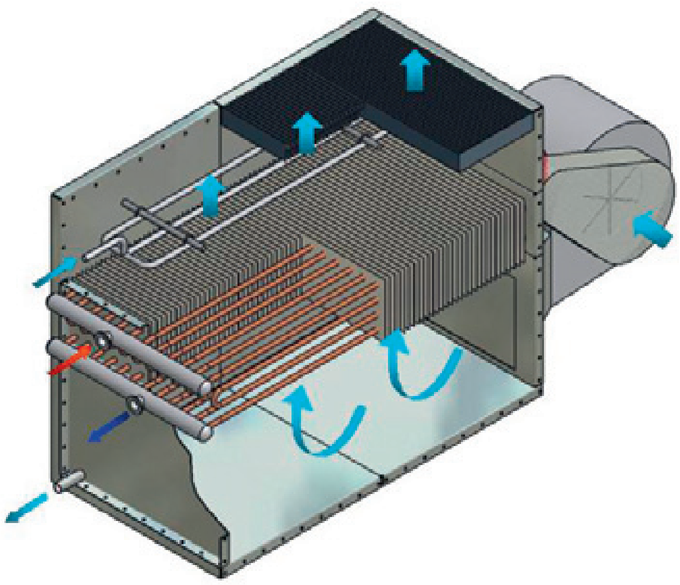
# Hybrid Water-Cooler

## Made to several patents and registered by E. W. GOHL® GmbH

### Operation of a Hybrid Water-Cooler

The liquid medium (water, glycol, etc.) which is to be cooled, flows via an inlet in the top heater into a finned block heat exchanger and leaves it at the bottom through a collector. During flowing through the heat exchanger the re-cooled medium gives off the heat output to the fresh air which blows in from below in counterflow with the sprayed water and flows out at the top. The re-cooled medium is then available to cool the load. Because a closed water circuit is used there are no water losses in the primary circuit and the cooling medium is always clean, preventing deposits or corrosion. In the low air temperature the heat transfer is achieved by dry cooling. With increasing the air temperatures > 15 °C to 18 °C the dry cooling operation will be´superimposed by a wet cooling operation.

A combined spray equipment is mounted over the heat exchanger. The same nozzles are used for wet cooling and for cleaning. For the wet cooling, the wetting of the heat exchanger surface is necessary only at certain intervals of time and will therefore result in a minor amount of make-up water.



The spray systems work intermittent, i. e. you will only spray make-up water as far as you use for evaporation.

The make-up water saving is approx. 75% compared with wet cooling. It corresponds to the design data.

The cleansing system for the automatic, periodic cleaning of the finned heat exchanger prevents deposits and corrosion. The surface of the heat exchanger will be kept permanently clean for an optimum of heat transmission. For cleaning you need warm water. Depending on requirements the travelling nozzles will clean the heat exchanger. After cleaning, rinse with clean water. The cleaning should take place during the hybrid cooler is out of use. The cleaning cycle is adjustable. For the fan drive will be used a adjustable speed motor with frequency transformer. For make-up water you need osmosis water or make-up water to be in accordance with the osmosis water.

### Application

Hybrid coolers are designed for economical usage in places where operators require a closed water circuit, water of high purity, no sediment and corrosion in the water cooling circuit. Where water is not plentiful and less make-up water is required, where fog formation is undesirable. Where a minimum of maintenance and cleaning is demanded. Even at high dry bulb temperature dry cooling operation is already possible. Less make-up water and automatic, periodic cleaning of the finned heat exchanger are dominant factors for an economical operation and an environment protecting heat transfer in the atmosphere.

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Arbeitskreis
Kühltürme

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Permanently Good Cooling

500/0509

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# Table 1 Technical Date

| Number of fans | Unit size | Wet cooling | Dry cooling | | | Centrifugal fan selected for an external pressure of: | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 0 to 40 pa | | | | 40 to 80 pa | | | | 80 to 130 pa | | | |
| | | Nominal cooling capacity (water cooling from 36 °C to 30 °C at an ambient wet-bulb temperature of 21 °C) | Cooling capacity (water cooling from 36 °C to 30 °C at an ambient dry bulb temperature of approx. 16 °C) | Nominal water flow rate (primary circuit) $G_N$ | Air-volume (approx. value) | absorbed fan power | number of revolutions | E-Motor (1500 $min^{-1}$) | sound pressure at 3 m | absorbed fan power | number of revolutions | E-Motor (1500 $min^{-1}$) | sound pressure at 3 m | absorbed fan power | number of revolutions | E-Motor (1500 $min^{-1}$) | sound pressure at 3 m |
| | | kW | kW | kg/h | $m^3/h$ | kW | $min^{-1}$ | kW | dB(A) | kW | $min^{-1}$ | kW | dB(A) | kW | $min^{-1}$ | kW | dB(A) |
| **1** | HK 33 | 121 | 121 | 17.343 | 20.000 | 3,8 | 516 | 5,5 | 69 | 4,2 | 546 | 5,5 | 69 | 4,6 | 576 | 5,5 | 70 |
| | HK 45 | 155 | 155 | 22.216 | 26.000 | 5,2 | 480 | 7,5 | 70 | 5,6 | 510 | 7,5 | 70 | 6,0 | 540 | 7,5 | 71 |
| | HK 52 | 185 | 185 | 26.516 | 32.000 | 7,2 | 490 | 11,0 | 71 | 7,6 | 520 | 11,0 | 71 | 8,1 | 550 | 11,0 | 72 |
| | HK 77 | 235 | 235 | 33.683 | 42.000 | 9,6 | 416 | 15,0 | 72 | 10,1 | 436 | 15,0 | 72 | 10,7 | 456 | 15,0 | 73 |
| **2** | HK 2/33 | 242 | 242 | 34.686 | 40.000 | 7,6 | 516 | 11,0 | 71 | 8,4 | 546 | 11,0 | 71 | 9,2 | 576 | 15,0 | 72 |
| | HK 2/45 | 310 | 310 | 44.432 | 52.000 | 10,4 | 480 | 15,0 | 72 | 11,2 | 510 | 15,0 | 72 | 12,0 | 540 | 15,0 | 73 |
| | HK 2/52 | 370 | 370 | 53.032 | 64.000 | 14,4 | 490 | 18,5 | 73 | 15,2 | 520 | 18,5 | 73 | 16,2 | 550 | 22,0 | 74 |
| | HK 2/77 | 470 | 470 | 67.366 | 84.000 | 19,2 | 416 | 30,0 | 74 | 20,2 | 436 | 30,0 | 74 | 21,4 | 456 | 30,0 | 75 |
| **3** | HK 3/45 | 465 | 465 | 66.648 | 78.000 | 15,6 | 480 | 22,0 | 73 | 16,8 | 510 | 22,0 | 74 | 18,0 | 540 | 22,0 | 74 |
| | HK 3/52 | 555 | 555 | 79.548 | 96.000 | 21,6 | 490 | 30,0 | 74 | 22,8 | 520 | 30,0 | 75 | 24,3 | 550 | 30,0 | 75 |
| | HK 3/77 | 705 | 705 | 101.049 | 126.000 | 28,8 | 416 | 37,0 | 75 | 30,3 | 436 | 37,0 | 76 | 32,1 | 456 | 37,0 | 76 |
| **4** | HK 4/45 | 620 | 620 | 88.864 | 104.000 | 20,8 | 480 | 2x15,0 | 74 | 22,4 | 510 | 2x15,0 | 75 | 24,0 | 540 | 2x15,0 | 75 |
| | HK 4/52 | 740 | 740 | 106.064 | 128.000 | 28,8 | 490 | 2x18,5 | 75 | 30,4 | 520 | 2x18,5 | 76 | 32,4 | 550 | 2x22,0 | 76 |
| | HK 4/77 | 940 | 940 | 134.732 | 168.000 | 38,4 | 416 | 2x30,0 | 76 | 40,4 | 436 | 2x30,0 | 77 | 42,8 | 456 | 2x30,0 | 77 |
| **5** | HK 5/45 | 775 | 775 | 111.080 | 130.000 | 26,0 | 480 | 15,0+22,0 | 75 | 28,0 | 510 | 15,0+22,0 | 76 | 30,0 | 540 | 15,0+22,0 | 76 |
| | HK 5/52 | 925 | 925 | 132.580 | 160.000 | 36,0 | 490 | 18,5+30,0 | 76 | 38,0 | 520 | 18,5+30,0 | 77 | 40,5 | 550 | 22,0+30,0 | 77 |
| | HK 5/77 | 1175 | 1175 | 168.415 | 210.000 | 48,0 | 416 | 30,0+37,0 | 77 | 50,5 | 436 | 30,0+37,0 | 78 | 53,5 | 456 | 30,0+37,0 | 78 |
| **6** | HK 6/45 | 930 | 930 | 133.296 | 156.000 | 31,2 | 480 | 2x22,0 | 75 | 33,6 | 510 | 2x22,0 | 76 | 36,0 | 540 | 2x22,0 | 76 |
| | HK 6/52 | 1110 | 1110 | 159.096 | 192.000 | 43,2 | 490 | 2x30,0 | 76 | 45,6 | 520 | 2x30,0 | 77 | 48,6 | 550 | 2x30,0 | 77 |
| | HK 6/77 | 1410 | 1410 | 202.098 | 252.000 | 57,6 | 416 | 2x37,0 | 77 | 60,6 | 436 | 2x37,0 | 78 | 64,2 | 456 | 2x37,0 | 78 |

The cooling capacities are guaranteed to DIN 1947

**Sound pressure level:** The indicated values in dB(A) relate to a measurement of 3 m in horizontal extension of the fan shaft (maximum noise development). Although the forward-curved fan impellers of the large units, with the centrifugal fans, are manufactured by a reputable company and designed for a particularly low-noise level at high efficiency, the dB(A) ratings must be regarded as guide values because the installation conditions of cooling towers vary widely. Permissible tolerance +/- 2 dB.

### A summary of the advantages:

- with cooling capacity depending control system
- dry operation of air temperatures < 16 – 18 °C
- make-up water saving in comparison to conventional wet cooling system: savings up to 75%
- high dry cooling range
- no fog formations
- no secondary circuit
- high safety by winter operation
- environment protecting operation method in combination with the advantages of wet and dry cooling
- extremely economical

| absorbed fan power kW | number of revolutions min⁻¹ | E-Motor (1500 min⁻¹) kW | sound pressure at 3 m dB(A) | Finned heat exchanger system: Surface area m² | Finned heat exchanger system: Contents of water kg | Overall dimensions (with water flanges, the unit are 280 mm longer): Length mm | Overall dimensions: Width mm | Overall dimensions: Height mm | Weight: Empty weight kg | Weight: Operations weight kg | Heaviest and largest part (heat exchanger): Weight kg | Heaviest and largest part: Length mm | Heaviest and largest part: Width mm | Heaviest and largest part: Height mm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 130 to 180 pa | | | | | | | | | | | | | | |
| 5,1 | 606 | 7,5 | 70 | 417 | 180 | 3325 | 1250 | 1750 | 1160 | 1340 | 480 | 2120 | 1250 | 440 |
| 6,5 | 566 | 7,5 | 71 | 535 | 225 | 3825 | 1250 | 1750 | 1360 | 1585 | 600 | 2620 | 1250 | 440 |
| 8,7 | 570 | 11,0 | 72 | 635 | 265 | 4245 | 1250 | 1750 | 1540 | 1805 | 700 | 3040 | 1250 | 440 |
| 11,3 | 476 | 15,0 | 73 | 812 | 335 | 5180 | 1250 | 2000 | 2000 | 2335 | 900 | 3790 | 1250 | 440 |
| 10,2 | 606 | 15,0 | 72 | 834 | 360 | 3325 | 2420 | 1750 | 2200 | 2560 | 480 | 2120 | 1250 | 440 |
| 13,0 | 566 | 18,5 | 73 | 1070 | 450 | 3825 | 2420 | 1750 | 2570 | 3020 | 600 | 2620 | 1250 | 440 |
| 17,4 | 570 | 22,0 | 74 | 1270 | 530 | 4245 | 2420 | 1750 | 2910 | 3440 | 700 | 3040 | 1250 | 440 |
| 22,6 | 476 | 30,0 | 75 | 1624 | 670 | 5180 | 2420 | 2000 | 3710 | 4380 | 900 | 3790 | 1250 | 440 |
| 19,5 | 566 | 30,0 | 75 | 1605 | 675 | 3825 | 3590 | 1750 | 3780 | 4455 | 600 | 2620 | 1250 | 440 |
| 26,1 | 570 | 37,0 | 76 | 1905 | 795 | 4245 | 3590 | 1750 | 4280 | 5075 | 700 | 3040 | 1250 | 440 |
| 33,9 | 476 | 45,0 | 77 | 2436 | 1005 | 5180 | 3590 | 2000 | 5420 | 6425 | 900 | 3790 | 1250 | 440 |
| 26,0 | 566 | 2x18,5 | 76 | 2140 | 900 | 3825 | 4760 | 1750 | 4990 | 5890 | 600 | 2620 | 1250 | 440 |
| 34,8 | 570 | 2x22,0 | 77 | 2540 | 1060 | 4245 | 4760 | 1750 | 5650 | 6710 | 700 | 3040 | 1250 | 440 |
| 45,2 | 476 | 2x30,0 | 78 | 3248 | 1340 | 5180 | 4760 | 2000 | 7130 | 8470 | 900 | 3790 | 1250 | 440 |
| 32,5 | 566 | 18,5+30,0 | 77 | 2675 | 1125 | 3825 | 5930 | 1750 | 6200 | 7325 | 600 | 2620 | 1250 | 440 |
| 43,5 | 570 | 22,0+37,0 | 78 | 3175 | 1325 | 4245 | 5930 | 1750 | 7020 | 8345 | 700 | 3040 | 1250 | 440 |
| 56,5 | 476 | 30,0+45,0 | 79 | 4060 | 1675 | 5180 | 5930 | 2000 | 8840 | 10515 | 900 | 3790 | 1250 | 440 |
| 39,0 | 566 | 2x30,0 | 77 | 3210 | 1350 | 3825 | 7100 | 1750 | 7410 | 8760 | 600 | 2620 | 1250 | 440 |
| 52,2 | 570 | 2x37,0 | 78 | 3810 | 1590 | 4245 | 7100 | 1750 | 8390 | 9980 | 700 | 3040 | 1250 | 440 |
| 67,8 | 476 | 2x45,0 | 79 | 4872 | 2010 | 5180 | 7100 | 2000 | 10550 | 12560 | 900 | 3790 | 1250 | 440 |

**The following data are essential for the selection of a hybrid cooler:**

1 water inlet temperature

2 water outlet temperature

3 water flow rate

4 wet bulb temperature

5 plan view of the available space for the installation

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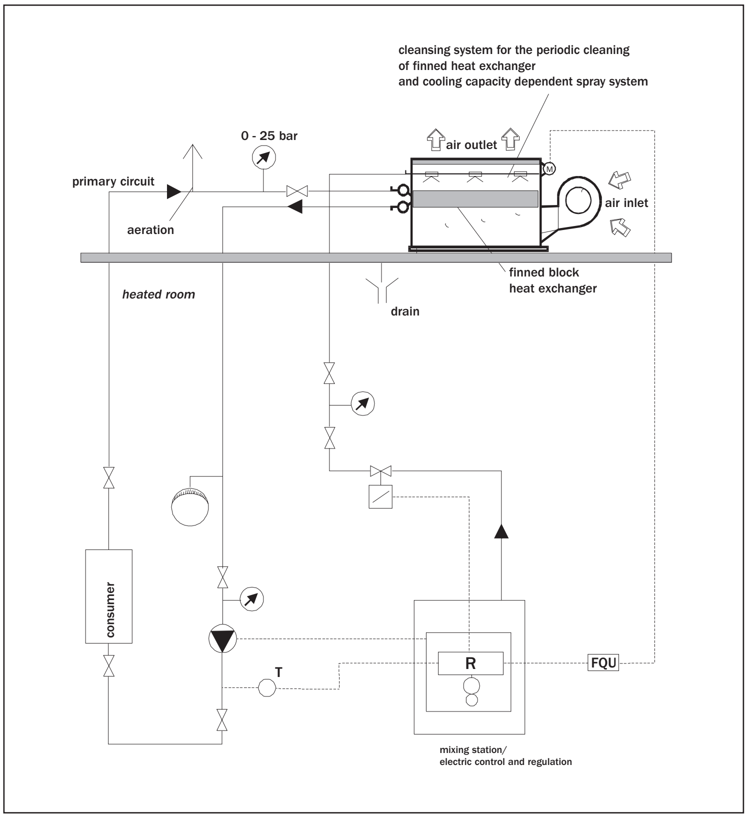


# Table 2 Capacity tables for the most popular conditions

**For operating conditions which you can´t find in table 2 the unit size has be calculated with correction factors k and the nominal cooling capacity $Q_N$ of table 1.**

## Cooling medium water

| Unit size | | | HK33 | | | HK45 | | | HK52 | | | HK77 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water temperature drop of | Wet-bulb temperature [°C] | Water-temperature [°C] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] |
| 5K | 21 | 32-27 | 85,9 | 14,8 | 0,10 | 110,0 | 18,9 | 0,19 | 131,4 | 22,6 | 0,10 | 166,9 | 28,7 | 0,10 |
| | | 33-28 | 96,8 | 16,6 | 0,13 | 124,0 | 21,3 | 0,23 | 148,0 | 25,5 | 0,13 | 188,0 | 32,3 | 0,12 |
| | | 34-29 | 107,7 | 18,5 | 0,16 | 138,0 | 23,7 | 0,28 | 164,7 | 28,3 | 0,15 | 209,2 | 36,0 | 0,15 |
| | | 35-30 | 118,6 | 20,4 | 0,18 | 151,9 | 26,1 | 0,32 | 181,3 | 31,2 | 0,17 | 230,3 | 39,6 | 0,17 |
| | | 36-31 | 129,5 | 22,3 | 0,21 | 165,9 | 28,5 | 0,38 | 198,0 | 34,1 | 0,20 | 251,5 | 43,3 | 0,19 |
| | | 37-32 | 141,6 | 24,4 | 0,25 | 181,4 | 31,2 | 0,44 | 216,5 | 37,2 | 0,23 | 275,0 | 47,3 | 0,23 |
| | | 38-33 | 153,7 | 26,4 | 0,28 | 196,9 | 33,9 | 0,51 | 235,0 | 40,4 | 0,27 | 298,5 | 51,3 | 0,26 |
| 6K | 21 | 33-27 | 88,3 | 12,7 | 0,08 | 113,2 | 16,2 | 0,14 | 135,1 | 19,4 | 0,08 | 171,6 | 24,6 | 0,08 |
| | | 34-28 | 99,2 | 14,2 | 0,10 | 127,1 | 18,2 | 0,18 | 151,7 | 21,7 | 0,09 | 192,7 | 27,6 | 0,09 |
| | | 35-29 | 110,1 | 15,8 | 0,12 | 141,1 | 20,2 | 0,21 | 168,4 | 24,1 | 0,11 | 213,9 | 30,7 | 0,11 |
| | | 36-30 | 121,0 | 17,3 | 0,14 | 155,0 | 22,2 | 0,25 | 185,0 | 26,5 | 0,13 | 235,0 | 33,7 | 0,13 |
| | | 37-31 | 131,9 | 18,9 | 0,16 | 169,0 | 24,2 | 0,28 | 201,7 | 28,9 | 0,16 | 256,2 | 36,7 | 0,15 |
| | | 38-32 | 144,0 | 20,6 | 0,18 | 184,5 | 26,4 | 0,33 | 220,2 | 31,6 | 0,18 | 279,7 | 40,1 | 0,17 |
| 7K | 21 | 36-29 | 112,5 | 13,8 | 0,09 | 144,2 | 17,7 | 0,17 | 172,1 | 21,1 | 0,09 | 218,6 | 26,9 | 0,09 |
| | | 37-30 | 123,4 | 15,2 | 0,11 | 158,1 | 19,4 | 0,20 | 188,7 | 23,2 | 0,10 | 239,7 | 29,4 | 0,10 |
| | | 38-31 | 134,3 | 16,5 | 0,13 | 172,1 | 21,1 | 0,23 | 205,4 | 25,2 | 0,12 | 260,9 | 32,1 | 0,13 |
| 5K | 20 | 32-27 | 95,6 | 16,4 | 0,12 | 122,5 | 21,1 | 0,23 | 146,2 | 25,1 | 0,12 | 185,7 | 31,9 | 0,12 |
| | | 33-28 | 106,5 | 18,3 | 0,15 | 136,4 | 23,5 | 0,28 | 162,8 | 28,0 | 0,15 | 206,8 | 35,6 | 0,14 |
| | | 34-29 | 117,4 | 20,2 | 0,18 | 150,4 | 25,9 | 0,32 | 179,5 | 30,9 | 0,17 | 228,0 | 39,2 | 0,17 |
| | | 35-30 | 128,3 | 22,1 | 0,21 | 164,3 | 28,3 | 0,37 | 196,1 | 33,7 | 0,20 | 249,1 | 42,8 | 0,19 |
| | | 36-31 | 139,2 | 23,9 | 0,23 | 178,3 | 30,7 | 0,43 | 212,8 | 36,6 | 0,23 | 270,3 | 46,5 | 0,22 |
| | | 37-32 | 151,3 | 26,0 | 0,27 | 193,8 | 33,3 | 0,50 | 231,3 | 39,8 | 0,26 | 293,8 | 50,5 | 0,26 |
| | | 38-33 | 163,4 | 28,1 | 0,31 | 209,3 | 36,0 | 0,57 | 249,8 | 43,0 | 0,30 | 317,3 | 54,6 | 0,29 |
| 6K | 20 | 33-27 | 98,0 | 14,0 | 0,10 | 125,6 | 18,0 | 0,18 | 149,9 | 21,5 | 0,09 | 190,4 | 27,3 | 0,09 |
| | | 34-28 | 108,9 | 15,6 | 0,12 | 139,5 | 20,0 | 0,20 | 166,5 | 23,9 | 0,11 | 211,5 | 30,3 | 0,11 |
| | | 35-29 | 119,8 | 17,2 | 0,14 | 153,5 | 22,0 | 0,24 | 183,2 | 26,3 | 0,13 | 232,7 | 33,4 | 0,13 |
| | | 36-30 | 130,7 | 18,7 | 0,16 | 167,4 | 24,0 | 0,28 | 199,8 | 28,6 | 0,15 | 253,8 | 36,4 | 0,15 |
| | | 37-31 | 141,6 | 20,3 | 0,18 | 181,4 | 26,0 | 0,32 | 216,5 | 31,0 | 0,17 | 275,0 | 39,4 | 0,17 |
| | | 38-32 | 153,7 | 22,0 | 0,21 | 196,9 | 28,2 | 0,37 | 235,0 | 33,7 | 0,20 | 298,5 | 42,8 | 0,19 |
| 7K | 20 | 36-29 | 122,2 | 15,0 | 0,11 | 156,6 | 19,2 | 0,19 | 186,9 | 23,0 | 0,10 | 237,4 | 29,2 | 0,10 |
| | | 37-30 | 133,1 | 16,4 | 0,13 | 170,5 | 20,9 | 0,23 | 203,5 | 25,0 | 0,13 | 258,5 | 31,8 | 0,11 |
| | | 38-31 | 144,0 | 17,7 | 0,15 | 184,5 | 22,7 | 0,26 | 220,2 | 27,1 | 0,14 | 280,0 | 34,4 | 0,13 |

## Cooling medium water with 35 weight % ethylene glycol

| Unit size | | | HK33 | | | HK45 | | | HK52 | | | HK77 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water temperature drop of | Wet-bulb temperature [°C] | Water-temperature [°C] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] | Operating cooling capacity [kW] | Operating water flow rate [m³/h] | Pressure drop [bar] |
| 5K | 21 | 32-27 | 82,5 | 15,9 | 0,14 | 105,6 | 20,3 | 0,26 | 126,1 | 24,3 | 0,14 | 160,2 | 30,9 | 0,13 |
| | | 33-28 | 93,0 | 17,9 | 0,18 | 119,0 | 22,9 | 0,32 | 142,1 | 27,4 | 0,17 | 180,5 | 34,8 | 0,16 |
| | | 34-29 | 103,4 | 19,9 | 0,21 | 132,5 | 25,5 | 0,39 | 158,1 | 30,5 | 0,21 | 200,8 | 38,7 | 0,19 |
| | | 35-30 | 113,9 | 21,9 | 0,25 | 145,9 | 28,1 | 0,46 | 174,0 | 33,5 | 0,24 | 221,1 | 42,6 | 0,23 |
| | | 36-31 | 125,6 | 24,2 | 0,30 | 160,9 | 31,0 | 0,55 | 192,1 | 37,0 | 0,29 | 244,0 | 47,0 | 0,27 |
| | | 37-32 | 137,4 | 26,5 | 0,35 | 176,0 | 33,9 | 0,64 | 210,0 | 40,5 | 0,34 | 266,8 | 51,4 | 0,32 |
| | | 38-33 | 149,1 | 28,7 | 0,40 | 191,0 | 36,8 | 0,74 | 228,0 | 43,9 | 0,39 | 289,6 | 55,8 | 0,35 |
| 6K | 21 | 33-27 | 84,8 | 13,6 | 0,11 | 108,7 | 17,4 | 0,20 | 129,7 | 20,8 | 0,11 | 164,7 | 26,4 | 0,10 |
| | | 34-28 | 95,2 | 15,3 | 0,13 | 122,0 | 19,6 | 0,25 | 145,6 | 23,4 | 0,13 | 185,0 | 29,7 | 0,12 |
| | | 35-29 | 105,7 | 17,0 | 0,16 | 135,5 | 21,8 | 0,30 | 161,7 | 26,0 | 0,16 | 205,3 | 33,0 | 0,15 |
| | | 36-30 | 116,2 | 18,7 | 0,19 | 148,8 | 23,9 | 0,35 | 177,6 | 28,5 | 0,18 | 225,6 | 36,2 | 0,17 |
| | | 37-31 | 128,0 | 20,5 | 0,22 | 164,0 | 26,3 | 0,41 | 195,6 | 31,4 | 0,22 | 248,5 | 39,9 | 0,21 |
| | | 38-32 | 139,7 | 22,4 | 0,26 | 179,0 | 28,7 | 0,48 | 213,6 | 34,3 | 0,25 | 271,3 | 43,6 | 0,24 |
| 7K | 21 | 36-29 | 108,0 | 14,9 | 0,13 | 138,4 | 19,0 | 0,23 | 165,2 | 22,7 | 0,12 | 209,9 | 28,9 | 0,12 |
| | | 37-30 | 118,5 | 16,3 | 0,15 | 151,8 | 20,9 | 0,28 | 181,2 | 24,9 | 0,15 | 230,1 | 31,7 | 0,14 |
| | | 38-31 | 129,0 | 17,8 | 0,18 | 165,2 | 22,7 | 0,32 | 197,2 | 27,1 | 0,17 | 250,5 | 34,5 | 0,16 |
| 5K | 20 | 32-27 | 91,8 | 17,7 | 0,17 | 117,6 | 22,7 | 0,32 | 140,4 | 27,0 | 0,17 | 178,3 | 34,3 | 0,16 |
| | | 33-28 | 102,2 | 19,7 | 0,21 | 131,0 | 25,2 | 0,38 | 156,3 | 30,1 | 0,20 | 198,5 | 38,2 | 0,19 |
| | | 34-29 | 112,7 | 21,7 | 0,25 | 144,4 | 27,8 | 0,45 | 172,3 | 33,2 | 0,24 | 218,9 | 42,2 | 0,23 |
| | | 35-30 | 123,2 | 23,7 | 0,29 | 157,8 | 30,4 | 0,53 | 188,3 | 36,3 | 0,28 | 239,1 | 46,1 | 0,26 |
| | | 36-31 | 135,0 | 26,0 | 0,34 | 173,0 | 33,3 | 0,62 | 206,4 | 39,8 | 0,33 | 262,2 | 50,5 | 0,31 |
| | | 37-32 | 146,8 | 28,3 | 0,39 | 188,0 | 36,2 | 0,72 | 224,4 | 43,2 | 0,38 | 285,0 | 54,9 | 0,36 |
| | | 38-33 | 158,5 | 30,5 | 0,45 | 203,0 | 39,1 | 0,82 | 242,3 | 46,7 | 0,43 | 307,8 | 59,3 | 0,41 |
| 6K | 20 | 33-27 | 94,1 | 15,1 | 0,13 | 120,6 | 19,4 | 0,24 | 143,9 | 23,1 | 0,13 | 182,8 | 29,3 | 0,12 |
| | | 34-28 | 104,5 | 16,8 | 0,16 | 134,0 | 21,5 | 0,29 | 159,9 | 25,7 | 0,15 | 203,0 | 32,6 | 0,14 |
| | | 35-29 | 115,0 | 18,5 | 0,19 | 147,4 | 23,7 | 0,34 | 175,9 | 28,2 | 0,18 | 223,4 | 35,9 | 0,17 |
| | | 36-30 | 125,5 | 20,1 | 0,22 | 160,7 | 25,8 | 0,40 | 191,8 | 30,8 | 0,21 | 243,6 | 39,1 | 0,20 |
| | | 37-31 | 137,4 | 22,1 | 0,26 | 176,0 | 28,3 | 0,47 | 210,0 | 33,7 | 0,24 | 266,8 | 42,8 | 0,23 |
| | | 38-32 | 149,1 | 23,9 | 0,29 | 191,0 | 30,7 | 0,54 | 228,0 | 36,6 | 0,28 | 289,5 | 46,5 | 0,27 |
| 7K | 20 | 36-29 | 118,5 | 16,3 | 0,15 | 151,9 | 20,9 | 0,28 | 181,3 | 24,9 | 0,15 | 230,3 | 31,7 | 0,14 |
| | | 37-30 | 129,1 | 17,8 | 0,18 | 165,4 | 22,8 | 0,32 | 197,4 | 27,2 | 0,17 | 250,7 | 34,5 | 0,16 |
| | | 38-31 | 139,7 | 19,2 | 0,20 | 179,0 | 24,6 | 0,37 | 213,6 | 29,4 | 0,19 | 271,6 | 37,4 | 0,18 |

Only the single fan unit capacity data have been printed. For multi fan units multiply the capacity by the number of fans.

# Recommended wet-bulb temperatures for the selection of wet cooling

## EUROPE

| | | °C |
|---|---|---|
| **Belgium** | Brussels | 22,0 |
| **Denmark** | Copenhagen | 20,0 |
| **Germany** | Berlin | 20,0 |
| | Cologne | 20,0 |
| | Frankfurt a.M. | 21,0 |
| | Hamburg | 20,0 |
| | Leipzig | 20,0 |
| | Mannheim | 22,5 |
| | Munich | 20,0 |
| | Nuremberg | 19,5 |
| | Stuttgart | 21,0 |
| **England** | Birmingham | 19,5 |
| | London | 19,0 |
| | Manchester | 20,0 |
| **Finland** | Helsinki | 19,0 |
| **France** | Bordeaux | 23,5 |
| | Lyon | 22,5 |
| | Marseille | 23,0 |
| | Paris | 22,5 |
| | Strasbourg | 22,0 |
| **Greece** | Athen | 22,0 |
| **Rep. Ireland** | Dublin | 18,5 |
| **Iceland** | Reykjavik | 14,0 |
| **Italy** | Florence | 21,5 |
| | Genova | 24,5 |
| | Milan | 23,0 |
| | Naples | 24,0 |
| | Palermo | 25,0 |
| | Rome | 23,0 |
| | Turin | 24,0 |
| | Venice | 24,5 |
| **Croatia** | Karlovac | 22,0 |
| **Netherlands** | Amsterdam | 19,5 |
| | Den Haag | 19,5 |
| | Rotterdam | 22,5 |
| **North Ireland** | Belfast | 17,5 |
| **Norway** | Oslo | 19,5 |
| **Austria** | Graz | 21,0 |
| | Innsbruck | 20,0 |
| | Salzburg | 21,0 |
| | Villach | 20,0 |
| | Vienna | 22,0 |
| **Poland** | Warsaw | 21,0 |
| **Portugal** | Lisbon | 22,5 |
| **Romania** | Bucharest | 22,0 |
| **Russia** | Moscow | 21,0 |
| **Sweden** | Stockholm | 17,5 |
| **Switzerland** | Basel | 22,5 |
| | Bern | 21,0 |
| | Geneva | 22,5 |
| | Lucerne | 21,0 |
| | Zurich | 21,0 |
| **Serbia** | Belgrade | 23,0 |
| **Slovakia** | Bratislava | 21,0 |
| **Spain** | Barcelona | 24,0 |
| **Czechos-lovakia** | Prague | 21,0 |
| **Turkey** | Ankara | 19,0 |
| | Istanbul | 24,0 |
| **Ukraine** | Kiew | 25,0 |
| **Hungary** | Budapest | 21,0 |
| **Belarus** | Minsk | 24,5 |
| **Cyprus** | Nikosia | 24,5 |

## NORTHAMERICA AND SOUTHAMERICA

| | | °C |
|---|---|---|
| **Argentina** | Buenos Aires | 24,0 |
| **Brazil** | Rio de Janeiro | 25,5 |
| | Sao Paulo | 25,5 |
| **Chile** | Santiago | 22,0 |
| **Canada** | Toronto | 23,5 |
| | Montreal | 24,0 |
| | Vancouver | 19,5 |
| **Cuba** | Havana | 26,5 |
| **Mexico** | Mexico City | 17,0 |
| **Peru** | Lima | 24,5 |
| **Uruguay** | Montevideo | 24,0 |
| **USA** | Boston | 24,0 |
| | Chicago | 24,0 |
| | Denver | 18,0 |
| | Los Angeles | 21,0 |
| | New York | 24,0 |
| | San Francisco | 18,5 |
| | Washington | 25,5 |
| **Venezuela** | Caracas | 22,0 |

## AUSTRALIA

| | | °C |
|---|---|---|
| **Australia** | Adelaide | 20,5 |
| | Brisbane | 24,5 |
| | Melbourne | 23,5 |
| | Sydney | 22,0 |

## ASIA

| | | °C |
|---|---|---|
| **Afghanistan** | Kabul | 21,0 |
| **India** | Bombay | 28,0 |
| | Calcutta | 28,5 |
| | Madras | 28,0 |
| | New-Delhi | 25,5 |
| **Iraq** | Baghdad | 24,0 |
| | Basra | 27,5 |
| **Iran** | Abadan | 26,5 |
| | Teheran | 22,0 |
| **Israel** | Haifa | 26,5 |
| | Jerusalem | 22,5 |
| | Tel Aviv | 26,5 |
| **Japan** | Hiroshima | 28,0 |
| | Osaka | 28,0 |
| | Tokio | 26,5 |
| **Jordan** | Amman | 20,0 |
| **Kuwait** | Kuwait | 27,0 |
| **Lebanon** | Beirut | 25,5 |
| **Malaysia** | Singapore | 28,0 |
| **Pakistan** | Karachi | 27,0 |
| **Philippines** | Manila | 26,5 |
| **Saudi Arabia** | Dschidda | 30,5 |
| | Medina | 26,5 |
| | Riad | 25,5 |
| **Sri Lanka** | Colombo | 28,0 |
| **South Korea** | Seoul | 26,0 |
| **Syria** | Damascus | 22,5 |
| **Thailand** | Bangkok | 28,5 |
| **People`s Rep. Of China** | Hong Kong | 28,0 |

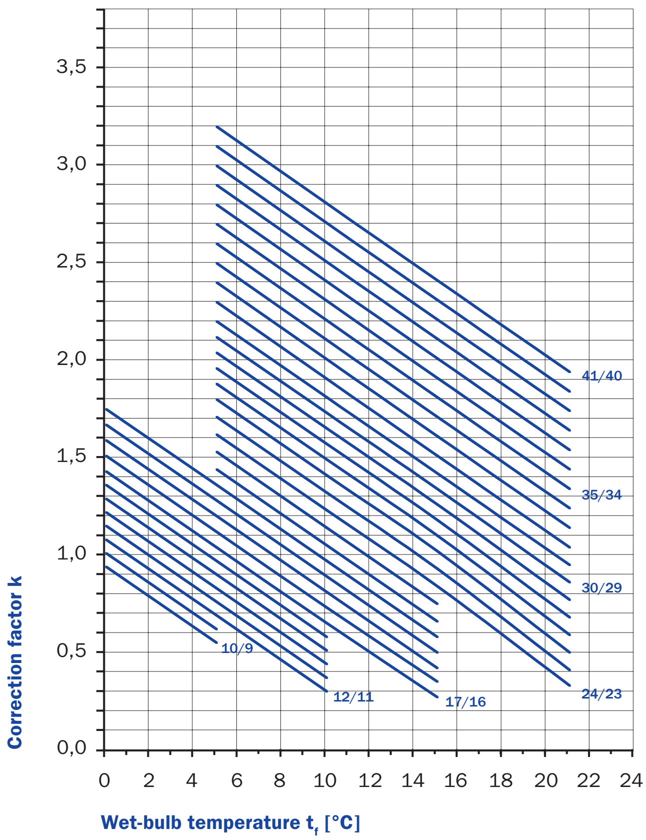
## AFRICA

| | | °C |
|---|---|---|
| **Egypt** | Alexandria | 26,5 |
| | Cairo | 27,0 |
| | Luxor | 26,5 |
| **Algeria** | Algier | 26,0 |
| **Angola** | Luanda | 27,0 |
| **Ethiopia** | Addis Abeba | 22,0 |
| **Ghana** | Accra | 28,0 |
| **Kenya** | Nairobi | 18,5 |
| **The Congo** | Brazzaville | 28,0 |
| **Liberia** | Monrovia | 28,0 |
| **Lybia** | Tripolis | 24,5 |
| **Madagascar** | Antananarivo | 22,5 |
| **Morocco** | Casablanca | 25,0 |
| **Namibia** | Windhuk | 19,5 |
| **Nigeria** | Lagos | 28,5 |
| **Tunisia** | Tunis | 25,5 |
| **South Africa** | Cape Town | 22,5 |
| | Durban | 24,5 |
| | Johannesburg | 20,5 |
| | Pretoria | 21,5 |
| **Sudan** | Khartum | 27,0 |
| | Port Sudan | 31,0 |

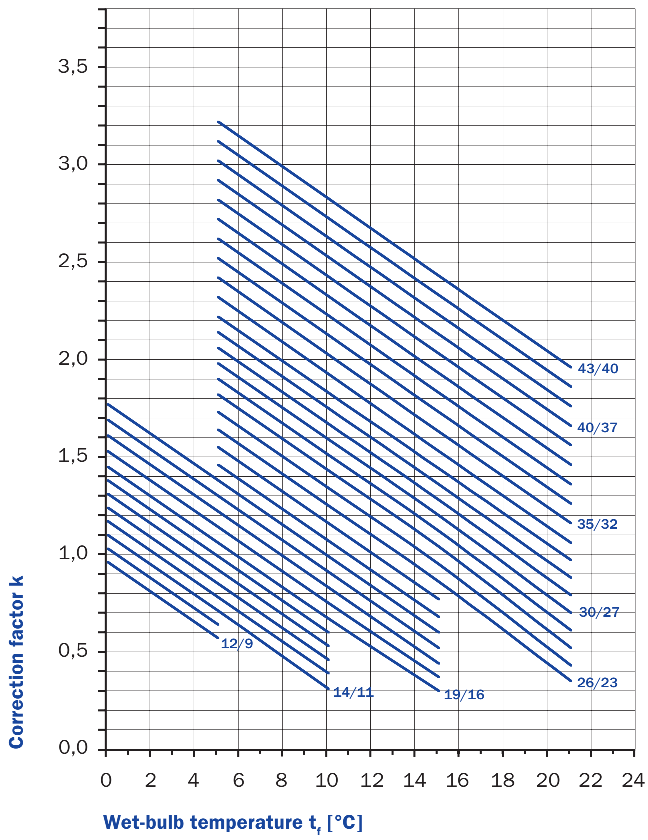
These wet-bulb temperatures are taken from known publised weather data. They are no peak values, but are suitable for the selection of wet cooling. They will be reached or passed slightly four times in one statistical year. Changes due to other weather data are possible.

# Selection curves

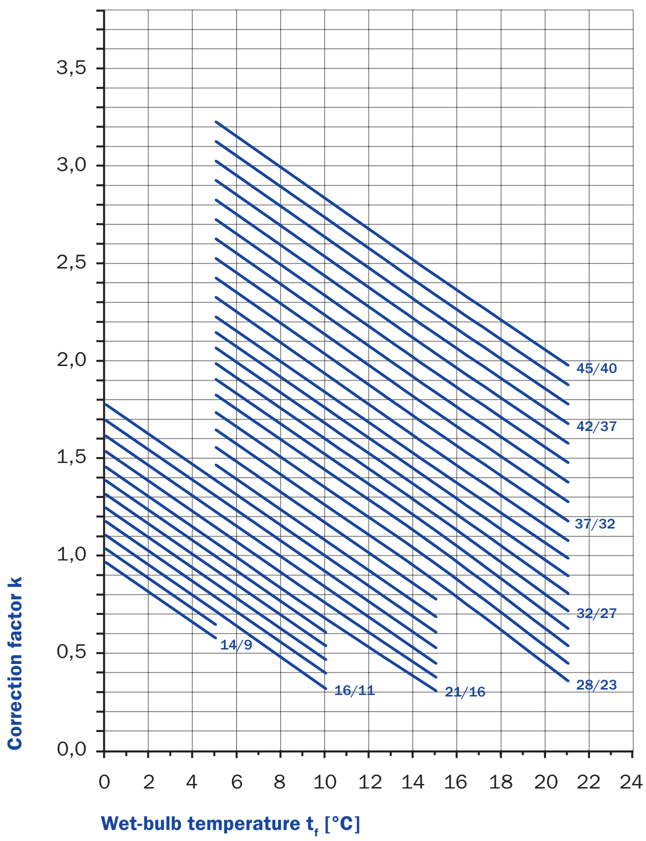
z = 1 K



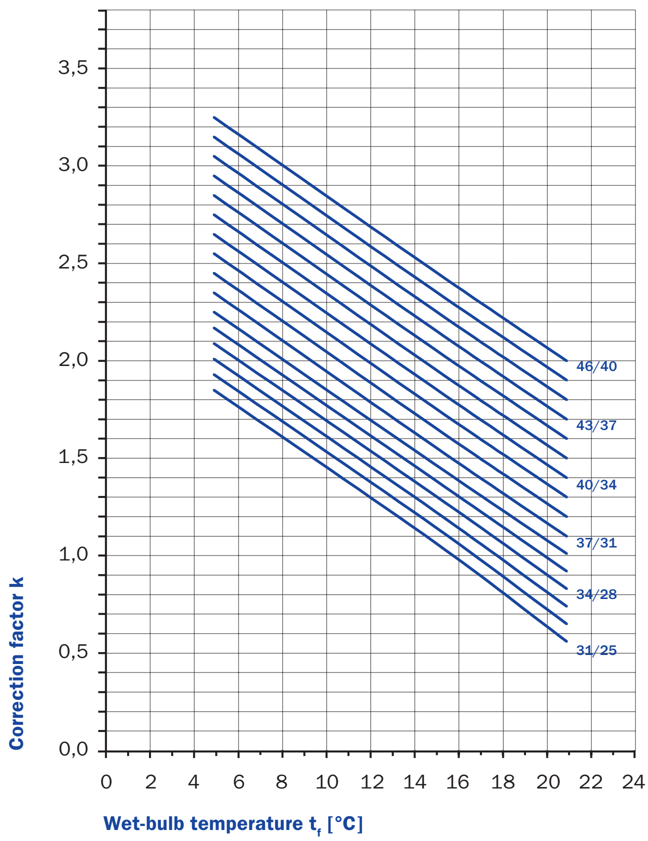

z = 3 K




z = 5 K

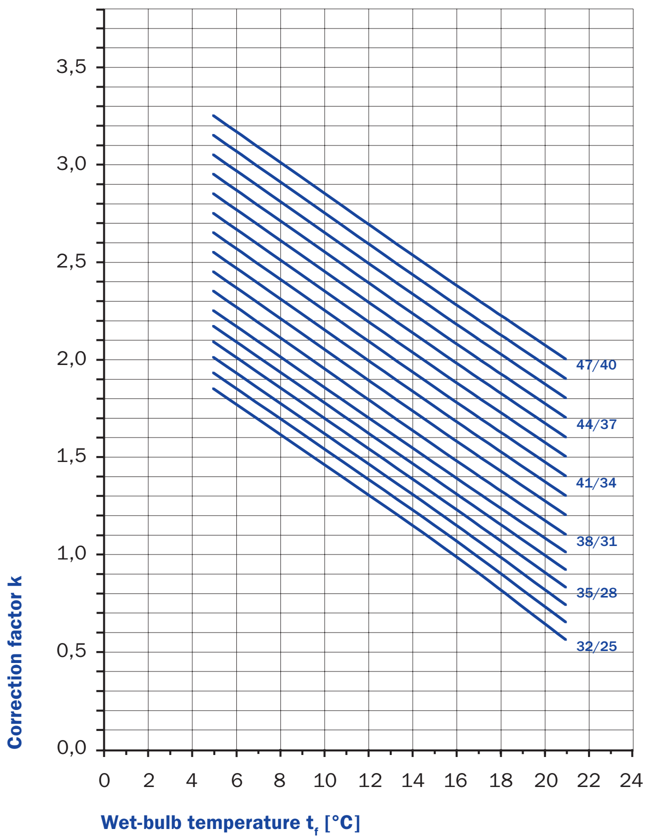



z = 6 K

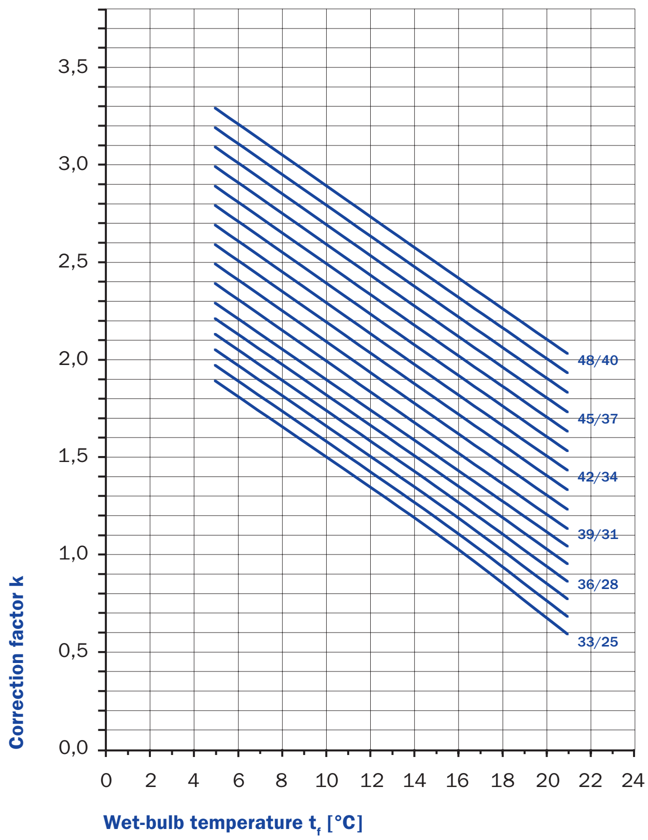


# Selection curves

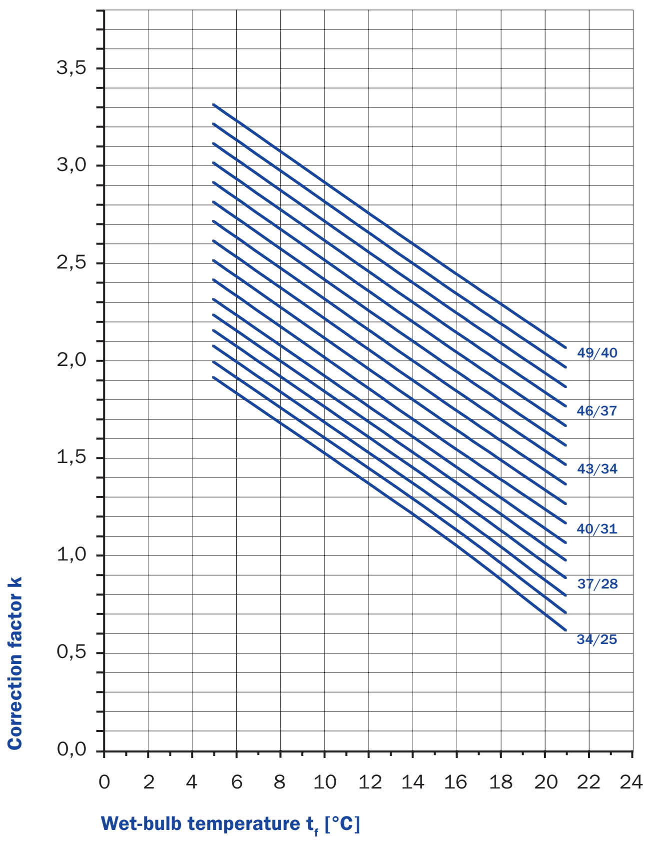
**z = 7 K**



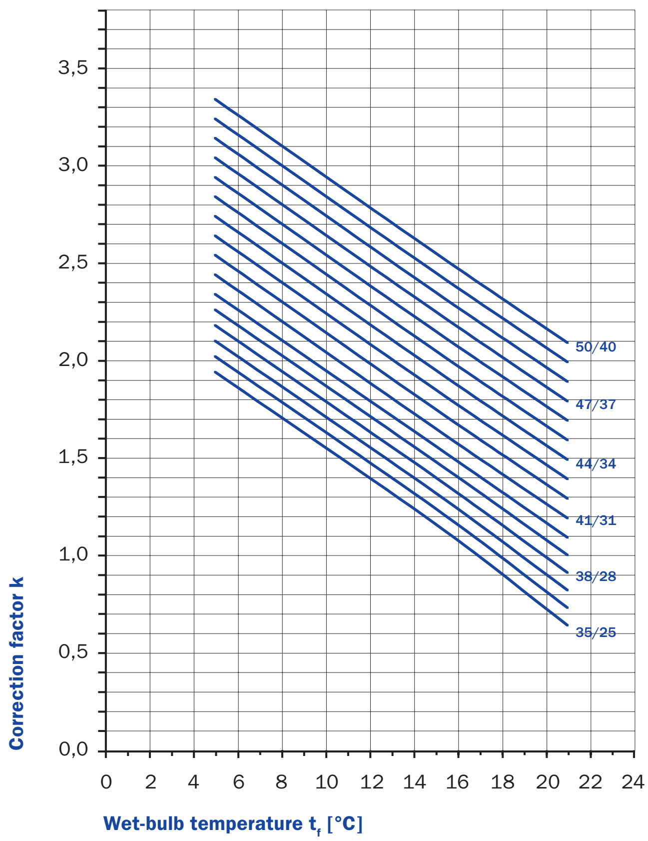

**z = 8 K**




**z = 9 K**

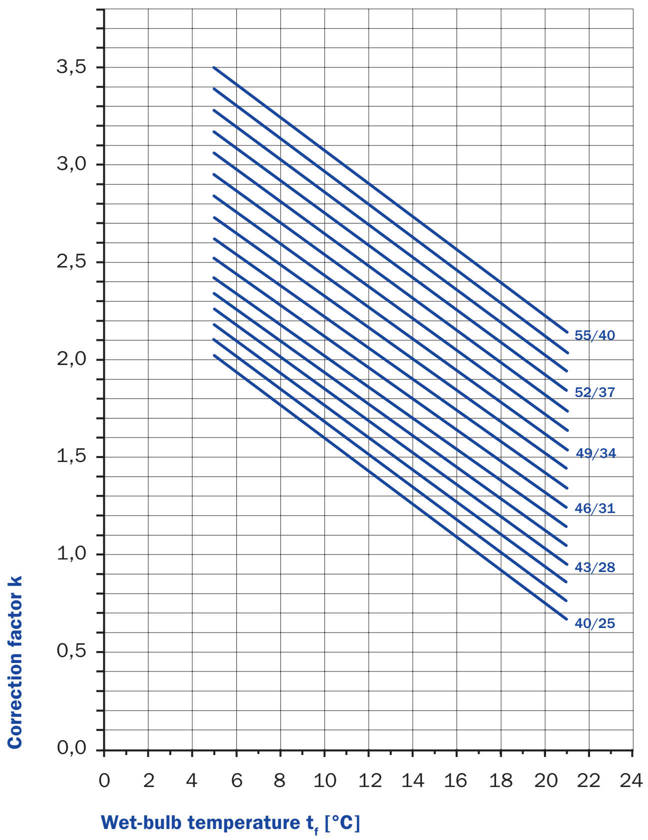



**z = 10 K**

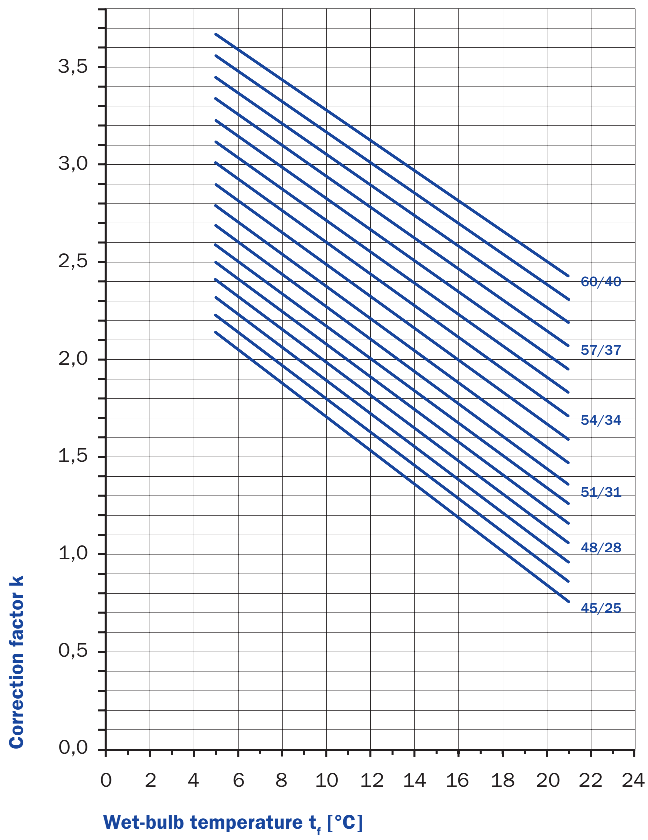


# Selection curves

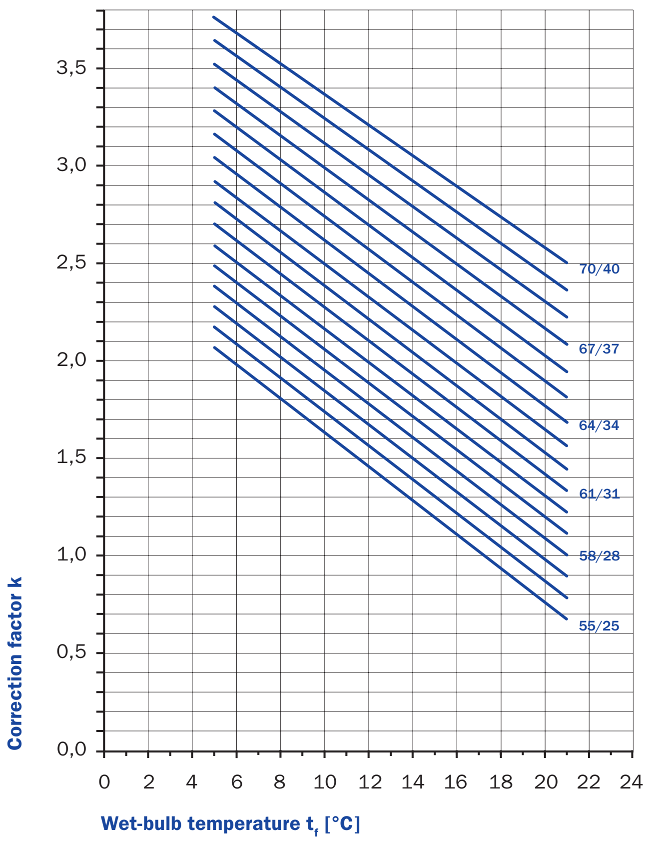
z = 15 K




z = 20 K




Auswahlkurve z = 30 K



# Evaporation loss at different dry-bulb temperatures

| $t_f$ Wet-bulb temperature [°C] | $t_L$ Dry-bulb temperature [°C] | $r_F$ Relative humidity of the air [%] | x Absolute water content of the air [g/kg $_{dry\ air}$] | h Enthalpy [kJ/(kg K)] | $G_{WV} = Q \times a \times 10^{-3}$ m³/h, Q in kW, Evaporation loss, Faktor a [1)]: Energy consumption optimized | Water consumption optimized |
|---|---|---|---|---|---|---|
| 22 | 34 | 35,8 | 12,05 | 64,9 | **1,522** | **1,522** |
| 21 | 32 | 37,9 | 11,40 | 61,2 | **1,490** | **1,490** |
| 20 | 30 | 40,5 | 10,87 | 57,8 | **1,365** | **1,290** |
| 19 | 28 | 43,3 | 10,34 | 54,4 | **1,240** | **1,090** |
| 18 | 26 | 46,6 | 9,88 | 51,2 | **1,070** | **0,845** |
| 17 | 24 | 50,3 | 9,47 | 48,1 | **0,900** | **0,600** |
| 16 | 22 | 54,5 | 9,09 | 45,1 | **0,800** | **0,450** |
| 15 | 20 | 59,6 | 8,97 | 42,3 | **0,700** | **0,300** |
| 14 | 18,5 | 61,8 | 8,28 | 39,5 | **0,675** | **Dry cooling** |
| 13 | 17,5 | 60,9 | 7,66 | 36,9 | **0,650** | |
| 12 | 16 | 63,3 | 7,23 | 34,3 | **0,625** | |
| 11 | 15 | 62,0 | 6,64 | 31,8 | **0,600** | |
| 10 | 13 | 69,5 | 6,53 | 29,5 | **0,575** | |
| 9 | 12 | 68,5 | 6,02 | 27,2 | **0,550** | |
| 8 | 10,5 | 71,8 | 5,71 | 24,9 | **0,525** | |
| 7 | 9,5 | 71,0 | 5,28 | 22,8 | **0,500** | |
| 6 | 8 | 75,1 | 5,05 | 20,7 | **0,470** | |
| 5 | 7 | 74,2 | 4,65 | 18,7 | **0,440** | |
| 4 | 6 | 73,5 | 4,30 | 16,8 | Dry cooling to protect the spray system against freezing up. | |
| 3 | 4,5 | 78,7 | 4,14 | 14,9 | | |
| 2 | 3 | 85,0 | 4,03 | 13,1 | | |
| 1 | 1,5 | 91,9 | 3,91 | 11,3 | | |
| 0 | 0,1 | 98,0 | 3,77 | 9,5 | | |

1) Remark: The heat will be eliminated in part by convection and in part by evaporation. The convection part of the hybrid cooler is much higher than the evaporation part of the cooling tower. With cooling capacity depending control system.
There are two options available: · Energy consumption optimized
· Water consumption optimized.
The evaporation losses depend on the adjusted optimized operation method.

# Selection of the hybrid water-coolers

The temperature of the water, as well as the wet-bulb temperature, are the deciding factors for determining the correction factor k. The higher the water temperature and the lower the wet-bulb temperature, the larger is k.

## Selection procedure

**Steps of calculation**

**1** Determination of operating cooling capacity $Q_B$.
**2** Correction factor k from selection curve 1. Interpolation if necessary.
**3** Determine nominal cooling capacity $Q_N$.

$$Q_N = \frac{Q_B}{k}$$

**4** Choose a unit with an equal or higher nominal capacity.
**5** Determine the finned heat exchanger with the computer program.
**6** Determine the change-over point from wet- to dry-cooling (at constant capacity) with the computer program.

## Selection example

**Given:** Operation water flow rate $G_W$ = 50000 kg/h
Water inlet temperature $t_{WE}$ = + 40 °C
Water outlet temperature $t_{WA}$ = + 30 °C
Wet-bulb temperature $t_f$ = + 21 °C

You can´t find the operating conditions in table 2!

**Result:**

**1** $Q_B$ = 50000(40-30) = 500000 kcal/h ≙ 581,4 kW
**2** k = 1,08 (Selection curve 10 K cooling range)
**3** $Q_N = \frac{581{,}4\ \text{kW}}{1{,}08} = 538{,}33$ kW
**4** Unit selected: HK 3/52 with $Q_{N\ is}$ = 555 kW
**5** Finned heat exchanger: 12 rows high with water pressure drop of 0,053 bar.
**6** Change-over point from wet- to dry-cooling at constant cooling capacity: + 19 °C.

**The following data use essential for the selection of a hybrid water-cooler:**

**1** Water inlet temperature $t_{WE}$
**2** Requested water outlet temperature $t_{WA}$
**3** Water flow rate $m_V$
**4** Ambient wet-bulb temperature $t_f$
**5** Plan view of the available space for the installation.
**6** Additional static pressure of the fan.

# Operation of a hybrid water-cooler

with ethylene glycol (table 3a)
with propylene glycol (table 3b)

If a hybrid water-cooler must be shut off at temperatures lower than 0 °C, and if the heat exchange system cannot be emptied, it is advisable to use a mixture of water and ethylene glycol for the circuit in order to prevent freezing in the heat exchanger.
A good mixture for middle european conditions consists of 40 weight % or 32,2 Vol. % ethylene glycol with water. If exact proportions are observed, however, a mixture of 30 weight % or 28 Vol. % may be sufficient.

## Table 3a Ethylene glycol* e.g. Antifrogen N (registered trade)

| Ethylene glycol portion | Mixture begins to freeze at | Density at +30 °C kg/m³ | Spec. heat at +30 °C kJ/kg K | Multiplier for the pressure drop in the heat exchanger compared to the water flow rate | Multiplier to calculate the ethylene glycol flow rate in kg/h | Correction factor $k_G$ |
|---|---|---|---|---|---|---|
| 40 weight % | - 26,7 °C | 1050 | 3,52 | 1,320 | 1,135 | 0,96 |
| 35 weight % | - 21,8 °C | 1045 | 3,58 | 1,275 | 1,120 | 0,97 |
| 30 weight % | - 17,0 °C | 1040 | 3,64 | 1,230 | 1,105 | 0,99 |
| 25 weight % | - 13,0 °C | 1034 | 3,73 | 1,190 | 1,080 | 1,00 |

The unit is selected in the same manner as using water. In step 3, as indicated in table 3 and shown in the example, consideration must be given to the correction factor $k_G$ for $Q_N$.
Ethylene glycol is successfully proved as brine for closed circuit by thousands of coolers inspite of its toxin characteristic feature.
Is there any doubt to use ethylene glycol you can use propylene glycol. But its heat transmission is unfavourable than by ethylene glycol.

## Table 3b Propylene glycol* f.e. Antifrogen L (registered trade)

| Propylene glycol portion | Mixture begins to freeze at | Density at +30 °C kg/m³ | Spec. heat at +30 °C kJ/kg K | Multiplier for the pressure drop in the heat exchanger compared to the water flow rate | Multiplier to calculate the propylene glycol flow rate in kg/h | Correction factor $k_G$ |
|---|---|---|---|---|---|---|
| 45 weight % | - 25 °C | 1033 | 3,70 | 1,42 | 1,090 | 0,91 |
| 40 weight % | - 21 °C | 1030 | 3,80 | 1,36 | 1,065 | 0,93 |
| 35 weight % | - 17 °C | 1027 | 3,88 | 1,31 | 1,040 | 0,95 |
| 30 weight % | - 14 °C | 1023 | 3,94 | 1,27 | 1,025 | 0,97 |

*** Remark**

Pure mixtures without inhibitors should not be used because of their corrosive characteristic features. The chemical industry offers only brines on glycol base. For example Antifrogen N with registered trade mark for ethylene glycol and Antifrogen L with registered trade mark for propylene glycol.

## Selection example

**Given:** Operation water flow rate $G_W$ = 50000 kg/h
Water inlet temperature $t_{WE}$ = + 40 °C
Water outlet temperature $t_{WA}$ = + 30 °C
Wet-bulb temperature $t_f$ = + 21 °C

**Result:**

1 $Q_B$= 50000(40-30) = 500000 kcal/h= 581,4 kW

2 k = 1,08 (Selection chart for 10 K cooling rage)

3 Correction factor $k_G$ from Table 3a : $k_G$ = 0,97

4 $$Q_{N\,req.} = \frac{Q_B}{k \cdot k_G} = \frac{581{,}4\ \text{kW}}{1{,}08 \cdot 0{,}97} = 554{,}98\ \text{kW}$$

5 Unit selected: HK 3/52 mit $Q_{N\,is}$ = 555 kW

**In this example the unit should work with a 35 weight % ethylene glycol mixture to prevent freezing in the exchanger. You can`t find the operating conditions in table 2.**

6 Finned heat exchanger: 12 rows with pressure drop of 0,053 bar

7 Change-over point from wet- to dry-cooling at constant cooling capacity approx. 18,5 °C.

8 The pressure drop in the heat exchanger system for water is 0,053 bar. For the mixture the pressure drop is to multiply with 1,275 (from table 3a): 0,053 x 1,275 = 0,068 bar.

9 When selecting the pump the operating ethylene glycol-water flow rate should be known. The multiplier is also given in table 3a: 1,12.

Example:
50000 kg/h water x 1,12 = 56000 kg/h weight % ethylene glycol-water mixture.

# Pressure drop in the heat exchanger

The pressure drop in the heat exchanger must be known to select the pump for the primary circuit. Consult curve 2 for this purpose.

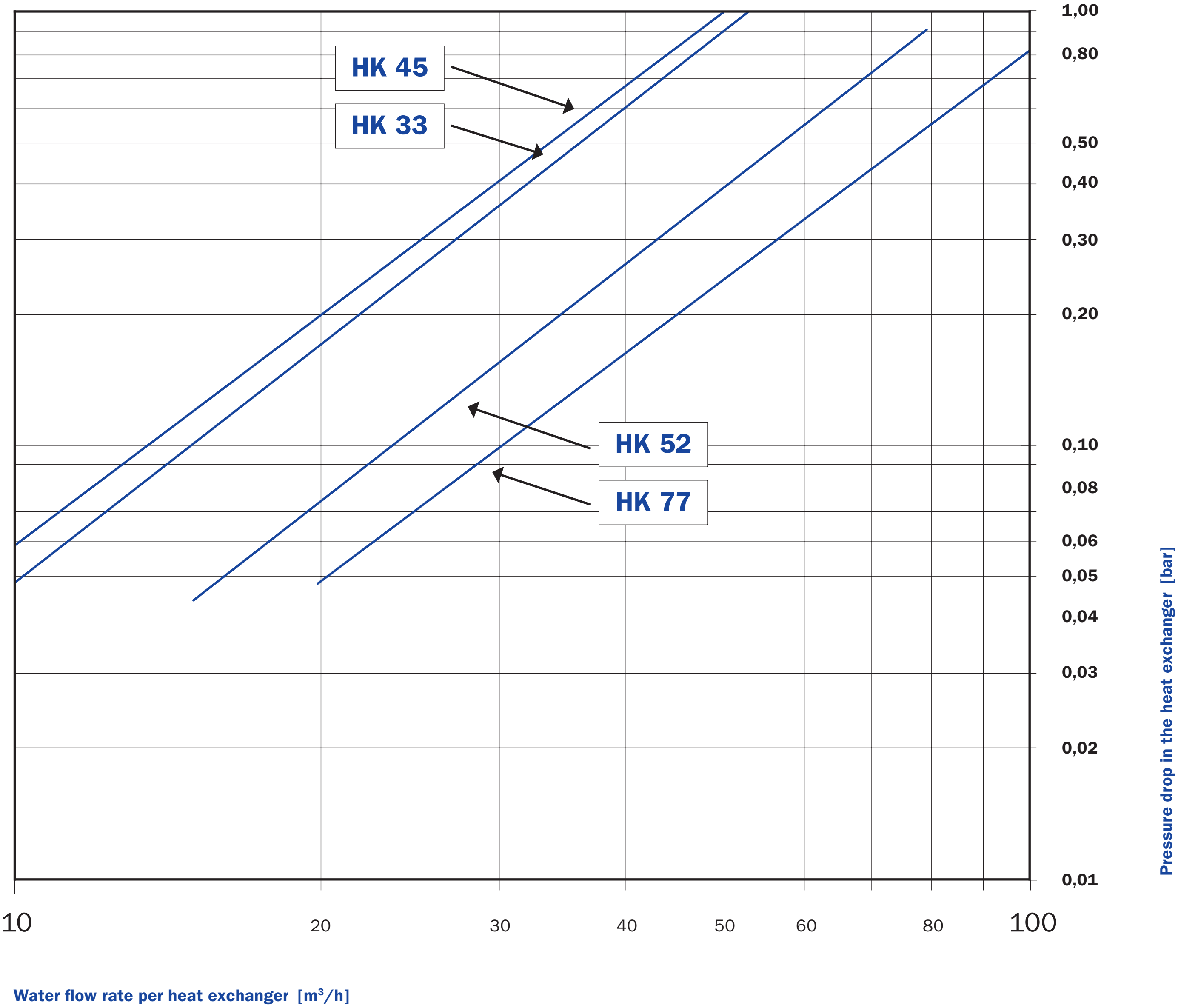
## Example 1 (water)

There are 50000 kg/h water to be cooled in a unit HK 3/52.
The unit has 3 fans (indicated by the first number).
Found: 0,053 bar.

## Example 2 (35 weight % ethylene glycol)

There are 33600 kg/h water to be cooled in a unit HK 77.
The unit has one fan.
Found for water: 0,12 bar.
Multiplier from table 3a for the pressure drop of ethylene glycol vs. water: 1,275
**For 35 weight % ethylene glycol:** 0,12 x 1,275 = **0,15 bar.**
Circulating ethylene glycol-water mixture (at same cooling range): 33600 x 1,12 = 37632 l/h
Multiplier 1,12 from table 3a.

## Selection curve 2



# Electrical switch and control box

The control of the unit is made by a SPS. For the input and the revision operation an „operator panel“ is available. It consists of input key buttons and display.

There are two options available for cooling capacity control: **Energy consumption optimized**
**Water consumption optimized**

By changing the PID-control parameters the control system can be adapted to the essential cooling capacity. The control system operates in dependance of the water outlet temperature of the cooler. If the water outlet temperature will be passed over the adjusted temperature, the PID-control system begins to operate. Each switch and control box is set up for a mains voltage of 230>/400 V, 50 Hz, IP 55 according to VDE. The wiring between the fan motor and the frequency changer must be wired with screen cables. The cable length between the fan motor and the switch and control box shouldn`t be longer than max. 15 to 20 m.

**Electrical switch and control box for single units/Mains and motor voltage 400 V ( 3~ ) 50 Hz**

| Unit size | Fan motor 1500 min⁻¹, 400 V, 50 Hz, IP 54, Range of adjustment: 10-50 Hz kW | *Frequency transformer, Fabr. Vacon* Pn CT/VT kW | Dimensions W/H/D mm | Weight kg | E-box size incl. base plate of 200 mm H/B/T mm |
|---|---|---|---|---|---|
| HK 33 | 5,5-7,5 | 4/5,5 - 5,5/7,5 | 135/430/205 | 7 | 2000/800/500 |
| HK 45 | 7,5 | 5,5/7,5 | 135/430/205 | 7 | 2000/800/500 |
| HK 52 | 11 | 7,5/11 | 135/430/205 | 7 | 2000/800/500 |
| HK 77 | 15 | 11/15 | 135/430/205 | 7 | 2000/800/500 |
| HK 2/33 | 11-15 | 7,5/11-11/15 | 135/430/205 | 7 | 2000/800/500 |
| HK 2/45 | 15-18,5 | 11/15-15/18,5 | 135/430/205 u. 185/595/215 | 7-21 | 2000/800/500 |
| HK 2/52 | 18,5-22 | 15/18,5-18,5/22 | 185/595/215 | 21 | 2000/800/500 |
| HK 2/77 | 30 | 22/30 | 185/595/215 | 21 | 2000/800/500 |
| HK 3/45 | 18,5-22-30 | 15/18,5-18,5/22-22/30 | 185/595/215 | 21 | 2000/1200/500 |
| HK 3/52 | 30 | 22/30 | 185/595/215 | 21 | 2000/1200/500 |
| HK 3/77 | 37-45 | 30/37-37/45 | 220/700/290 | 38 | 2000/1200/500 |
| HK 4/45 | 2 x (15-18,5) | 2 x (11/15-15/18,5) | 2 x (135/430/205-185/595/215) | 7-21 | 2000/1600/500 |
| HK 4/52 | 2 x (18,5-22) | 2 x (15/18,5-18,5/22) | 2 x 185/595/215 | 2 x 21 | 2000/1600/500 |
| HK 4/77 | 2 x 30 | 2 x 22/30 | 2 x 185/595/215 | 2 x 21 | 2000/1600/500 |
| HK 5/45 | (15-18,5)+(18,5-22-30) | (11/15-15/18,5)+(15/18,5-22/30) | 2 x (135/430/205-185/595/215) | 7-21 | 2000/1600/500 |
| HK 5/52 | (18,5-22) + 30 | (15/18,5-18,5/22) + 22/30 | 2 x 185/595/215 | 2 x 21 | 2000/1600/500 |
| HK 5/77 | 30 + (37-45) | 22/30 + (30/37-37/45) | 2 x (185/595/215-220/700/290) | 21-38 | 2000/1600/500 |
| HK 6/45 | 2 x (18,5-22-30) | 2 x (15/18,5-18,5/22-22/30) | 2 x 185/595/215 | 2 x 21 | 2000/1600/500 |
| HK 6/52 | 2 x 30 | 2 x 22/30 | 2 x 185/595/215 | 2 x 21 | 2000/1600/500 |
| HK 6/77 | 2 x (37-45) | 2 x (30/37-37/45) | 2 x 220/700/290 | 2 x 38 | 2000/1600/500 |

# Mixing station with cleansing equipment

The mixing station will be supplied ready for connection with all safety armatures, cleaning tank with dosing pump and empty code indicator. The hydraulic components are complete tubed in a metal cupboard. The piping between mixing station and hybrid water cooler as well as the fresh water and the warm water supply must be done by customers. The construction and type for metal cupboard, dosing pump, cleaning tank, armatures etc. are according to our specifications. The mixing station must be installed in a heated room.

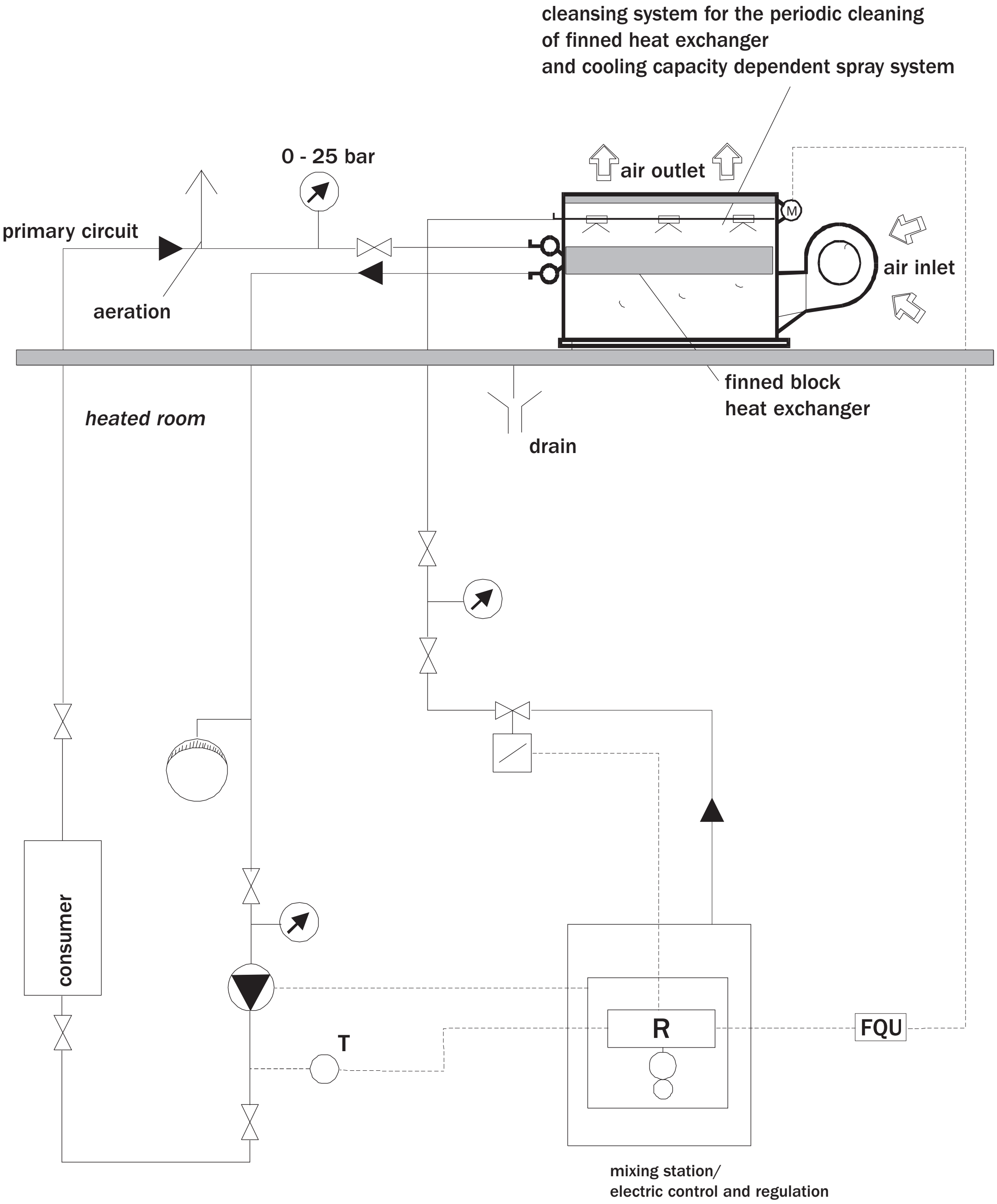
| Mixing station for single units | | | | | Mixing station for several units | | |
|---|---|---|---|---|---|---|---|
| Unit size | Cupboard size incl. base plate 200 mm H/W/D mm | Mixing station size | Required primary pressure for the cleansing system bar | Required primary pressure for the spray system bar | Number of units | Cupboard size incl. base plate 200 mm H/W/D mm | Mixing station size |
| HK 33 | 2000/800/600 | R 1“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1“ |
| HK 45 | 2000/800/600 | R 1“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1“ |
| HK 52 | 2000/800/600 | R 1“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1“ |
| HK 77 | 2000/800/600 | R 1“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1“ |
| HK 2/33 | 2000/800/600 | R 1“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1“ |
| HK 2/45 | 2000/800/600 | R 1“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1“ |
| HK 2/52 | 2000/800/600 | R 1“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1“ |
| HK 2/77 | 2000/800/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 3/45 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 3/52 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| Hk 3/77 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 4/45 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 4/52 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 4/77 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 5/45 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 5/52 | 2000/1200/600 | R 1 1/2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 1 1/2“ |
| HK 5/77 | 2000/1200/600 | R 2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 2“ |
| HK 6/45 | 2000/1200/600 | R 2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 2“ |
| HK 6/52 | 2000/1200/600 | R 2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 2“ |
| HK 6/77 | 2000/1200/600 | R 2“ | 3,5 | 1,1 - 2,0 | 2 - 4 | 2000/1200/600 | R 2“ |

# Operation of the unit during winter

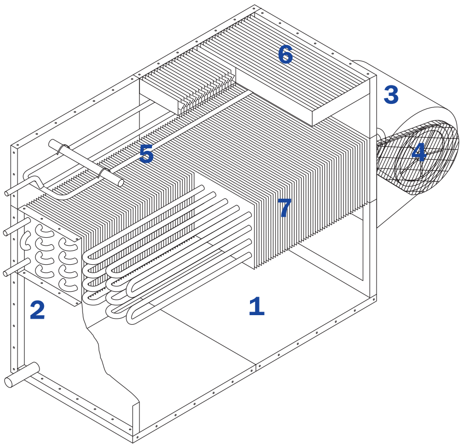
## Suggestion

| | |
|---|---|
| Primary circuit | Ethylene glycol 35 weight % |
| Spray system | A safety thermostat switches off the spray system if the dry bulb temperature < + 5 °C. |
| Cleansing system | At dry bulb temperatures below + 5 °C the feeding pipe will be automatically drained. |

The primary circuit is filled with a 35% ethylene glycol-water mixture which has its freezing point at – 21,8 °C. The mixing station must be installed in a heated room.



# Technical specification




### Technical data

Hybrid water-cooler
type ______
Cooling capacity ______ kW
Water inlet temperature ______ °C
Water outlet temperature ______ °C
Wet-bulb temperature ______ °C
Dry-bulb temperature ______ °C
Change-over point from wet to dry cooling ______ °C
(at constant cooling capacity)
Water circuit flow rate ______ m³/h
with 30 weight% ethylene glycol
Water pressure drop in the heat exchanger ______ bar
Water capacity in the heat exchanger ______ kg
Surface area of the heat exchanger ______ m²
Fresh water consumption by evaporation ______ m³/h
(approx. 1,49 kg/kW)
Drop losses (max. 10 %) ______ m³/h
Total fresh water consumption ______ m³/h
For make-up water you need osmosis water or make-up water to be in accordance with the osmosis water.

| | |
|---|---|
| Break pressure of the spray nozzles | 0,7 bar |
| Pressure of nozzle for the spray system | 1,1-2,0 bar |
| Pressure of nozzle for the cleansing system | 3,5 bar |
| Duration for cleaning and rinsing | 12 min |

Hot water consumption (45-50°C) for each
cleaning process ______ kg
(approx. 1 time per week)
Hot water flow rate ______ kg/h
Detergent consumption for each
cleaning process ______ kg
spray system will be moved with a servomotor 24 V, 120 W, 5 A
Number and type of fans ______ pcs
Additional static pressure of the fan ______ Pa
Air volume ______ m³/h
Fan speed ______ $min^{-1}$
Fan power absorbed ______ kW
Shipping weight ______ kg
Operating weight ______ kg
Dimensions l/w/h ______ mm
Noise at 3 m horizontally in extension of the fan shaft with free acoustic propagation,
approx. ______ dB(A)

### Technical data with components:

Shipping weight with accessories ______ kg
Operated weight with accessories at a water level up to
overflow ______ kg
Dimensions with accessories l/w/h ______ mm

### 1 Casing and pan section

The casing and pan section form one unit and consist of heavy-gaupge galvanised, folded sheet metal panels, which are assembled into a box structure, using stainless steel bolts and a permanently flexible sealing compound. Galvanised steel beams carry the finned heat exchanger. Deflector plates distribute the air uniformly over the finned heat exchanger. An inspection door provides access for adjustment of eventual available armatures and for the cleaning of the pan section.

### 2 Water connections

All water connections fitted to the heat exchanger, are provided with flanges, PN 16 DIN 2633. The drain connection has internal thread, it is provided with a plastic coated strainer.

### Overflow indicator

An electric indicator will be used to control the max. allowed water level of the water pan.

### 3 Double width inlet centrifugal fan

Low noise level high efficiency, heavy duty fans with forward-curved blades are used. The galvanised fan impeller is statically and dynamically balanced. The fan shaft is made of stainless steel X20Cr11, material-no. 1.4021. The feather is made of steel C45K according to DIN 6885.
The heavy duty ball-bearings which are assembled in pillow blocks and equipped with lip or labyrinth seals are provided with grease nipples led to the end of the fan housing for maintenance ease. The fan housing is made of galvanised steel and equipped with an outlet diffuser.
The drive is via V-belts. The V-belt pulleys are of cast aluminium with steel hubs. The fan is located in the dry entering air and is readily accessible for maintenance purposes.

### 4 Belt guard and air intake guard

The guards are hot dipped galvanised after fabrication. By using a fan enclosure the guards will not be needed.

### 5 Spray system

The water is sprayed over the finned pack surface with a intermittent working spray system. The spray system is mounted on a horizontal movable equipment above the heat exchanger. The spray system and the movable equipment are manufactured of stainless steel.
The equipment will be moved with a servomotor.
The water is sprayed through special nozzles made of fibreglass (nozzle insert made of brass and the strainer of stainless steel).

### Cleansing system

The cleansing system will be used for automatic, periodic cleaning of the finned heat exchanger. Depending on requirements the travelling nozzles will clean the heat exchanger with a special cleansing agent. The cleaning will take place during the standstill of the unit.

### 6 Moisture eliminators

The moisture eliminators are made of synthetic material for optimum water elimination at a low pressure drop. In the upper part of the eliminators the air directed vertically upwards.

### 7 Heat exchanger

The finned pack consists of copper tubes mechanically expanded into copper fins. The fins space is 3 mm. The distributor and header are manufactured out of steel or copper tubes. The frame can be stainless steel (V2A) or copper.
The heat exchanger subjected to a air pressure test according to DIN 8975.

### Corrosion protection

All galv. sheet metal parts are lightly sandblasted, heated in a furnace, and dipped into a plastic powder bed (Performance Polymer Alloy). The plastic coat is approx. 0,3 mm thick on each side. It has a homogeneous surface, it is elastic, resistant to chemical attack, light- and weatherproof. (Not coated are: eliminators, fan wheel incl. shaft and pulleys, spray system, bolts and nuts, and all parts which are not dipped galvanised).

**Accessories** are described at a separate brochure.

# Installation and operating instructions

**Noise level**
The values indicated in dB(A) relate to a measurement taken 3 m in horizontal extension of the fan shaft (maximum noise development). Although the forward-curved fan impellers of the larger units have been designed by a reputable company and are selected to operate at a particularly low noise level at high efficiency, the dB(A) values must be considered as guide values because the installation conditions (acoustic reflection from the walls of buildings etc.), vary widely.

**Cooling performance with centrifugal fan drive by speed controlled motor**
Range of adjustment from 50 to 10 Hz. Continuously adjustable speed control from 1500 $min^{-1}$ to 300 $min^{-1}$. The cooling performance drops from 100 to 25 %. If the fan and the spraying are shut off the cooling performance is about 5 % dependent on the dry-bulb temperature. Fan motors should be selected about 10 to 15 % larger than the indicated absorbed power for the fan. The maximum size for all motors is: 200 L, maximum, however 320 kg.

**Standard-units with two fan motors**
Units with 4, 5 and 6 fans supplied with two fan motors which must be switched on and off together. In case that the fan motors should operate separately we need two units which are assembled to one unit. (Example: 1 x 4/77 d 2 x 2/77) or we need an air dividing wall. If the unit is provided with an air dividing wall the fan motors at the left and right side can be switched on and off separately.

**Test and working pressure for the heat exchanger**
Test pressure: 15 bar; Working pressure: allowed max. 8 bar. Working temperature: allowed max. 100 °C.

**Fresh water supply and consumption**
Fresh water consumption includes quantity of water evaporated and quantity of drop losses.
The spray system works intermittent, i.e. you will only spray water as far as you use for evaporation. The max. fresh water consumption by evaporation is about 1,49 kg per 1 kW cooling performance and a wet-bulb temperature of 21 °C. The drop losses are max. 10 % of the consumption by evaporation. For make-up water you need osmosis water or make-up water to be in accordance with the osmosis water.

**Cleansing system**
The heat exchange will be cleaned with normal tap water. For cleaning you need warm water from 40 to 45 °C and a cleansing agent which will be dosed automatically. Required pressure for the spray nozzles: 3,5 bar.
The cleaning cycle is adjustable. The cleaning should be done after 70 to 100 operating hours dependant on the operating conditions. Cleansing agent consumption for each cleaning process depends on the size of the unit.

**Mixing station with electrical control**
The mixing station must be installed into a heated room. The cleansing system will be supplied ready for connection with all necessary components for safety and safety armatures, cleaning tank and dosing pump. Each switch cupboard is designed according to VDE for nominal voltage of 230/400 V, 50 Hz and protection mode IP 53. The wiring between the fan motor and the frequency changer must be wired with screened cable. The cable length between the fan motor and the switch and control box shouldn`t be longer than max. 15 to 20 m.

**Accessories**
Speed controlled fan motor, overflow indicator, air discharge damper “open/shut”, inlet air damper “open/shut”, maintenance channel, mixing station, electrical control, inspection hatches for spray system, silencer, fan enclosure, air discharge venturi, flexible duct connector, omega spring anti vibration rails, neoprene rubber strips, “top in/top out” arrangements and other accessories are available on request. The accessories are described at a separate brochure.

**Possibilities of delivery**

1. All units can be supplied broken down. Assembly is carried out on site. The heat exchanger is the largest and heaviest component. A crane will be required to unload the components and to position the heat exchanger after assembly of the unit casing.
2. The units can be supplied assembled and ready for operation, in sizes 33 up to incl. 2/77. A crane is required just once to position the unit from the lorry on the prepared foundation. There are no costs for the assembly of the unit.

**Important instructions**

1. We recommend the only use of those types of foundations which are in accordance with our suggestions.
   All foundations for our units (including enclosures) installed outdoors should be made water-tight. When erecting the unit in buildings both - the foundation and the floor - should be made water-tight designed as a pan is to be additionally recommended. A jointing solution could be added to the concrete, or a waterproof coat of paint may be applied. Also possible is the use of sheet or plastic covers.
2. Load deflection of the support beams under the unit over the entire length:
   - Maximum value: overall length/400
   - Maximum value when using the longitudinal sound absorbing spring rails or neoprene rubber strips: overall length/600
3. Acceptable deviation of installation position of the unit with regard to the horizontal:
   - Maximum value: 5 mm per 3 m housing length
4. Units with two or more fan-motors have no air partition wall. All motors have to be operated simultaneously.
   A time delay of max. 10 sec. is permissible. Number of switching actuations for the fan motor: max. 15/h.
5. Units which might tip over must be anchored to the foundation. This applies in particular to all those equipments having a low width as compared to their overall height (exhaust duct connection pieces to be considered) as well as to the equipment having a large wind surface.
6. We recommend inspection doors for spray nozzles or a duct piece with inspection door above the unit, if eliminators and the spray system are not accessible freely from above.
7. Pipelines and collectors/distributors on the part of the builder may not capacitate the plant connection and shall therefore be supported or hung on the builder`s part. Furthermore, there may be no horizontal or vertical deviation between these pipelines and the plant connections so that assembly free of tension is ensured.
8. When ordering the omega spring rails or neoprene rubber strips, the direction of the foundation must be given. However, a prerequisite for an efficient sound absorbing effect is that rigid tube connections are adjusted by means of compensators.
9. Please note in the special case the respective instructions in our confirmation of order.
10. In order to place the water connections and the accessories in the correct position specify the set up of the unit in your order
    (e.g. installation drawings).
11. The cut of the ceiling should be generally 100 mm larger than unit dimensions so that we have a space of 50 mm at each side of the unit.
    The space will be closed with a flashing.
12. Foundations for our units should be made uniformly (approx. 100 mm longer than the unit dimensions).
13. For outdoor-installations we recommend a lightning arrester and overvoltage protection at the casing of the unit.
14. All dimensions are approximate value. On account of the tolerances the piping can only be made after set up of the unit.

# Special Design Features

**Design**

**1** „Blow-through"- hybrid cooler. The fan is located in the dry entering air and not in the corrosive saturated discharge air.
**2** Recirculation of air is not possible with this design.
**3** Pressure chamber. The fans discharge the air into a pressure chamber where an intensive heat exchanger takes place between air and spraying water.
**4** The units can be disassembled completely because all components are bolted.
**5** Simple connection of discharge ducting because an all-round flange is provided at the discharge side.
**6** Simple assembly if assembly on site is to be carried out because of the compact rectangular design.
**7** Compact construction with particularly low equipment height and low weight.
**8** Accessories offered in great variety: speed controlled fan motor, cleansing system for heat exchanger, cooling capacity dependenting control system, neoprene rubber or spring anti vibration mountings, fan enclosures, inlet- and outlet silencers, outlet plenums, inspection hatches for spray nozzles and other accessories are available on request.

**Construction**

**1** Corrosion protection:
All galv. sheet metal parts are lightly sandblasted, heated in a furnace and dipped into a plastic powder bed. The plastic coat is on each side approx. 0,3 mm thick. It has a homogeneous surface, it is elastic, resistant to chemical attack, light- and waterproof. (Not coated are: eliminators, fan wheel incl. shaft and pulleys, spray system, bolts and nuts, and all parts which are not hot dipped galvanised.)
**2** Cooling capacity dependenting control system.
**3** Automatic, periodic cleansing system for the heat exchanger.

**Operation**

**1** A combination of wet- and dry-cooling operations with an environment protecting heat transfer.
**2** High dry cooling range, no fog formations.
**3** No secondary circuit, no treatment of the water.
**4** High safety by winter operation, extremely economical.

**Maintenance**

**1** Because of the low installed height, the units are easily accessible for maintenance.
**2** The cleansing system for the heat exchanger prevents deposits and corrosion.
**3** A large number of trained representatives all over Europe provide an effective and first class after sales service.

**Noise**

**1** Units employing centrifugal fans are inherently quiet. The forward curved blades of the fan impellers enable a low RPM to be used. Because of the considerable pressure reserve supplies, silencers, etc. can be fitted to the unit.

**The manufactures reserve the right to make technical modifications as a result of further development and technical advances.**