EVAPORATIVE CONDENSER

蒸发式冷凝器

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1. Evaporative Condenser Introduction 蒸发式冷凝器介绍

Introduction

An evaporative condenser is a high-performance heat exchange unit that integrates efficient condensation with significant water and energy savings. By ingeniously combining the latent heat of water evaporation with forced air convection, it achieves far superior heat transfer efficiency compared to traditional air-cooled or water-cooled condensers.

The core working principle is as follows: high-temperature, high-pressure refrigerant vapor from the refrigeration system enters the coil circuit. Simultaneously, a recirculating water pump sprays water evenly over the external surface of the coil, creating a thin film. An axial fan then draws air upwards through the unit, causing it to pass at high velocity over the wet coil surface. During this process, a portion of the water evaporates instantly, absorbing a vast amount of latent heat of vaporization, which efficiently removes heat from the refrigerant inside the coils, causing it to condense rapidly into a liquid. The unevaporated water falls back into the bottom sump for reuse.

This synergistic effect of "sensible heat transfer" and "latent heat transfer" allows its condensing temperature to approach the ambient **wet-bulb temperature**. Compared to air-cooled condensers that rely on the higher **dry-bulb temperature**, the system's condensing pressure can be significantly reduced, leading to a notable decrease in compressor power consumption and achieving energy efficiency improvements often exceeding 20%. Furthermore, as it primarily relies on water evaporation for heat dissipation, its water consumption is only 5-10% of that required by a traditional cooling tower combined with a shell-and-tube condenser system. This makes it particularly suitable for regions with water scarcity or high water costs.

Additionally, evaporative condensers feature a compact structure, a small footprint, and flexible installation options. They are widely used in numerous industrial fields such as refrigeration, chemical processing, pharmaceuticals, food processing, and power generation, standing as an ideal choice for upgrading industrial cooling systems towards higher efficiency, environmental friendliness, and energy conservation.

介绍

蒸发式冷凝器是一种集高效冷凝、节水节能于一身的高性能换热设备。它巧妙地将水的蒸发潜热与空气的强制对流相结合，实现了远超传统风冷或水冷式冷凝器的换热效率。

其核心工作原理是：制冷系统产生的高温高压制冷剂蒸汽进入盘管，与此同时，循环水泵将水均匀喷淋在盘管外表面，形成一层水膜；轴流风机则从下往上强制吸入空气，使空气高速掠过湿热的盘管表面。在此过程中，一部分水迅速蒸发，吸收大量汽化潜热，从而高效地将盘管内制冷剂的热量带走，使其迅速冷凝成液体。未蒸发的水回落至底部水箱，循环使用。

这种“显热交换”与“潜热交换”的协同作用，使其冷凝温度能够逼近环境的**湿球温度**，相较于依赖**干球温度**的风冷，系统冷凝压力可大幅降低，从而显著降低压缩机功耗，实现高达 20%以上的能效提升。同时，因其主要依靠水分蒸发散热，其耗水量仅为传统冷却塔+壳管式冷凝器系统的 5%-10，特别适用于水资源匮乏或水成本高昂的地区。

此外，蒸发式冷凝器结构紧凑，占地面积小，安装灵活，广泛应用于制冷、化工、制药、食品加工及电力等多个工业领域，是推动工业冷却系统向高效、环保、节能方向升级的理想选择

2. Evaporative Condenser Application

➢ Metallurgical Industry

The evaporative condenser can be used in the soft water cooling and sealing cycle of the iron-making blast furnace; the cooling water of the steel-making heating furnace, crystallizer, and oxygen lance; the cooling water system of steel rolling and coking; Cooling water of blower, motor and other equipment

蒸发式冷凝器可用于炼铁高炉的软水冷却和密封循环；炼钢加热炉、结晶器和氧枪的冷却水；轧钢焦化冷却水系统；鼓风机、电机等设备的冷却水

➢ Power industry

Evaporative condenser is mainly used in the power industry as an auxiliary cooling system for the main air cooling system, for condensing exhaust steam from small steam turbines and replacing or retrofitting traditional water cooling systems.

蒸发式冷凝器在电力行业主要应用主空冷系统的辅助降温，用于小汽轮机乏汽冷凝以及替代或改造传统水冷系统。

➢ Chemical industry

Evaporative condensers are mainly used in the chemical industry for condensation in distillation and distillation systems, cooling and condensation in reaction vessels, condensation in vacuum systems, cooling and condensation of process gases, and recovery of steam condensate water.

蒸发式冷凝器在化工行业主要应用于蒸馏与精馏系统的冷凝，反应釜的冷却与冷凝，真空系统的冷凝，工艺气体的冷却与冷凝和蒸汽冷凝水的回收

➢ Coal chemical industry

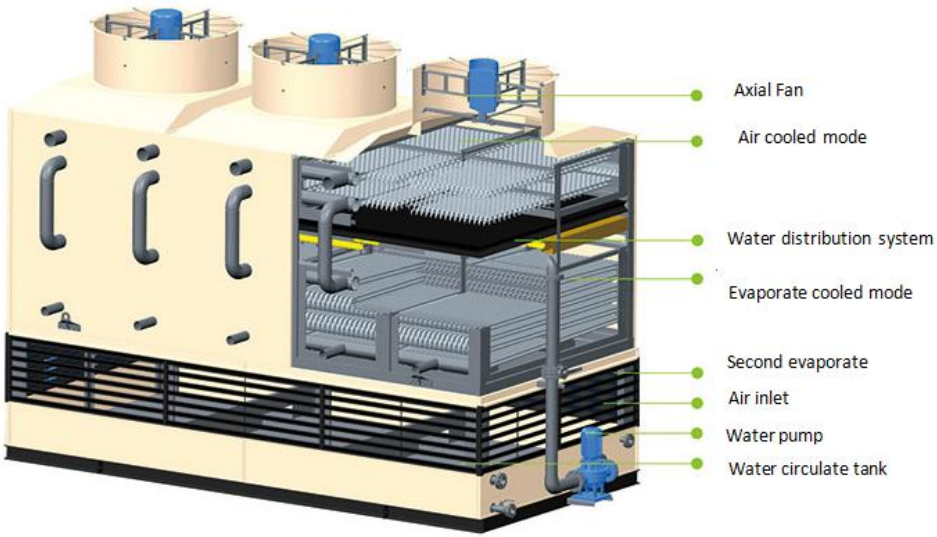
Evaporative condensers are used in the coal chemical industry for methanol production, such as cooling and condensation in methanol distillation, synthesis, and compression sections, and cooling in synthetic ammonia production, such as compression and synthesis sections; Condensation in ammonia synthesis systems, cooling condensation in urea production and downstream chemical product production processes such as dimethyl ether, olefins, etc

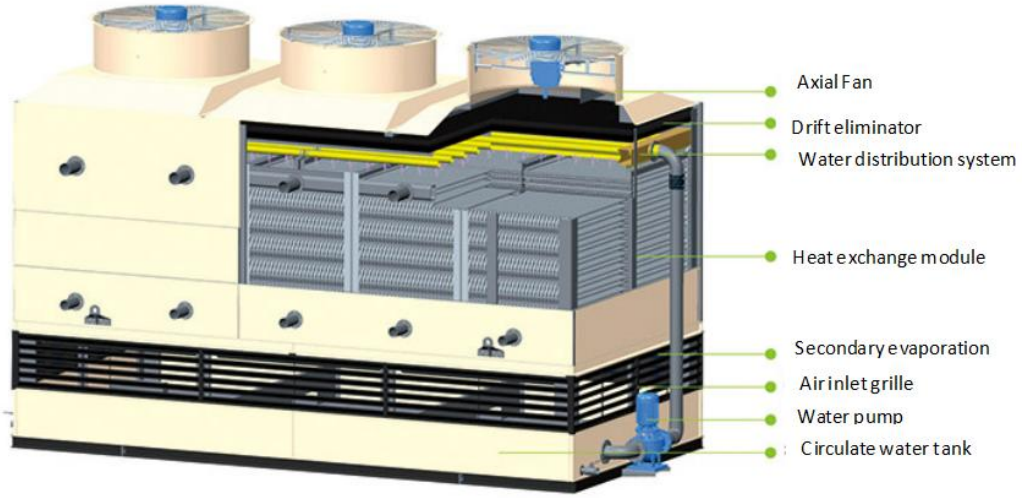
蒸发式冷凝器在煤化工行业应用于甲醇生产，如甲醇精馏工段、合成工段、压缩工段的冷却与冷凝，合成氨生产，如合成氨压缩段、合成段的冷却；氨合成系统的冷凝，尿素生产和下游化工产品生产如二甲醚、烯烃等产品生产过程中的冷却冷凝.

3. Evapotative Condenser Features 特点

Compared with traditional air cooled, open cooling system, the evaporative condensers have the advantaged of water-saving, electricity-saving,small area and easy maintain.

与传统的风冷、开式冷却系统相比，蒸发式冷凝器具有节水、节电、占地面积小、易于维护等优点。





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4. Evaporative condenser type 蒸发式冷凝器的类型

4.1 Header type evaporative condenser 管箱式蒸发式冷凝器

Header type evaporative condenser includes plug header-box type evaporative condenser and remove-cover plate evaporative condenser

管箱式蒸发式冷凝器包括**丝堵管箱式蒸发式冷凝器**和**可拆盖板式蒸发式冷凝器**

Advantages 优点:

(1).Without fill, long service life.

(2).Straight pipe is plugged and sealed, easy to check for leaks and low maintenance cost.

(3).The tube bundle is evenly arranged, wind efficiency is higher than that of the serpentine coil.

1.无需填料，使用寿命长。

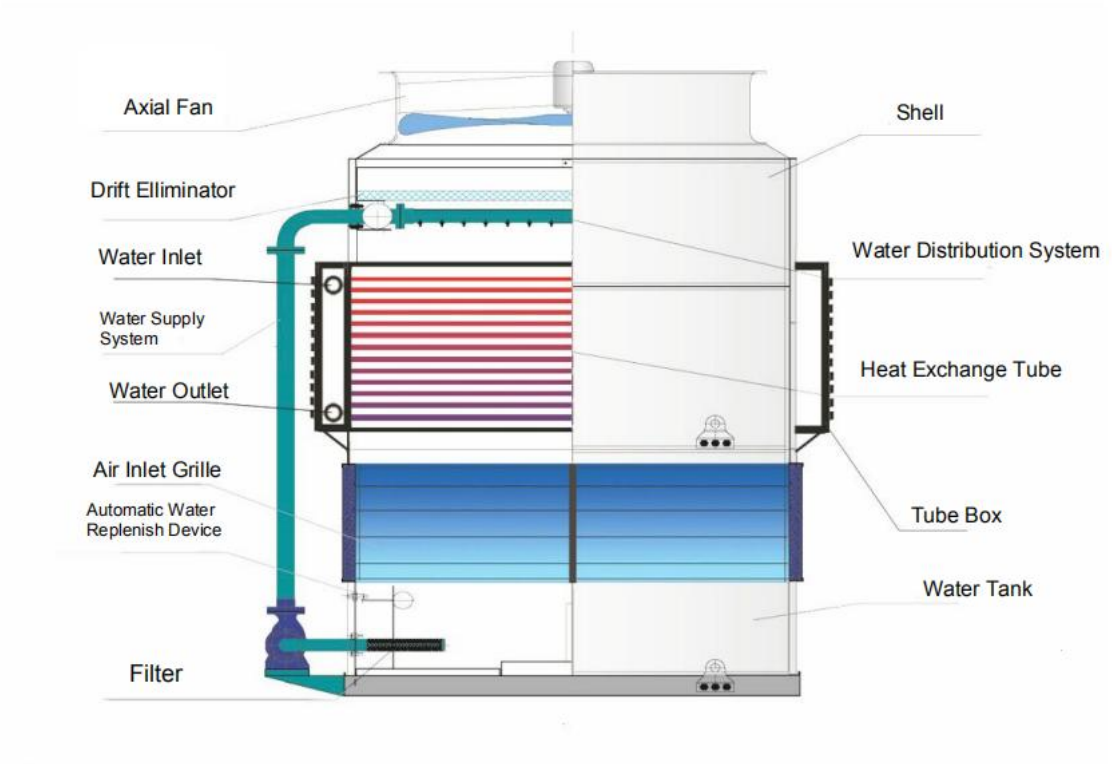
2.该直管段采用封闭式封堵，不仅便于检漏，而且维护成本低廉

3.管束排列均匀，风效高于蛇形盘管。

Disadvantage 缺点:

(1).The price is a little high.

(1)价格较高

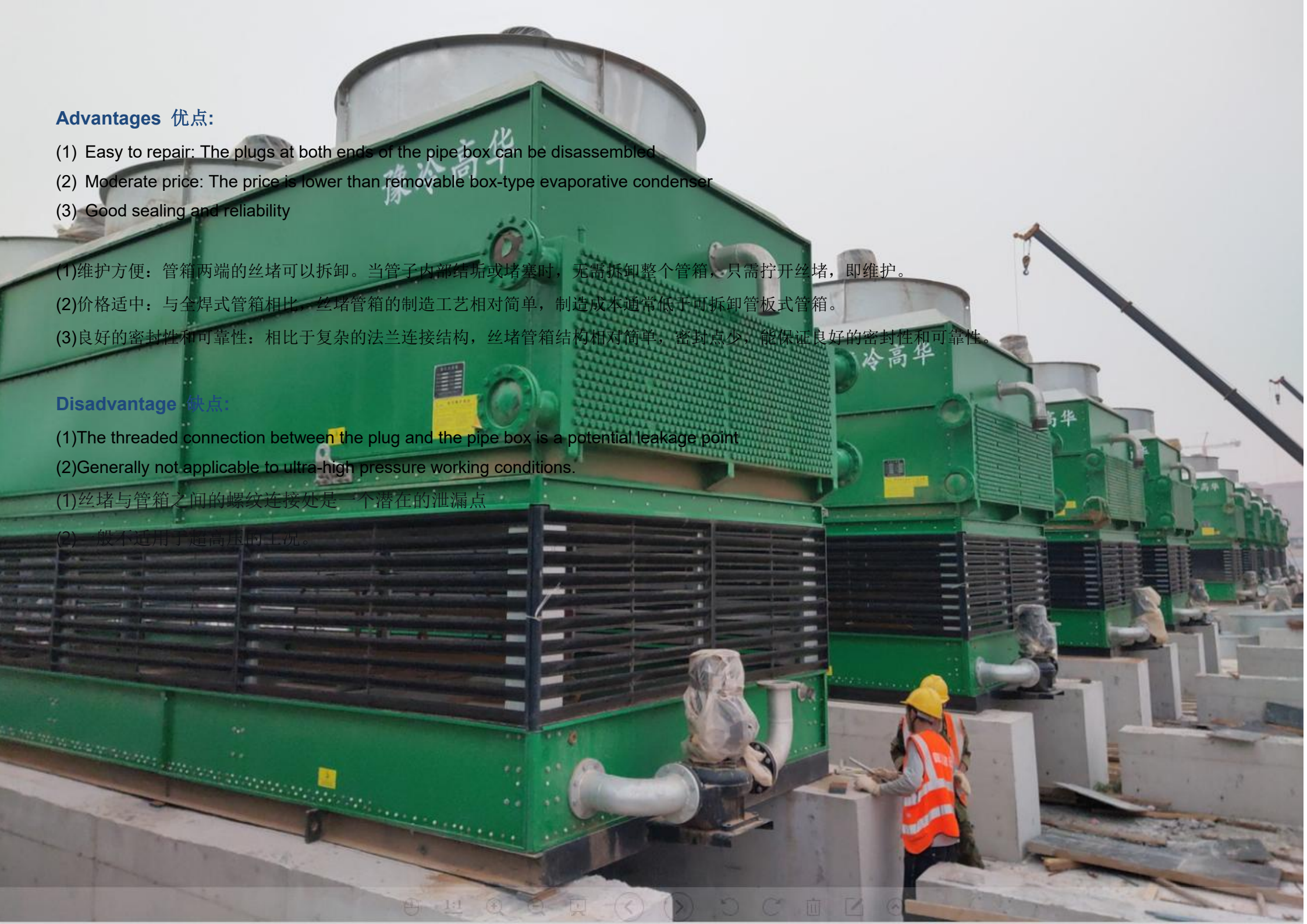


➢ Plug Header Box-Type Evaporative Condenser

丝堵管箱式蒸发式冷凝器

➢ Remove-Cover Plate Evaporative Condenser

可拆盖板式蒸发式冷凝器



Advantages 优点:

(1) Easy to repair: The plugs at both ends of the pipe box can be disassembled

(2) Moderate price: The price is lower than removable box-type evaporative condenser

(3) Good sealing and reliability

(1)维护方便：管箱两端的丝堵可以拆卸。当管子内部结垢或堵塞时，无需拆卸整个管箱，只需拧开丝堵，即维护。

(2)价格适中：与全焊式管箱相比，丝堵管箱的制造工艺相对简单，制造成本通常低于可拆卸管板式管箱。

(3)良好的密封性和可靠性：相比于复杂的法兰连接结构，丝堵管箱结构相对简单，密封点少，能保证良好的密封性和可靠性。

Disadvantage 缺点:

(1)The threaded connection between the plug and the pipe box is a potential leakage point

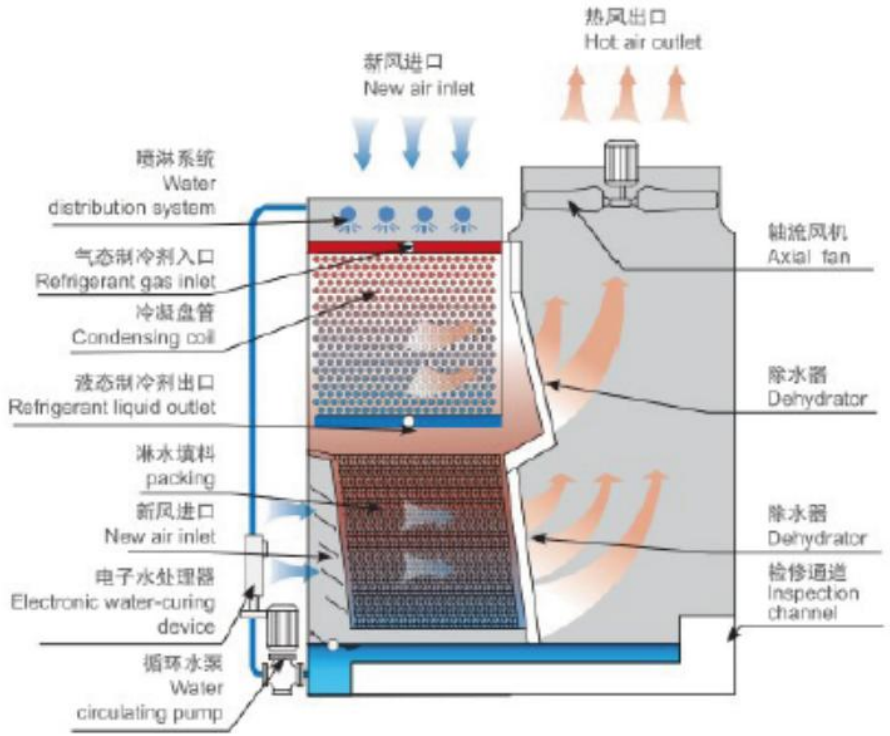
(2)Generally not applicable to ultra-high pressure working conditions.

(1)丝堵与管箱之间的螺纹连接处是一个潜在的泄漏点

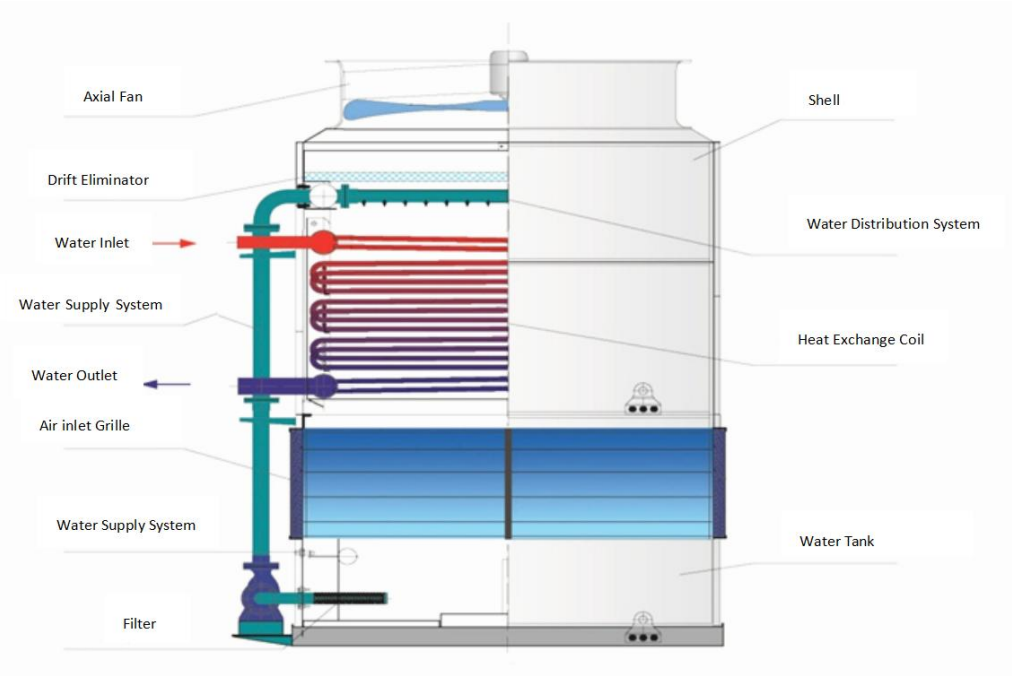
(2) 一般不适用于超高压的工况。

4.2 Coil type evaporative condenser 盘管式蒸发式冷凝器

Coil type evaporative condensers are divided into **Coil Type Cross flow evaporative condenser** and **Coil Type Counter flow type evaporative condenser**
盘管式蒸发式冷凝器分为**顺流式盘管蒸发式冷凝器**和**逆流式盘管蒸发式冷凝器**



顺流式盘管蒸发式冷凝器



逆流式盘管蒸发式冷凝器

➢ Coil type cross flow evaporative condenser

Advantages 优点

1.Using PVC fill to replace part of heat exchange coil, heat transfer efficiency is higher than counter type

2. Light weight, small initial investment

1. 使用 PVC 填充物代替部分换热盘管，传热效率高于逆流式

2. 重量轻，前期投资小

Disadvantage 缺点

1. Fill is prone to blockage and need to be cleaned each 2 years, replaced 3~5 years.

2. Large installation area

1.填料容易堵塞，需要每 2 年清洗一次，3~5 年更换一次。

Coil type cross flow evaporative condenser

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➢ Coil type counter flow evaporative condenser

Advantages 优点

(1).Without fill, long service life.

(2). Cheaper than box type evaporative

(3). Fully welded and sealed, not easy to leak

1.无需填充，使用寿命长。

2.比箱式蒸发式更便宜

3.全焊接密封，不易泄漏

Disadvantage 缺点

(1).Hard to find leak point and maintain when leaking due to fully welded.

(2).The serpentine tube structure has large wind resistance.

(3).Many takeovers and complicated pipelines

(1). 全焊接结构导致泄漏时难以定位和维护。

(2). 蛇形管结构风阻较大。

(3). 接管众多，管道布局复杂。

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