# Energy recovery with plates and rotors

Energy recovery can be carried out in many ways, with only the circuit connect system, short CC-System, the supply air and exhaust air do not have to be combined, so that you can save considerable costs with regard to the air ducts.

Furthermore, only the CC-System and the plate heat exchanger may be used in hospitals, because only with these two systems can air mixing and bacterial moisture transfer be ruled out.

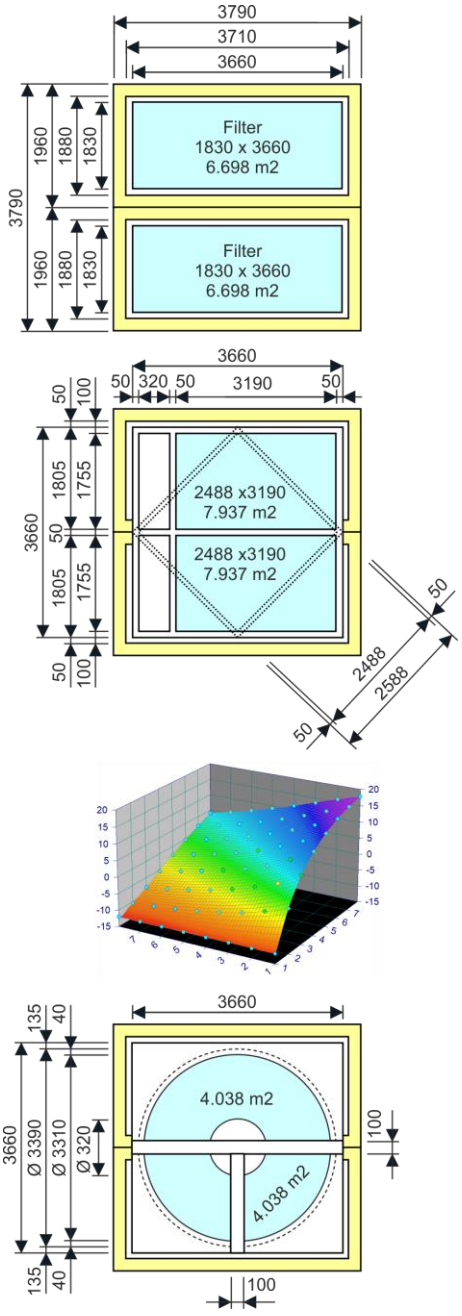
Because the two air handling units must form a square with the rotor heat exchanger, this is also assumed here for all energy recovery systems as an example for comparison purposes.

Furthermore, the size of the air handling units was chosen so that standard filter units of 610 x 610 mm can be used. In the picture on the right, 3 x 6 filters are provided, resulting in dimensions of 1,830 x 3,660 mm. With a maximum prescribed air speed of 2.00 m/s, this results in an air volume flow of 48,224 m3/h, which, however, cannot be maintained in all energy recovery systems with regard to the inflow area.

On the following pages, 43,350 m3/h is calculated for the supply air and 39,020 m3/h for the exhaust air, i.e. 10% less, which is mostly the case in practice. With the CC-System type CCSD, a temperature efficiency of 76.40% is achieved in winter with a construction depth of 950 mm and air-side pressure drops of 135 Pa. No finned heat exchangers are required for post-heating in winter and for post-cooling in summer.

The **plate heat exchanger** must be designed with a bypass so that no permanent damage is caused in winter when there is a risk of frost, which is why the width must be adjusted accordingly. In winter, a temperature efficiency of 73.57% is achieved, with the overall depth of 3,660 mm exceeding the KV system by a factor of 3.46. The pressure drop on the air side is 102 Pa in the exhaust air and 111 Pa in the supply air. In the supply air, there is an additional 45 Pa for the after-heater and the after-cooler, resulting in a total pressure drop of 156 Pa, i.e. exceeding the CC-System by a factor of 1.16. It should be noted that the mean supply air outlet temperature is 11.54°C, but has a bandwidth of 13.6 K from 4.9°C to 18.5°C, which requires a mixing zone before the reheater can be stably regulated at all.

In winter, when there is a risk of frost, the **rotor heat exchanger** can suffer irreparable damage such as out-of-roundness if the speed is not throttled early enough. In winter, a temperature efficiency of 73.56% is achieved, with the overall depth of 590 mm undercutting the CC-System by a factor of 0.62. The pressure drop on the air side is 199 Pa in the exhaust air and 217 Pa in the supply air. In the supply air, there is an additional 45 Pa for the after-heater and the after-cooler, resulting in a total pressure drop of 244 Pa, i.e. exceeding the CC-System by a factor of 1.81. The mixing of air is a big problem, but together with the humidity, a bacterial transfer of up to 30% is to be accepted, if the slip ring seals are not replaced regularly at very short intervals, which increases the maintenance costs considerably.



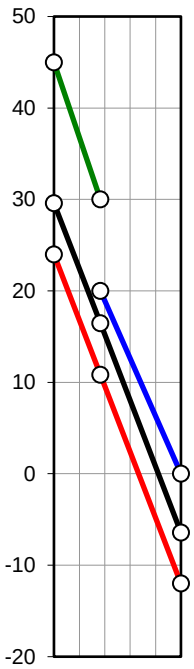

**Following pages**

| CC-System in winter | | SA-He | Pt | RA-Co | Definition |
|---|---|---|---|---|---|
| Height over sea level | m | | | | 106.000 |
| Pressure | hPa | | | | 1000.564 |
| Capacity | % | 100.000 | 36.602 | 63.398 | |
| Capacity sensible | kW | 514.913 | 188.468 | 258.483 | |
| Capacity latent | kW | --- | --- | 65.720 | |
| Capacity frost | kW | --- | --- | 2.243 | |
| Capacity total | kW | 514.913 | 188.468 | 326.445 | |
| Surface reserve | % | 0.100 | | 0.435 | |
| Present surface | m2 | 3795.681 | | 3795.681 | |

| SA-He ( ff = 0.00005 m2K/W ) | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | -12.000 | 24.000 | 20.000 |
| Rel. humidity | % | 90.000 | 6.517 | 40.000 |
| Abs. humidity | g/kg | 1.208 | 1.208 | 5.858 |
| Volume flow humid | m3/h | 38332.221 | 43616.185 | 43350.000 |
| Velocity | m/s | 1.768 | 2.012 | 2.000 |
| Pressure drop | Pa | | 131.968 | |

| RA-Co ( ff = 0.00005 m2K/W ) | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | 20.000 | 0.020 | 20.000 |
| Rel. humidity | % | 40.000 | 99.747 | 40.000 |
| Abs. humidity | g/kg | 5.858 | 3.829 | 5.858 |
| Volume flow humid | m3/h | 39020.000 | 36243.171 | 39020.000 |
| Velocity | m/s | 1.800 | 1.672 | 1.800 |
| Pressure drop (dry 125 Pa) | Pa | | 135.213 | |

| 25 V% Et.glycol | | SA-He | Pt | RA-Co |
|---|---|---|---|---|
| Temp. in | °C | 29.587 | 16.477 | -6.413 |
| Temp. out | °C | -6.413 | 29.587 | 16.477 |
| Volume flow | m3/h | 13.340 | 13.385 | 13.337 |
| Velocity | m/s | 0.948 | | 0.947 |
| Reynolds | --- | 4818.823 | | 3925.386 |
| Pressure drop | kPa | 186.535 | | 197.132 |

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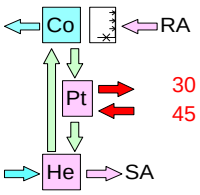


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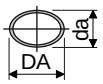
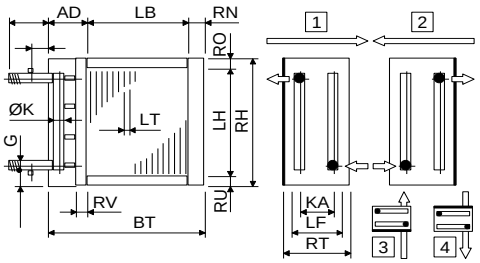
| Technical data | | | SA-He | RA-Co | | SA-He | RA-Co |
|---|---|---|---|---|---|---|---|
| Tubes total | | Piece | 1200 | 1200 | Tubes: | Cu | Cu |
| Tubes blank | | Piece | 16 | 16 | Tubes: | smooth | smooth |
| Int. vent./drains | | Piece | 11 | 11 | Tubes: | in line | in line |
| Tube rows on the depth | | Piece | 24 | 24 | Tubes: | circular | circular |
| Tube rows on the height | | Piece | 50 | 50 | Collectors: | Cu | Cu |
| Tube coupling in series | | Piece | 32 | 32 | Collectors: | 0.91 m/s | 0.91 m/s |
| Number of circuits (NC) | | Piece | 37 | 37 | Connections: | Rg7 | Rg7 |
| Volume | | l | 466 | 466 | Connections: | 0.91 m/s | 0.91 m/s |
| Weight | | kg | 1739 | 1739 | Fins: | Al | Al |
| Connections | G | --- | 2 ½" | 2 ½" | Fins: | smooth | smooth |
| Frame height | RH | mm | 1830 | 1830 | Frame: | AISI 304 | AISI 304 |
| Frame width | BT | mm | 3660 | 3660 | Air flow direction: | horizontal | horizontal |
| Frame depth | RT | mm | 950 | 950 | Protection: | without | without |
| Finned height | LH | mm | 1750 | 1750 | Protection: | --- | --- |
| Finned width | LB | mm | 3441 | 3441 | | | |
| Finned depth | LF | mm | 840 | 840 | | | |
| Frame on top | RO | mm | 40 | 40 | | | |
| Frame on bottom | RU | mm | 40 | 40 | | | |
| Frame in front | RV | mm | 30 | 30 | | | |
| Frame on back (~53/53mm) | RN | mm | 53 | 53 | | | |
| Collector-Diameter | K | mm | 76 | 76 | | | |
| Collector covering | AD | mm | 166 | 166 | | | |
| Collector distance | KA | mm | 844 | 844 | | | |
| Fin spacing | LT | mm | 2.500 | 2.500 | | | |
| Fin thickness | LD | mm | 0.200 | 0.200 | | | |
| Tube diameter | DA | mm | 12.400 | 12.400 | Delivery: | | 5-6 weeks |
| Tube diameter | da | mm | 12.400 | 12.400 | Validity: | | 12 weeks |
| Tube thickness | S | mm | 0.400 | 0.400 | Condit.: | | net, prepaid address |
| Tube interval on the height | S1 | mm | 35.000 | 35.000 | Payment: | | 30 days net |
| Tube interval on the depth | S2 | mm | 35.000 | 35.000 | | | |




**SA-He: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304** — **SA-He: EUR 23126.00**

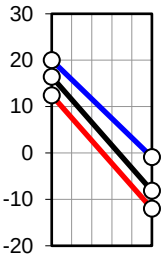
**RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304** — **RA-Co: EUR 23126.00**

| CC-System in winter without Pt | | SA-He | RA-Co | Definition |
|---|---|---|---|---|
| Height over sea level | m | | | 106.000 |
| Pressure | hPa | | | 1000.564 |
| Efficiency | % | 76.400 | 65.279 | |
| Capacity sensible | kW | 349.625 | 270.107 | |
| Capacity latent | kW | --- | 74.751 | |
| Capacity frost | kW | --- | 4.767 | |
| Capacity total | kW | 349.625 | 349.625 | |
| Surface reserve | % | 0.099 | 0.095 | |
| Present surface | m2 | 3795.681 | 3795.681 | |

| SA-He ( ff = 0.00005 m2K/W ) | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | -12.000 | 12.448 | 20.000 |
| Rel. humidity | % | 90.000 | 13.436 | 40.000 |
| Abs. humidity | g/kg | 1.208 | 1.208 | 5.858 |
| Volume flow humid | m3/h | 38332.221 | 41920.619 | 43350.000 |
| Velocity | m/s | 1.768 | 1.934 | 2.000 |
| Pressure drop | Pa | | 128.221 | |

| RA-Co ( ff = 0.00005 m2K/W ) | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | 20.000 | -0.889 | 20.000 |
| Rel. humidity | % | 40.000 | 100.000 | 40.000 |
| Abs. humidity | g/kg | 5.858 | 3.550 | 5.858 |
| Volume flow humid | m3/h | 39020.000 | 36106.438 | 39020.000 |
| Velocity | m/s | 1.800 | 1.666 | 1.800 |
| Pressure drop (dry 126 Pa) | Pa | | 137.245 | |

| 25 V% Et.glycol | | | SA-He | RA-Co |
|---|---|---|---|---|
| Temp. | in | °C | 16.424 | -8.148 |
| Temp. | out | °C | -8.148 | 16.424 |
| Volume flow | | m3/h | 13.312 | 13.312 |
| Velocity | | m/s | 0.946 | 0.946 |
| Reynolds | | --- | 3803.442 | 3785.743 |
| Pressure drop | | kPa | 198.103 | 198.383 |

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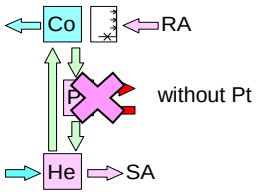
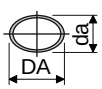
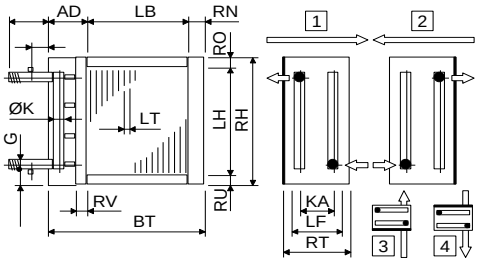



Software by www.zcs.ch

| Technical data | | | SA-He | RA-Co | | SA-He | RA-Co |
|---|---|---|---|---|---|---|---|
| Tubes total | | Piece | 1200 | 1200 | Tubes: | Cu | Cu |
| Tubes blank | | Piece | 16 | 16 | Tubes: | smooth | smooth |
| Int. vent./drains | | Piece | 11 | 11 | Tubes: | in line | in line |
| Tube rows on the depth | | Piece | 24 | 24 | Tubes: | circular | circular |
| Tube rows on the height | | Piece | 50 | 50 | Collectors: | Cu | Cu |
| Tube coupling in series | | Piece | 32 | 32 | Collectors: | 0.91 m/s | 0.91 m/s |
| Number of circuits (NC) | | Piece | 37 | 37 | Connections: | Rg7 | Rg7 |
| Volume | | l | 466 | 466 | Connections: | 0.91 m/s | 0.91 m/s |
| Weight | | kg | 1739 | 1739 | Fins: | Al | Al |
| Connections | G | --- | 2 ½" | 2 ½" | Fins: | smooth | smooth |
| Frame height | RH | mm | 1830 | 1830 | Frame: | AISI 304 | AISI 304 |
| Frame width | BT | mm | 3660 | 3660 | Air flow direction: | horizontal | horizontal |
| Frame depth | RT | mm | 950 | 950 | Protection: | without | without |
| Finned height | LH | mm | 1750 | 1750 | Protection: | --- | --- |
| Finned width | LB | mm | 3441 | 3441 | | | |
| Finned depth | LF | mm | 840 | 840 | | | |
| Frame on top | RO | mm | 40 | 40 | | | |
| Frame on bottom | RU | mm | 40 | 40 | | | |
| Frame in front | RV | mm | 30 | 30 | | | |
| Frame on back (~53/53mm) | RN | mm | 53 | 53 | | | |
| Collector-Diameter | K | mm | 76 | 76 | | | |
| Collector covering | AD | mm | 166 | 166 | | | |
| Collector distance | KA | mm | 844 | 844 | | | |
| Fin spacing | LT | mm | 2.500 | 2.500 | | | |
| Fin thickness | LD | mm | 0.200 | 0.200 | | | |
| Tube diameter | DA | mm | 12.400 | 12.400 | Delivery: | | 5-6 weeks |
| Tube diameter | da | mm | 12.400 | 12.400 | Validity: | | 12 weeks |
| Tube thickness | S | mm | 0.400 | 0.400 | Condit.: | | net, prepaid address |
| Tube interval on the height | S1 | mm | 35.000 | 35.000 | Payment: | | 30 days net |
| Tube interval on the depth | S2 | mm | 35.000 | 35.000 | | | |

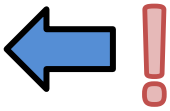



**SA-He: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304** — **SA-He: EUR 23126.00**

**RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304** — **RA-Co: EUR 23126.00**

| CC-System in winter | | SA-He | Pt1 | RA-Co | Definition |
|---|---|---|---|---|---|
| Height over sea level | m | | | | 106.000 |
| Pressure | hPa | | | | 1000.564 |
| Capacity | % | 100.000 | 44.786 | 55.214 | |
| Capacity sensible | kW | 514.913 | 230.611 | 235.687 | |
| Capacity latent | kW | --- | --- | 48.615 | |
| Capacity frost | kW | --- | --- | 0.000 | |
| Capacity total | kW | 514.913 | 230.611 | 284.302 | |
| Surface reserve | % | 0.100 | | 0.090 | |
| Present surface | m2 | 3795.681 | | 3795.681 | |



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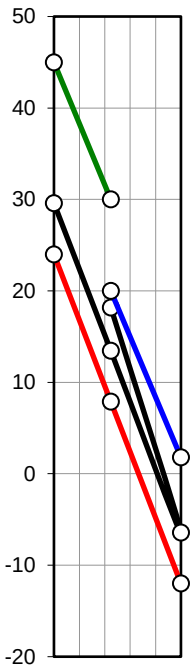
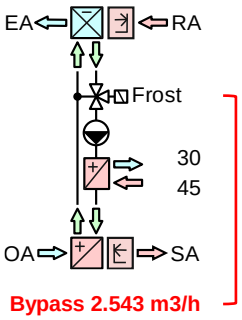
| SA-He ( ff = 0.00005 m2K/W ) | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | -12.000 | 24.000 | 20.000 |
| Rel. humidity | % | 90.000 | 6.517 | 40.000 |
| Abs. humidity | g/kg | 1.208 | 1.208 | 5.858 |
| Volume flow humid | m3/h | 38332.221 | 43616.185 | 43350.000 |
| Velocity | m/s | 1.768 | 2.012 | 2.000 |
| Pressure drop | Pa | | 131.968 | |

| RA-Co ( ff = 0.00005 m2K/W ) | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | 20.000 | 1.800 | 20.000 |
| Rel. humidity | % | 40.000 | 99.799 | 40.000 |
| Abs. humidity | g/kg | 5.858 | 4.357 | 5.858 |
| Volume flow humid | m3/h | 39020.000 | 36510.097 | 39020.000 |
| Velocity | m/s | 1.800 | 1.684 | 1.800 |
| Pressure drop (dry 123 Pa) | Pa | | 131.290 | |

| 25 V% Et.glycol | | SA-He | Pt1 | RA-Co |
|---|---|---|---|---|
| Temp. in | °C | 29.587 | 13.463 | -6.413 |
| Temp. out | °C | -6.413 | 29.587 | 18.183 |
| Volume flow | m3/h | 13.340 | 13.380 | 10.797 |
| Velocity | m/s | 0.948 | | 0.767 |
| Reynolds | --- | 4818.823 | | 3456.202 |
| Pressure drop | kPa | 186.535 | | 133.628 |




**Bypass 2.543 m3/h**

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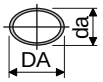
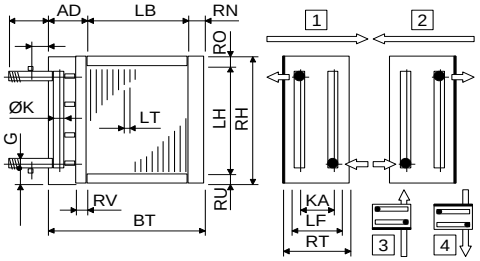
| Technical data | | | SA-He | RA-Co | | SA-He | RA-Co |
|---|---|---|---|---|---|---|---|
| Tubes total | | Piece | 1200 | 1200 | Tubes: | Cu | Cu |
| Tubes blank | | Piece | 16 | 16 | Tubes: | smooth | smooth |
| Int. vent./drains | | Piece | 11 | 11 | Tubes: | in line | in line |
| Tube rows on the depth | | Piece | 24 | 24 | Tubes: | circular | circular |
| Tube rows on the height | | Piece | 50 | 50 | Collectors: | Cu | Cu |
| Tube coupling in series | | Piece | 32 | 32 | Collectors: | 0.91 m/s | 0.73 m/s |
| Number of circuits (NC) | | Piece | 37 | 37 | Connections: | Rg7 | Rg7 |
| Volume | | l | 466 | 466 | Connections: | 0.91 m/s | 0.73 m/s |
| Weight | | kg | 1739 | 1739 | Fins: | Al | Al |
| Connections | G | --- | 2 ½" | 2 ½" | Fins: | smooth | smooth |
| Frame height | RH | mm | 1830 | 1830 | Frame: | AISI 304 | AISI 304 |
| Frame width | BT | mm | 3660 | 3660 | Air flow direction: | horizontal | horizontal |
| Frame depth | RT | mm | 950 | 950 | Protection: | without | without |
| Finned height | LH | mm | 1750 | 1750 | Protection: | --- | --- |
| Finned width | LB | mm | 3441 | 3441 | | | |
| Finned depth | LF | mm | 840 | 840 | | | |
| Frame on top | RO | mm | 40 | 40 | | | |
| Frame on bottom | RU | mm | 40 | 40 | | | |
| Frame in front | RV | mm | 30 | 30 | | | |
| Frame on back (~53/53mm) | RN | mm | 53 | 53 | | | |
| Collector-Diameter | K | mm | 76 | 76 | | | |
| Collector covering | AD | mm | 166 | 166 | | | |
| Collector distance | KA | mm | 844 | 844 | | | |
| Fin spacing | LT | mm | 2.500 | 2.500 | | | |
| Fin thickness | LD | mm | 0.200 | 0.200 | | | |
| Tube diameter | DA | mm | 12.400 | 12.400 | Delivery: | | 5-6 weeks |
| Tube diameter | da | mm | 12.400 | 12.400 | Validity: | | 12 weeks |
| Tube thickness | S | mm | 0.400 | 0.400 | Condit.: | | net, prepaid address |
| Tube interval on the height | S1 | mm | 35.000 | 35.000 | Payment: | | 30 days net |
| Tube interval on the depth | S2 | mm | 35.000 | 35.000 | | | |




**SA-He: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304** — **SA-He: EUR 23126.00**

**RA-Co: 35/35/12-24R-50T-3441A-2.5PA-37C-Cu/Al/AISI 304** — **RA-Co: EUR 23126.00**

| Standard plate-HE: B2588 -H2588 -T3288 | | Cold air | Hot air | Definition |
|---|---|---|---|---|
| Height over sea level | m | | | 106.000 |
| Pressure | hPa | | | 1000.564 |
| Efficiency | % | 73.573 | 63.355 | |
| Capacity sensible | kW | 336.683 | 262.235 | |
| Capacity latent | kW | | 68.648 | |
| Capacity frost | kW | | 5.800 | |
| Fouling factor | m2K/W | 5.000E-05 | 5.000E-05 | |
| Present surface | m2 | | | 3546.240 |
| k-coeff. | W/m2K | | | 16.320 |
| Average temp. diff. ( 58.16 % ) | K | | | 5.817 |

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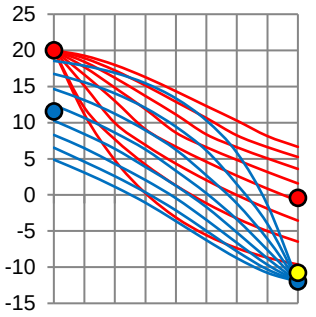
Software by www.zcs.ch

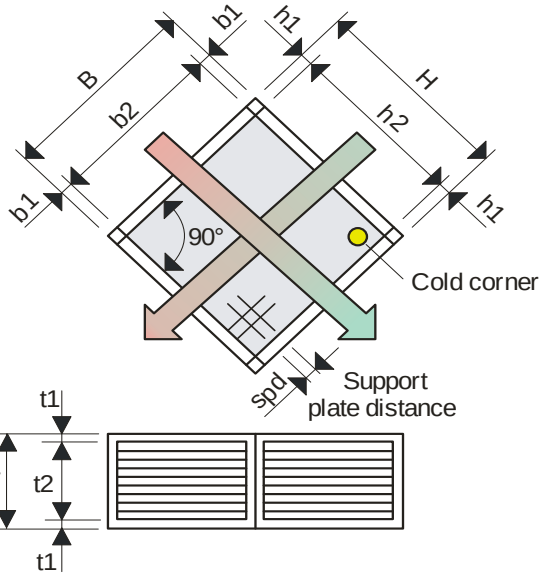
| Cold air | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | -12.000 | 11.543 | 20.000 |
| Rel. humidity | % | 90.000 | 14.259 | 40.000 |
| Abs. humidity | g/kg | 1.208 | 1.208 | 5.858 |
| Density humid | kg/m3 | 1.333 | 1.223 | 1.185 |
| Enthalpy humid | kJ/kg | -9.078 | 14.663 | 34.992 |
| Volume flow humid | m3/h | 38332.221 | 41787.822 | 43350.000 |
| Mass flow dry | kg/h | 51053.643 | 51053.643 | 51053.643 |
| Velocity | m/s | 3.204 | 3.493 | |
| Pressure drop | Pa | | 110.750 | |

| Hot air | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Temp. | °C | 20.000 | -0.273 | 20.000 |
| Rel. humidity | % | 40.000 | 100.000 | 40.000 |
| Abs. humidity | g/kg | 5.858 | 3.739 | 5.858 |
| Density humid | kg/m3 | 1.185 | 1.274 | 1.185 |
| Enthalpy humid | kJ/kg | 34.992 | 9.071 | 34.992 |
| Volume flow humid | m3/h | 39020.000 | 36199.005 | 39020.000 |
| Mass flow dry | kg/h | 45954.168 | 45954.168 | 45954.168 |
| Surface temperature | °C | 12.115 | -2.705 | |
| Condensate flow | kg/h | | 97.399 | |
| Velocity | m/s | 3.261 | 3.025 | |
| Pressure drop (dry 95 Pa) | Pa | | 102.051 | |




**Technical data** — **Danger of freezing**

| | | |
|---|---|---|
| Cold corner - Surface temperature | °C | -10.793 |
| Cold air - Outlet - Min. | °C | 4.877 |
| Cold air - Outlet - Max. | °C | 18.542 |
| Hot air - Outlet - Min. | °C | -9.627 |
| Hot air - Outlet - Max. | °C | 6.643 |




| Standard plate-HE | | | |
|---|---|---|---|
| Plate-Material | | --- | Al |
| Box-Material | | --- | AISI 304 |
| Box-Thickness | | mm | 1.000 |
| Weight | | kg | 2621.377 |
| Support plate distance | spd | mm | 50.000 |
| Width | b1 | mm | 50.000 |
| Width | b2 | mm | 2488.000 |
| Box-Width | B | mm | 2588.000 |
| Altitude | h1 | mm | 50.000 |
| Altitude | h2 | mm | 2488.000 |
| Box-Altitude | H | mm | 2588.000 |
| Depth | t1 | mm | 50.000 |
| Depth | t2 | mm | 3188.100 |
| Box-Depth | T | mm | 3288.100 |
| Number of splits per side | n | Piece | 253.000 |
| Split width on cold air side | sk | mm | 6.000 |
| Split width on hot air side | sw | mm | 6.000 |
| Plate thickness | ld | mm | 0.300 |

| | |
|---|---|
| Delivery: | 5-6 weeks |
| Validity: | 12 weeks |
| Condit.: | net, prepaid address |
| Payment: | 30 days net |
| **Price net:** | **EUR 29152.00** |

| Thermic rotor: N-3310-277 | | Cold air | Hot air | Definition |
|---|---|---|---|---|
| Height over sea level | m | | | 106.000 |
| Pressure | hPa | | | 1000.564 |
| Capacity total | kW | | | 446.246 |
| Present surface | m2 | | | 4061.034 |
| Cold air for washing zone | % | | | 3.500 |
| Cold air for washing zone | m3/h | | | 1517.250 |
| Speed | rpm | | | 20.000 |
| Temp. efficiency | % | 73.558 | 78.814 | |
| Efficiency humid | % | 65.929 | 73.245 | |

| Cold air | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Fouling | m2K/W | | | 5.000E-05 |
| Temp. | °C | -12.000 | 11.538 | 20.000 |
| Rel. humidity | % | 90.000 | 50.207 | 40.000 |
| Abs. humidity | g/kg | 1.208 | 4.274 | |
| Density | kg/m3 | 1.333 | 1.221 | |
| Enthalpy humid | kJ/kg | -9.078 | 22.389 | |
| Volume flow humid | m3/h | 38332.221 | 41992.587 | 43350.000 |
| Mass flow dry | kg/h | 51053.643 | 51053.643 | |
| Velocity | m/s | 2.610 | 2.860 | |
| Pressure drop dry | Pa | | 195.974 | |
| Pressure drop wet | Pa | | 216.820 | |

| Hot air | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Fouling | m2K/W | | | 5.000E-05 |
| Temp. | °C | 20.000 | -5.221 | 20.000 |
| Rel. humidity | % | 40.000 | 100.000 | 40.000 |
| Abs. humidity | g/kg | 5.858 | 2.452 | |
| Density | kg/m3 | 1.185 | 1.299 | |
| Enthalpy humid | kJ/kg | 34.992 | 0.856 | |
| Volume flow humid | m3/h | 39020.000 | 35469.724 | 39020.000 |
| Mass flow dry | kg/h | 45954.168 | 45954.168 | |
| Condensate flow | kg/h | | 156.510 | |
| Surface temperature | °C | 14.826 | -7.781 | |
| Velocity | m/s | 2.609 | 2.372 | |
| Pressure drop dry | Pa | | 180.518 | |
| Pressure drop wet | Pa | | 199.075 | |

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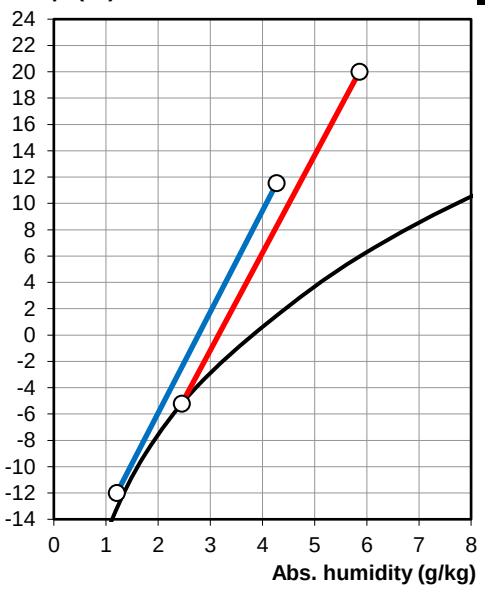
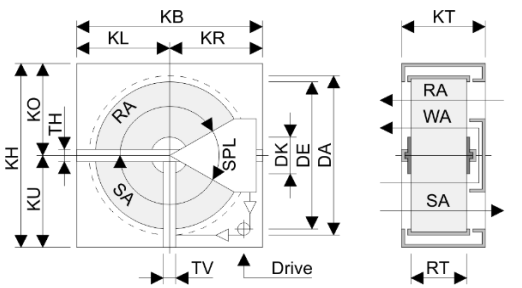
Object
Position

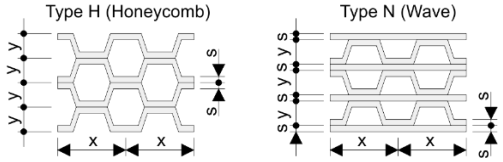



**Technical data** — Software by www.zcs.ch

| Rotor | | | Al |
|---|---|---|---|
| Type | | | Wave structure |
| Material density | | kg/m3 | 2660.000 |
| Material specific heat | | J/kgK | 900.000 |
| Material thermal conductivity | | W/mK | 236.000 |
| Structure wave-length | x | mm | 4.200 |
| Structure wave-height | y | mm | 1.895 |
| Struc. wave-thickness | s | mm | 0.205 |
| Rotor outside diameter | DA | mm | 3390.000 |
| Rotor diameter effective | DE | mm | 3310.000 |
| Rotor core diameter | DK | mm | 320.000 |
| Rotor depth | RT | mm | 277.000 |
| Rotor angle for supply air | | ° | 177.000 |
| Rotor angle for return air | | ° | 177.000 |
| Rotor angle for wash air | SPL | ° | 6.000 |

| Box | | | AISI 316 |
|---|---|---|---|
| Rotor cassette height | KH | mm | 3660.000 |
| Rotor cassette width | KB | mm | 3660.000 |
| Rotor cassette depth | KT | mm | 590.000 |
| Weight empty total | | kg | 2048.000 |

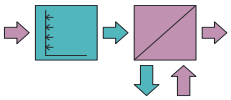



| | | |
|---|---|---|
| Delivery: | | 7-8 weeks |
| Validity: | | 12 weeks |
| Condit.: | | net, prepaid address |
| Payment: | | 30 days net |
| **Price net:** | **EUR** | **18740.00** |

**Heater - dry: 35/35/12-4R-50T-3447A-6.0PA-50C-Cu/Al/FeZn** Software by www.zcs.ch

| | | | | |
|---|---|---|---|---|
| Capacity | kW | 178.233 | ------ sensible: | 178.233 |
| Surface reserve | % | 4.616 | latent: | 0.000 |
| Present surface | m2 | 279.715 | | |
| Required surface | m2 | 267.372 | | |
| k-coeff. | W/m2K | 34.000 | | |
| Average temp. diff. | K | 19.606 | | |



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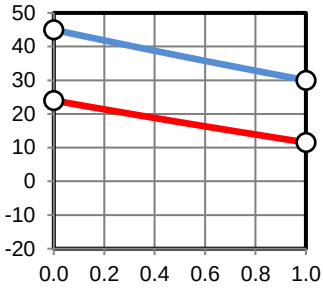
Plant
Object
Position

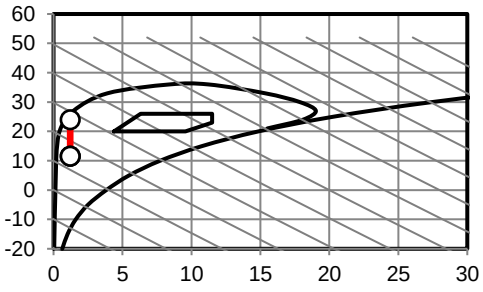
| **Air humid (ff=0.00005 m2K/W)** | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Height over sea level | m | | | 106.000 |
| Pressure | hPa | | | 1000.564 |
| Temp. | °C | 11.543 | 24.000 | 20.000 |
| Rel. humidity | % | 14.259 | 6.516 | 40.000 |
| Abs. humidity | g/kg | 1.208 | 1.208 | 5.858 |
| Density humid | kg/m3 | 1.223 | 1.172 | 1.185 |
| Enthalpy humid | kJ/kg | 14.662 | 27.230 | 34.992 |
| Volume flow humid | m3/h | 41787.784 | 43616.182 | 43350.000 |
| Mass flow dry | kg/h | 51053.643 | 51053.643 | 51053.643 |
| Velocity | m/s | 1.924 | 2.008 | 1.996 |
| Pressure drop dry | Pa | | 14.195 | |
| Pressure drop wet | Pa | | 14.195 | |
| Evaporation total | kg/h | | 0.000 | (15.000 °C) |

| **Water (ff=0.00005 m2K/W)** | | |
|---|---|---|
| Temp. in | °C | 45.000 |
| Temp. out | °C | 30.000 |
| Density | kg/m3 | 993.154 |
| Spec. heat | kJ/kgK | 4.177 |
| Heat cond. | W/mK | 0.627 |
| Viscosity | Pas | 6.852E-04 |
| Volume flow | m3/h | 10.312 |
| Velocity | m/s | 0.542 |
| Pressure drop ( T/C = 6.941 ) | kPa | 6.992 |

**Temp. (°C)**

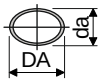


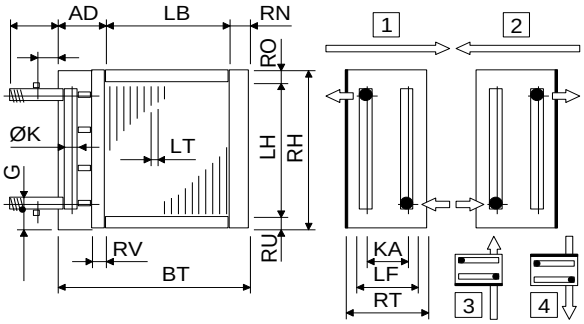

**Temp. (°C)**




**Technical data**

| | | | | | | |
|---|---|---|---|---|---|---|
| Tubes total | | Piece | 200 | Tubes: | | Cu |
| Tubes blank | | Piece | 0 | Tubes: | | smooth |
| Int. vent./drains | | Piece | 0 | Tubes: | | in line |
| Tube rows on the depth | | Piece | 4 | Tubes: | | circular |
| Tube rows on the height | | Piece | 50 | Collectors: | 0.51 m/s | Cu |
| Tube coupling in series | | Piece | 4 | Connections: | 0.51 m/s | Rg7 |
| Number of circuits (NC) | | Piece | 50 | Fins: | | Al |
| Volume | | l | 97 | Fins: | | smooth |
| Weight | | kg | 242 | Frame: | 2.00 mm | FeZn |
| Connections | G | --- | 3" | Circulations: | 1 | Default |
| Frame height | RH | mm | 1830 | Protection: | | without |
| Frame width | BT | mm | 3660 | Protection: | | --- |
| Frame depth | RT | mm | 230 | Air flow direction: | | horizontal |
| Finned height | LH | mm | 1750 | | | |
| Finned width | LB | mm | 3447 | | | |
| Finned depth | LF | mm | 140 | | | |
| Frame on top | RO | mm | 40 | | | |
| Frame on bottom | RU | mm | 40 | | | |
| Frame in front | RV | mm | 30 | | | |
| Frame on back (~53mm) | RN | mm | 53 | | | |
| Collector-Diameter | K | mm | 89 | | | |
| Collector covering | AD | mm | 160 | | | |
| Collector distance | KA | mm | 109 | | | |
| Fin spacing | LT | mm | 6.000 | | | |
| Fin thickness | LD | mm | 0.200 | | | |
| Tube diameter | DA | mm | 12.400 | Delivery: | | 5-6 weeks |
| Tube diameter | da | mm | 12.400 | Validity: | | 12 weeks |
| Tube thickness | S | mm | 0.400 | Condit.: | | net, prepaid address |
| Tube interval on the height | S1 | mm | 35.000 | Payment: | | 30 days net |
| Tube interval on the depth | S2 | mm | 35.000 | **Price net:** | | **EUR 3597.00** |



**Cooler: 35/35/12-6R-50T-3428A-5.0PA-75C-Cu/Al/AISI 304** — **Software by www.zcs.ch**

| | | | | |
|---|---|---|---|---|
| Capacity | kW | 209.495 | ------ sensible: | 98.982 |
| Surface reserve | % | 3.476 | latent: | 110.513 |
| Present surface | m2 | 492.699 | frost: | 0.000 |
| Required surface | m2 | 476.149 | | |
| k-coeff. | W/m2K | 43.130 | | |
| Average temp. diff. ( 98.14 % ) | K | 10.201 | | |

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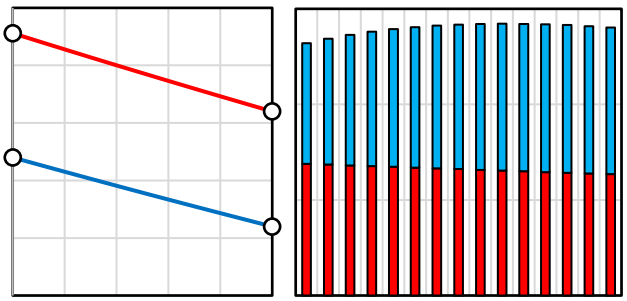
Plant
Object
Position

| **Air humid ( ff = 0.00005 m2K/W )** | | Inlet | Outlet | Definition |
|---|---|---|---|---|
| Height over sea level | m | | | 106.000 |
| Pressure | hPa | | | 1000.564 |
| Temp. | °C | 22.800 | 16.000 | 20.000 |
| Rel. humidity | % | 78.000 | 92.831 | 40.000 |
| Abs. humidity | g/kg | 13.725 | 10.660 | 5.858 |
| Density humid | kg/m3 | 1.168 | 1.198 | 1.185 |
| Enthalpy humid | kJ/kg | 57.842 | 43.070 | 34.992 |
| Volume flow humid | m3/h | 44312.157 | 43085.383 | 43350.000 |
| Mass flow dry | kg/h | 51053.643 | 51053.643 | 51053.643 |
| Condensate flow | kg/h | | 156.479 | |
| Surface temperature | °C | 15.161 | 8.927 | |
| Velocity | m/s | 2.052 | 1.995 | 2.007 |
| Pressure drop (dry 24 Pa) | Pa | | 30.682 | |

| **25 V% Et.glycol ( ff = 0.00005 m2K/W )** | | |
|---|---|---|
| Temp. Inlet | °C | 6.000 |
| Temp. Outlet | °C | 12.000 |
| Temp. Selection | °C | 8.190 |
| Density | kg/m3 | 1041.558 |
| Spec. heat | kJ/kgK | 3.701 |
| Heat cond. | W/mK | 0.459 |
| Viscosity | Pas | 2.635E-03 |
| Volume flow | m3/h | 32.609 |
| Velocity | m/s | 1.143 |
| Reynolds | --- | 5240.183 |
| Pressure drop ( T/C = 8.545 ) | kPa | 36.435 |

**Temp. (°C)**




**Technical data**

| | | | | | | |
|---|---|---|---|---|---|---|
| Tubes total | | Piece | 300 | Tubes: | | Cu |
| Tubes blank | | Piece | 0 | Tubes: | | smooth |
| Int. vent./drains | | Piece | 0 | Tubes: | | in line |
| Tube rows on the depth | | Piece | 6 | Tubes: | | circular |
| Tube rows on the height | | Piece | 50 | Collectors: | 1.09 m/s | Cu |
| Tube coupling in series | | Piece | 4 | Connections: | 1.09 m/s | Rg7 |
| Number of circuits (NC) | | Piece | 75 | Fins: | | Al |
| Volume | | l | 144 | Fins: | | smooth |
| Weight | | kg | 366 | Circulations: | 1 | Default |
| Connections | G | --- | 4" | Frame: | 2.0 mm | AISI 304 |
| Frame height | RH | mm | 1830 | Protection: | | without |
| Frame width | BT | mm | 3660 | Protection: | | --- |
| Frame depth | RT | mm | 310 | Air flow direction: | | horizontal |
| Finned height | LH | mm | 1750 | | | |
| Finned width | LB | mm | 3428 | | | |
| Finned depth | LF | mm | 210 | | | |
| Frame on top | RO | mm | 40 | | | |
| Frame on bottom | RU | mm | 40 | | | |
| Frame in front | RV | mm | 30 | | | |
| Frame on back (~53mm) | RN | mm | 53 | | | |
| Collector-Diameter | K | mm | 108 | | | |
| Collector covering | AD | mm | 179 | | | |
| Collector distance | KA | mm | 175 | | | |
| Fin spacing | LT | mm | 5.000 | | | |
| Fin thickness | LD | mm | 0.200 | | | |
| Tube diameter | DA | mm | 12.400 | Delivery: | | 5-6 weeks |
| Tube diameter | da | mm | 12.400 | Validity: | | 12 weeks |
| Tube thickness | S | mm | 0.400 | Condit.: | | net, prepaid address |
| Tube interval on the height | S1 | mm | 35.000 | Payment: | | 30 days net |
| Tube interval on the depth | S2 | mm | 35.000 | **Price net:** | **EUR** | **5762.00** |