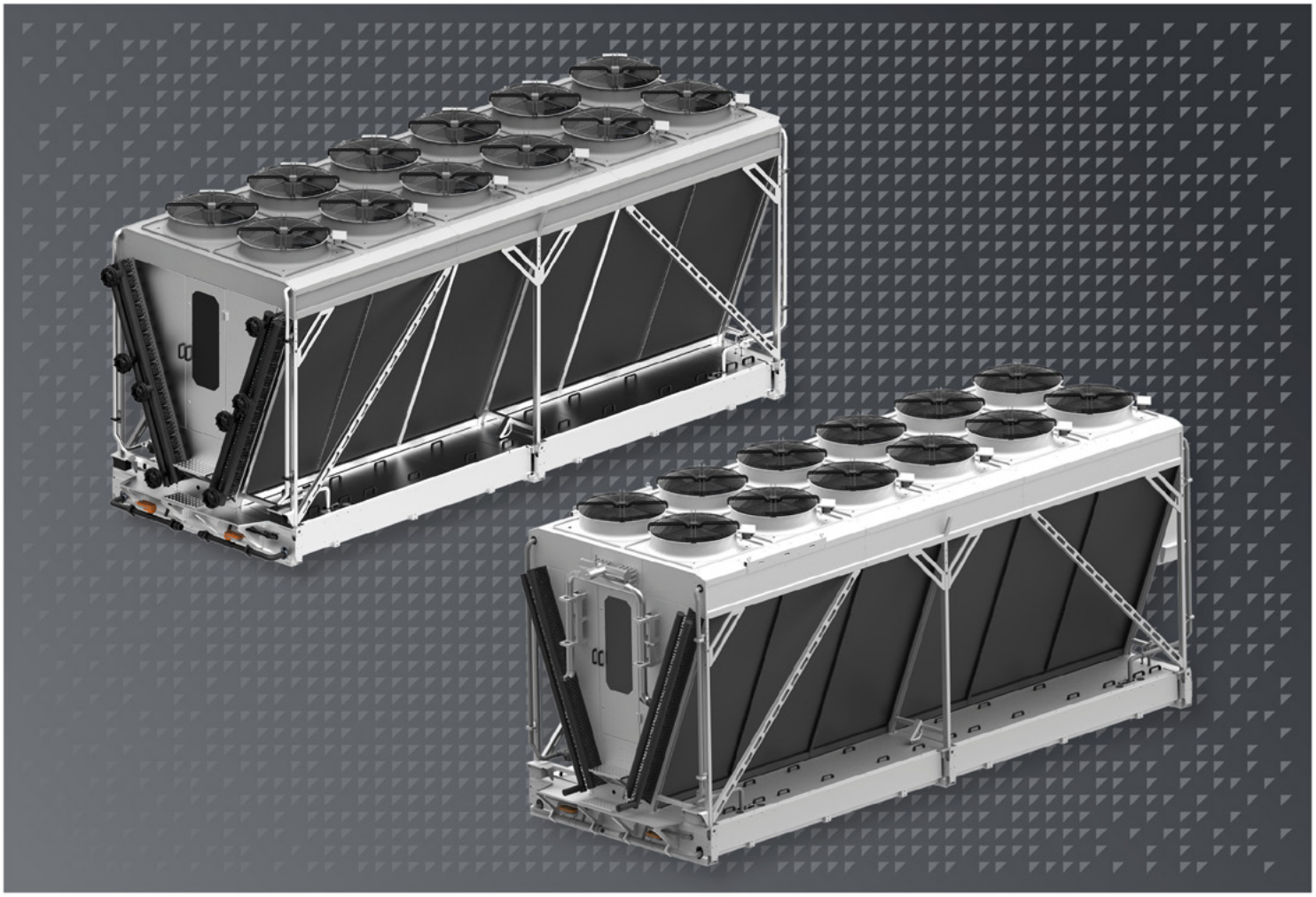


THDD/THDW hybrid dry coolers - 混合干式冷却器
THACD/THACW hybrid condensers - 混合冷凝器

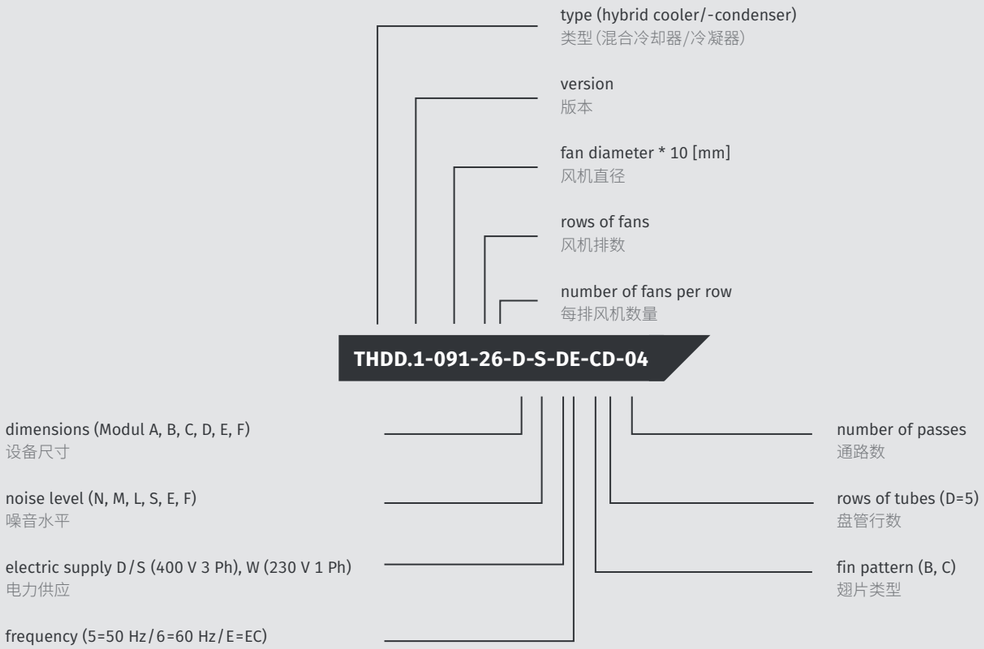
HYBRID COOLING
混合冷却

www.thermofin.de/cn

thermofin®
德默菲换热器(平湖)有限公司

设备命名

Nomenclature



产品系列

Series

dry coolers

series	airflow
THDW **THDD**	drawing in laterally, blowing out vertically upwards
Medium	water glycol mixture

干式冷却器

风向	干式冷却器
THDW **THDD**	侧方吸风, 垂直出风
medium	水 醇类

condensers

series	airflow
THACW, **THACD**	drawing in laterally, blowing out vertically upwards
Medium	NH_3

冷凝器

风向	干式冷却器
THACW, **THACD**	侧方吸风, 垂直出风
medium	氨

操作模式

Mode of operation

The thermofin® hybrid coolers are developed especially for low medium temperatures in the cooling circuit, for high performance requirements with space limitations and associated sound requirements.

thermofin®混合式冷却器是专门针对低温冷却介质而开发的，可满足高性能要求，空间限制和相关噪音要求。

The combination of a dry operation and a moistened mode enables an energy-optimised regulation of the system to the different yearly temperatures. The synergy of a sensible and a latent heat exchanging process permits an operation with medium temperatures below the maximum ambient temperatures. For this case, the defining factor is the ambient wet bulb temperature.

干式模式和湿式模式的结合使系统能够针对一年中不同的温度进行能量优化的调节。合理的与潜在的热交换过程的协同作用允许在低于最大环境温度的低温度下运行。对于这种情况，关键因素是周围空气的湿球温度。

An example follows:
- ambient temperature: 34 °C
- wet bulb temperature: 22 °C
- possible system temperature hybrid dry cooler
  - medium inlet: 30 °C
  - medium outlet: 26 °C
- possible system temperature hybrid condenser
  - condensation temperature: 27 °C

例如如下条件:
- 周围温度: 34 °C
- 湿球温度: 22 °C
- 可行的干式冷却器运行条件
  - 媒介进入温度: 30 °C
  - 媒介出口温度: 26 °C
- 可行的冷凝器器运行条件
  - 冷凝温度: 27 °C

The TCS controller (thermofin® control system) measures the ambient and return flow temperature and automatically activates the water moistening. During a sensible heat exchanging process in dry operation, heat is convectively transferred to the ambient air. In doing so, the unit operates from the lowest outside air temperature range until a switching temperature as a conventional dry cooler/air-cooled condenser. Within this temperature range no water is required for the economically advantageous operation of the system. If the temperature exceeds a defined switching temperature, the finned surface is moistened.

TCS控制器 (thermofin®控制系统) 可测量环境温度和回流温度，并自动激活湿式模式。在干式模式下，媒介和周围空气进行合理的热交换过程，热量会通过对流传递到周围空气中。从外部空气温度，到干冷器/冷凝器的切换温度范围内，系统的运行不需要水。如果温度超过定义的开关温度，则将翅片表面将被湿润。

Consequently, the dry operation is combined with a wet operation and heat is discharged additionally by evaporation from the medium to be cooled. With increasing temperature, the moistening degree and the evaporation quantity are also increased continuously. If the maximum moistening degree is reached, the unit operates as an evaporative cooler exclusively without vapor formation.

因此，干式模式与湿式模式相结合，并且另外通过蒸发将热量从要冷却的介质中排出。随着温度的升高，润湿度和蒸发量也不断增加。如果达到最大润湿度，则该装置仅作为蒸发冷却器运行而不会形成蒸汽。

Compared to the conventional dry operation a threefold to fourfold efficiency increase can be reached by this interaction. On one hand, it is possible to reduce the operating costs and the sound values with same system performance. On the other one, a high dry cooling capacity with lowest operating costs can also be reached under limited spatial conditions. The intensity of both operating modes depends on the climatic conditions at the site of installation and on influencing values already defined with the dimensioning. Such influences may be the yearly temperature variations and the load characteristics of the entire system.

与传统的干式操作相比，这种相互作用可以使设备效率提高三到四倍。一方面，可以在相同的系统性能下降低运行成本和噪音值。另一方面，在有限的空间条件下也可以实现具有最低运行成本的高干式冷却能力。两种操作模式的强度取决于安装现场的气候条件以及一些影响设备尺寸的因素。比如整个系统的一年内的温度变化和负载的热力学特性等。

设计与功能

Design and function

The thermofin® hybrid coolers complies with the constructive prescriptions of VDI 2047-2 to ensure the hygiene-compliant operation of evaporative systems.

thermofin®混合式冷却器符合建设性规定VDI 2047-2，可确保蒸发系统符合卫生要求。

The technical dimensioning together with the material selection sets standards for cooling systems and ensures a safe system operation by considering the manufacturer instructions.

合理的技术尺寸以及严格的材料选择为冷却系统提供了质量保证，并且遵守制造商生产规则来确保整个系统的安全。

Two finned heat exchanger coils with compact design are arranged in a V-shape and assembled on a stable steel construction. That forms the remarkable basic design of the hybrid dry cooler. This structure allows the compliance with special static and dimensional requirements. In standard, all construction parts containing the circulation water are made of SS304 (1.4301).

两个设计紧凑的翅片式换热器盘管呈V形排列，并组装在稳定的钢结构上。这形成了混合干式冷却器非凡的基本设计。这种结构可以满足特殊的静态和尺寸要求。按照标准，所有包含循环水的建筑部件均由不锈钢制成。

The reliable heat exchanger system made of copper tubes and aluminum fins are coated before assembly with a black coating. This cathodic dip paint coating is a multi-stage electrochemical painting process with the result of an evenly thin, chemical-resistant layer with excellent paint adhesion and corrosion protection characteristics.

由铜管和铝翅片制成的可靠的热交换器系统在组装前先涂有黑色涂层。这种阴极沉浸涂料是一个多阶段的电化学涂装工艺，其结果是得到具有优异的涂料附着力和防腐性能的均匀薄的耐化学腐蚀层。

The draw-through fans centrally arranged above the heat exchanger coils generate an air flow, which passes the fins and extracts heat from the medium to be cooled. They are directly driven and continuously speed-controlled via a frequency converter or on EC motor. The unit controller TCS monitors all relevant parameters and controls the system in an energy-optimised way. Additionally to the adjustment of a second set value, it is possible to enter a day and night mode in order to comply with sound-related environmental requirements.

布置在热交换器盘管上方中央的抽风机产生气流，该气流通过散热片并从要冷却的介质中吸收热量。它们由变频器直接驱动并通过变频器或EC电动机进行可连续的速度调节。单元控制器TCS监视所有相关参数，并以能量优化的方式控制系统。除了设置第二设定值外，还可以进入昼夜模式，以符合与声音有关的环境要求 。

An inspection door allows a direct access to the inside of the hybrid cooler for easy cleaning of the water distribution system and the heat exchanger coils against the air direction. For safety purposes, the fans are deactivated automatically when opening the inspection door.

检查门可直接进入混合式冷却器的内部，以便轻松清洁配水系统和热交换器盘管的内测。为了安全起见，打开检查门时会自动停用风机。

The moistening water circuit installed on the upper side of both coils ends in an open channel, which provides water on the outside of the fins where it is partially evaporated. The excessive water prevents the deposition of atmospheric pollutants and pollen on the fins. It is collected in a water tray below the heat exchanger coils and returned to the water circuit by means of one or two immersion pumps also controlled via the TCS.

安装在两个盘管上侧的加湿水回路的末端是一个开放的通道，该通道在散热片的外部将水部分蒸发掉。过量的水阻止了翅片上大气污染物和花粉的沉积。循环水收集在热交换器盘管下方的集水盘中，并通过一台或两台由TCS控制的潜水泵返回水循环系统。

A filling level sensor between the two pumps ensures the compliance with the minimum and maximum limits of the circulation water filling level. The conductivity measurement device integrated into the water circuit checks the water quality, regulates the function of the desludging valve and activates the sporadic supply of an additive. Since only pure water is evaporated during the process, the salt and pollution content increases constantly. If certain values are exceeded, the desludging valve opens and circulating water is discharged partially to the wastewater system.

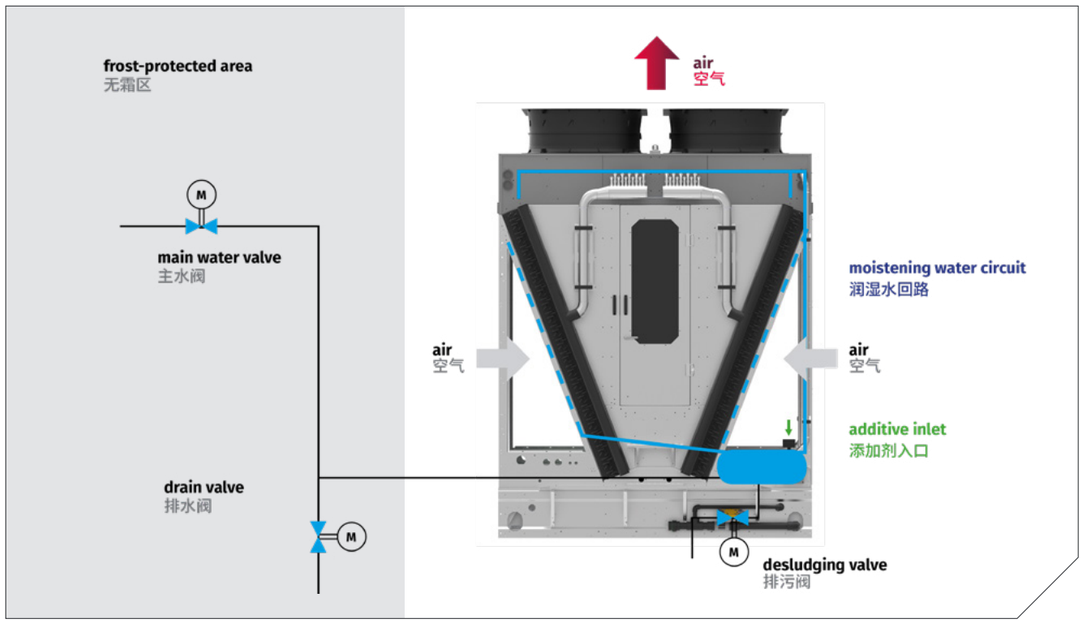
两个泵之间的液位传感器控制循环水液位所需范围内。集成在水回路中的电导率测量设备可检查水质，同时具有调节排污阀的功能并可以激活零星的添加剂供应。由于在冷却过程中仅蒸发纯水，因此盐分和污染物含量不断增加。如果超过标准值，则排污阀打开，循环水部分排放到废水系统。

It is replaced by the identical quantity of treated fresh water. Considering resource preservation and the optimisation of operating costs, It is ensured that only the required water is replaced. Furthermore, the scope of delivery comprises motor valves to control the water supply: The main water valve that shall be provided in the frost-free area and the draining valve for assembly on the lowest point of supply line. The draining of the supply line for purposes of freezing protection and the rinsing for hygienic reasons according to 42. BImSchV can be controlled by the TCS.

取而代之的是相同数量的经过处理的新鲜水。考虑到资源节约和运营成本的优化，确保冷凝过程仅更换所需的水。此外，供货范围包括控制供水的电动阀：应在无霜区域内提供的主供水阀，以及在供水管线最低点进行组装的排水阀。出于防冻和卫生（根据BImSchV第42条的规定）的目的，供应管线可以排空，并由TCS控制。

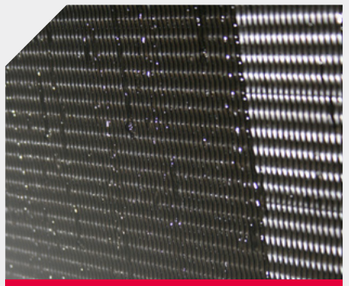
flow chart

流程图



结构设计

Constructional design



heat exchanger/热交换器

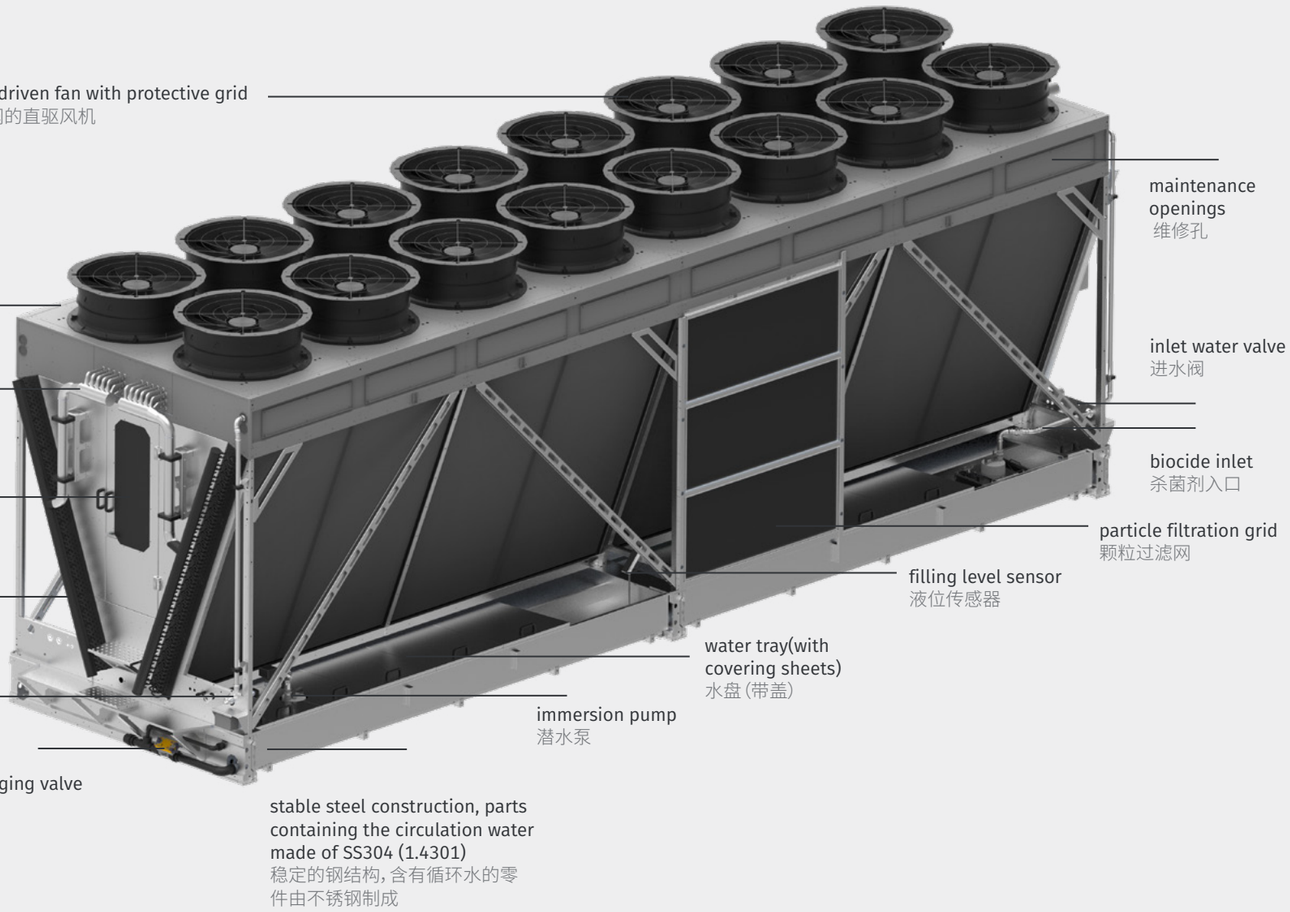
- heat exchanger coil with cathodic dip-paint coating
- 带有阴极浸涂涂层的热交换盘管

immersion pump/潜水泵

- water circulation incl. dry-run protection
- 用于水循环包括空转保护

water tray/水盘

- for moistening water, with removable covering sheets
- 用于润湿用水并带有可移除的盖板

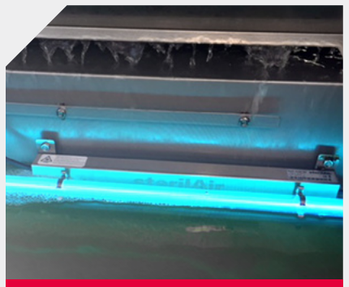


optional: 可选配件

particle filtration grid/颗粒过滤网

- protection of the heat exchanger and the circulating water from pollution
- 保护热交换器和循环水不受污染

optional: 可选配件



UV disinfection/紫外线消毒

- reduction of microbiological growth in the water tray
- 减少水盘中微生物的生长

TCS-controller/TCS控制器

- control cabinet with TCS controller, all-pole sinus filter, frequency converter (continuous speed control)
- 带TCS控制器的控制柜, 全极点正弦滤波器, 变频器 (连续速度控制)

filling level sensor/液位传感器

- level monitoring water
- 监控水位

optional: 可选配件

jalousie dampers or shutter gates/百叶窗风门或者百叶窗

- reduction of free convection and with it decrease of the post heating in case of non-frost-resistant units
- 对于非防冻机组, 减少了自由对流并降低了后加热热量需求

控制系统

Control system

The TCS (thermofin® control system) monitors, controls and records all data of the thermofin® coolers. Especially for the use in hybrid coolers, it is equipped with all required program modules and connection options.

TCS（thermofin®控制系统）能够监视，控制和记录thermofin®冷却器的所有数据。尤其是用于混合冷却器时，它配备了所有必需的程序模块和连接选项。

With the TCS, hybrid coolers receive an optimal performance adaption to the heat to be transferred in consideration of the climatic ambient conditions, a maximum possible energy efficiency and a water-saving operation. All required program modules for the regulation of the fan speed, the pump control as well as the water control and the water treatment are included in the controller. A frequently tested program for the automatic frost protection in case of low outside temperatures is also included in the scope of delivery.

借助TCS，混合冷却器在考虑到气候环境条件，最大可能的能源效率和节水运行的情况下，可以以最佳工况传递热量。控制器可以进行风机速度调节，泵控制以及水和水处理所需的所有程序模块控制。它还提供了一个可经常检测自动防霜系统的程序，以防止外界温度过低。

The following system modules are available:

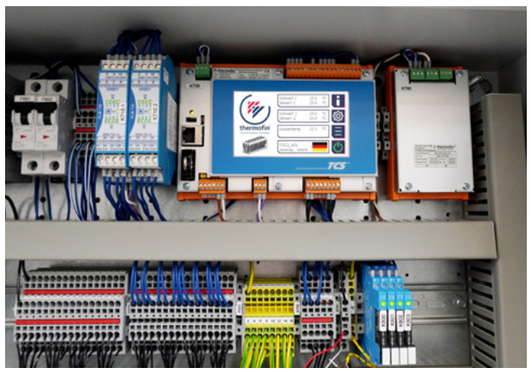
- cooler control via the outlet temperature or the condensation pressure
- set value shift via the outside temperature, external signal or external Bus
- activation and control of the moistening water pumps
- winter draining of the circulation water system
- hygiene and rinsing circuit for circulation water system and water supplies according to 42. BImschV
- external communication via wired contacts or Modbus RTU; Profinet and BACnet possible additionally
- digital inlets for external disturbance feed forward control
- collective fault with initial value and new value message
- collective fault message with first and new value message
- extensive protocol evaluation for operating and fault message data with text, time and data message
- real-time clock as well as automatic summer/winter time shift
- master control in case of systems with several dry coolers operated parallel

TCS提供以下系统模块

- 通过出口温度或冷凝压力控制冷却
- 通过外部温度，外部信号或外部总线进行设置值转换
- 激活和控制润湿水泵
- 冬季循环水系统的排水
- 符合42. BImschV标准的循环水系统和供水的卫生和冲洗回路。
- 通过有线或总线 RTU进行外部通讯；Profinet和BACnet可以接入
- 数字输入口，用于外部干扰前馈控制
- 具有初始值和新值消息的故障收集信息
- 具有首值和新值消息的故障收集信息
- 通过文本，时间和数据消息对操作和故障消息数据进行广泛的协议评估
- 实时时钟以及夏季/冬季自动时移
- 如果系统具有多个并联运行的干式冷却器，可以进行主控制

Special solutions are available on customer's request.

特殊解决方案可应客户要求提供



水质

Water quality

In order to prevent salt deposits as far as possible and to exclude corrosion damages, high attention shall be paid to water quality. In doing so, two types of treated water are possible.

为了尽可能防止盐分沉积并排除腐蚀损害，应特别注意水质。所以，以下两种水处理方法是可以接受的。

Deionised fresh water
The high advantage of water treatment with a reverse osmosis system is the nearly completely removed mineral content. For this mode of operation, the risk of salt depositions is minimised. Depending on the ambient conditions, completely deionised water can be concentrated 8- to 12-fold and with it, the water consumption can be kept very low.

去离子水
使用反渗透系统进行水处理的最大优势是几乎完全去除了矿物质。对于这种操作模式，将盐沉积的风险降到最低。根据环境条件，可以将完全去离子的水浓缩8至12倍，并可以将耗水量保持在非常低的水平。

Softened fresh water
If the raw water quality allows it, the softening can be effected via an ion exchanger system. Here, only the hardness forming calcium and magnesium ions are replaced by sodium ions. The concentration of other water contents and with it, the conductivity and the pH value are not decreased. In order to ensure the economic operation of the hybrid cooler, the 3-fold thickening of the moistening water should not be exceeded.

软化水
如果原水质量允许，则可以通过离子交换器系统进行软化。在此，仅硬度形成的钙和镁离子被钠离子代替。其他水的含量以及随之而来的电导率和pH值均未降低。为了确保混合式冷却器的经济运行，湿润水的浓度增加不得超过3倍。

Regarding the risk of corrosion, the permitted thickening degree depends on the total mineral content and the chloride content of the deluging water. A too high chloride content can strongly influence the electrical conductivity of the deluging water. With the aim to ensure a constantly high water quality and to prevent legionella formation, an additive mixture is added to the circulation water. Optionally, UV lamps can be integrated in the water circuit. In order to prevent frost damages, the entire water circulation is drained automatically from an outside temperature below 4 °C.

关于腐蚀的风险，允许的稠化程度取决于总的矿物质含量和渗水的氯化物含量。氯化物含量过高会严重影响渗漏水的电导率。为了确保恒定的高水质并防止菌落形成，将添加剂混合物添加到循环水中。或者可选地，将紫外线灯集成在水回路中。为了防止霜冻损害，当外部温度低于4°C时，整个水循环会自动从管路中排除。

prescriptions on water quality **水质要求**

	fresh water reference values 新鲜水参考值		limit values 极限值
	softened water 软化水	**reverse osmosis** 反渗透	**circulating water** 循环水
thickening factor* 增稠因子*	2 – 3	6 – 8 (max. 10)	–
hardness 硬度	< 0,2 °dH	< 0,2 °dH	< 2 °dH
pH-value (20 °C) pH值 (20 °C)	7 – 8,3	7 – 8,3	7 - 8,4
electrical conductivity* (25 °C) 电导率 (25 °C)	< 700 µS/cm	< 30 µS/cm (加入添加剂后 < 100)	< 1500 µS/cm
chloride 氯化物	< 40 g/m³	< 5 g/m³	< 100 g/m³
sulphate 硫酸盐	< 100 g/m	< 5 g/m³	< 200 g/m³
ammonium 铵盐	< 2 g/m³	< 2 g/m³	< 2 g/m³
copper ions 铜离子	< 0,05 g/m³	< 0,05 g/m³	< 0,05 g/m³
appearance, colour 外观，颜色	clear, colourless and suspended particle free 透明，无色，无悬浮颗粒		–
smell 味道	neutral 中性		

thermofin® recommends to analyse the water characteristic values on site by a specialist company already in planning stage and to provide a suitable water treatment system. / thermofin® 建议已在设计阶段由专业公司在现场分析水的特性值，并提供合适的水处理系统。

* binding maximum values will be defined project-related by thermofin®
* 结合最大值将由thermofin®视具体项目而定

混合冷凝器参考实例

Reference hybrid condensers

Quelle Bilder: JCI / SSP KÄLTEPLANER AG

As a leading manufacturer of the Swiss food industry with nearly 1,000 employees, a company in Bischofszell has specialised its production on food, beverage and convenience products for the wholesale and retail sector.

For the different production steps, varied temperature levels both for the cooling and the deep freezing areas must be provided. Three existing cooling systems were replaced during operation by one central system operated with the natural refrigerant ammonia. The entire energy demand could be reduced by 50 %. With this new concept, the operating company invests sustainably in the future and takes many advantages. As an example, the system can be operated efficiently, also in partial load and service works can be effected on one central place.

Additionally to numerous evaporators, thermofin® also delivered in 2018 three hybrid condensers of the series THACD with an overall capacity of 7,500 kW (2,500 kW each) for heat dissipation.

作为瑞士食品工业的领先制造商，拥有近1,000名员工，位于比绍夫斯采尔的该公司专门从事食品，饮料和便民产品的批发和零售生产。

对于不同的生产步骤，必须为冷却区域和深度冷冻区域提供不同的环境温度。在运行过程中，三个现有的冷却系统被一个使用天然制冷剂氨运行的中央系统所取代。整个能源需求可以减少50%。有了这个新系统，该公司将在未来进行更多可持续投资并获得许多优势。例如，该系统可以以最高效率运行，也可以部分负载并且在一个中央位置进行维修工作。

除众多蒸发器外，thermofin®还于2018年交付了THACD系列的三台混合冷凝器，总散热量为7,500 kW（每台2500kW）。

PERFORMANCE DATA:

total condensator capacity:	7,500 kW
condensator capacity per unit:	2,500 kW
set value of condensation:	33 °C
wet bulb temperature:	22 °C

性能数据：

冷凝器总容量:	7,500 kW
单台冷凝器容量:	2,500 kW
冷凝温度设定:	33 °C
湿球温度:	22 °C

混合干式冷却器实例

Reference hybrid dry coolers

With more than 10,000 employees, TÜV Nord Group is one of the largest technical service companies in the world. The processing and storage of large amounts of data requires an ultramodern, safe and perfectly functioning technical equipment. In order to meet these continuously growing requirements, the location Hannover was modernised according to the latest technology and the safety standards ISO / IEC 27001 and 20000. The new data center inaugurated in 2014 comprises the entire IT area of all 270 locations of the company and provides space for the central computer technology of other companies.

For the first and second construction phase, thermofin® delivered three hybrid dy coolers of the series THDD with an overall dry cooling capacity of 2,100 kW. Since there is a pure residential area In the north of the building plan area, special sound emission data had to be respected. For pure residential areas, a maximum value of 50 dB(A) for day mode and 35 dB(A) for night mode are defined. The control of both modes (day / night) is made by the integrated thermofin® control system (TCS).

TÜV诺德集团拥有10,000多名员工，是全球最大的技术服务公司之一。处理和存储大量数据需要超现代，安全和功能完善的技术设备。为了满足这些不断增长的需求，汉诺威根据最新技术和安全标准ISO / IEC 27001和20000对地点进行了现代化改造。2014年启用的新数据中心包括公司所有270个地点的整个IT区域，以及为其他公司的中央计算机技术提供了空间。

在第一和第二施工阶段，thermofin®提供了三台THDD系列混合式干式冷却器，容量为2,100 kW。由于在建筑计划区域的北部有一个纯居民区，因此必须遵守特殊的声音发射数据。对于纯居民区，白天模式的最大值定义为50 dB（A），夜间模式的最大值定义为35 dB（A）。两种模式（白天/夜晚）均由集成的thermofin®控制系统（TCS）进行控制。

性能数据：

total cooling capacity:	2,100 kW
cooling capacity per unit:	700 kW
set value of free cooling:	8 °C
set value of machine cooling:	22 °C

性能数据：

冷凝器总容量:	2,100 kW
单台冷凝器容量:	700 kW
冷凝温度设定:	8 °C
湿球温度:	22 °C

运行

Design

heat exchanger coils

The fins are made of pure aluminum and arranged in packages. For the protection against corrosion and other environmental influences, the fins and the tubes are provided with a cathodic dip-paint coating. Thanks to the V-shaped arrangement of the heat exchanger coils, the units require a comparatively small installation surface though being characterised by a high nominal power.

热交换器盘管

翅片由纯铝制成，并以整包形式排列。为了防止腐蚀和其他环境影响，散热片和管子均配有阴极浸漆涂层。由于热交换器盘管的V形布置，在具有较高的标称功率的同时，这些单元所需的安装表面相对较小。

fans

The fan unit is adapted to the required design conditions, assembled of individual components and completed in-house. The fans have a diameter between Ø 800 and Ø 2000 mm and are equipped with a protective grid. The fan blades are optimally adapted to volume flow, pressure drop and to specified sound values. They are driven by norm motors with different number of pole pairs or EC motors. Frequency converters integrated into the control system regulate the speed of the fans for the optimum adaption to the cooling capacity. Maintenance-intensive V-belt drives are not use. The fan nozzles have of a corrosion-resistant design.

风机

风机单元适应所需的设计条件，由单个组件组装并在工厂内组装完成。风扇的直径在Ø800到Ø2000 mm之间，并配有保护网。风扇叶片最适合体积流量，压降和指定的声音值。它们由具有不同极对数的标准电动机或EC电动机驱动。集成到控制系统中的变频器可以调节风扇的速度，以最佳地适应冷却能力。无需要大量维护的三角皮带驱动器。风扇喷嘴具有耐腐蚀设计。

unit design

The constructive design and material selection achieve a high recognition value and give the unit outstanding characteristics for applications in industrial areas.

设备设计

结构设计和材料选择具有很高的辨识价值，并且在工业领域的应用提供了出色的特性。

water circuit

For the efficient performance increase of the hybrid cooler, the finned surface of the heat exchanger coils is moistened with treated water.

水回路

为了有效地提高混合冷却器的性能，在热交换器盘管的翅片表面上浸润处理过的水。

accessories

- temperature sensor with immersion sleeve for dry coolers
- pressure sensor for condensers
- main water and draining valves with servomotor for fresh water supply line
- particle filtration grid to reduce the entry of dirt in the heat exchanger and the moistening water system
- UV sterilisation for the reduction of the biological growth in the circulation water tray
- winter package:
  - jalousie dampers/shutter gates for the reduction of the free convection and with it the decrease of the post heating in case of non-frost-resistant units
  - defrost heater in cooling circuit
  - thermal insulation of the external tubes to reduce thermal losses

配件

- 带浸入式套筒的温度传感器，用于干式冷凝器
- 冷凝器压力传感器
- 用于水供应管线，带伺服电机的主给水和排水阀
- 颗粒物过滤网减少了灰尘进入热交换器和加湿水系统
- 紫外线杀菌，以减少循环水盘中的生物生长
- 冬季安装包：
  - 百叶窗风门/百叶窗，以减少自由对流，并减少非防冻装置的后加热热量需求
  - 冷却回路中的除霜加热器
  - 外管保温以减少热损失

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