
Frame in front	RV	mm 30
Frame on back (~65mm)	RN	mm 65
Collector-Diameter	K	mm 76
Covering (~162mm)	AD	mm 162
Collector distance	KA	mm 97
Fin spacing	LT	mm 3.000
Fin thickness	LD	mm 0.200
Tube diameter	DA	mm 15.400
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Collectors:	1.31 m/s Cu
Connections:	1.31 m/s Rg7
Fin:	Al
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Frame:	2.0 mm AISI 304
Protection:	without
Protection:	---
Air flow direction:	horizontal



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