



## Application Note AN-PAN-1040

# 火力发电厂冷却水中的氨

Thermal power plants require enormous amounts of water, using high purity steam at high pressure to rotate turbines. A separate cooling water circuit is implemented, helping to form a vacuum when the steam condenses after the turbines. Maintaining this vacuum with optimal condensation parameters is critical for the power plant efficiency.

The copper condensers are susceptible to corrosion by ammonia ( $\text{NH}_3$ ). Small cracks in the condenser combined with the large pressure differential between the steam circuit and the

cooling water circuit will contaminate the high purity water in the boiler, causing major problems and necessitating a shutdown for plant maintenance. Monitoring  $\text{NH}_3$  online in cooling water with a process analyzer can signal early problems in a plant before significant intermediation is necessary.

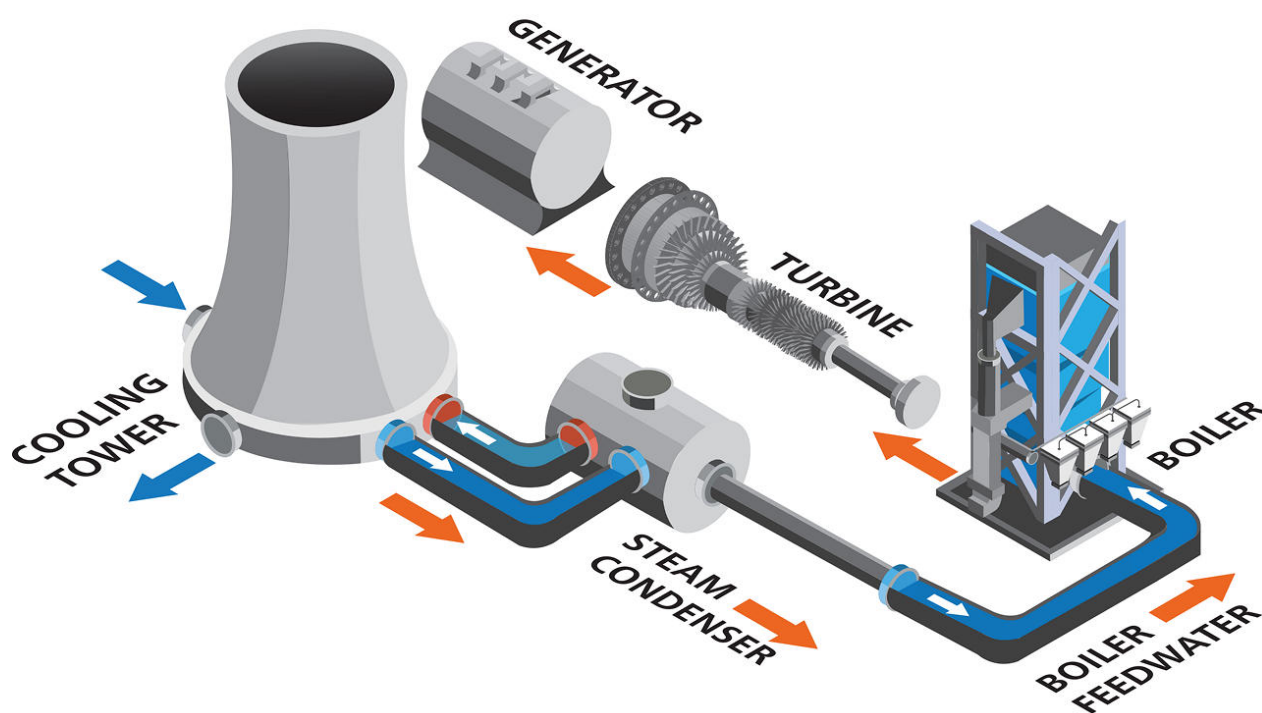
This Process Application Note presents a way to closely monitor the  $\text{NH}_3$  concentration in cooling water of power plants to ensure protection of expensive company assets (e.g. pipes, boiler, and more) and helps to safeguard plant operations.

## INTRODUCTION

Thermal power plants require enormous amounts of water to convert energy from generated heat to electricity, using high purity steam at high pressure to rotate turbines. The steam loses energy and condenses, forming a vacuum after the turbines, and the re-condensed vapor is sent back to the boiler for reuse. Maintaining this vacuum with optimal condensation parameters is critical for the power plant efficiency.

Cooling water is used in a separate water circuit to exchange heat from the condenser to the ambient surroundings. Water sources for cooling can range from seawater, lakes, and rivers, to re-treated municipal wastewater (MWW). The cooling water circuit, discussed in other Metrohm Process Application Notes ([AN-PAN-](#)

[1013](#), [AN-PAN-1038](#)), is classified as either once-through or recirculating (dry cooling is not discussed here). The growing number of environmental guidelines and thermal discharge limits has forced many plants to use closed recirculating cooling water circuits, reducing the cooling water needs by about 95% compared to once-through cooling systems. The heat from the condenser can dissipate in a number of manners, most commonly by an evaporative cooling tower (**Figure 1**). Only small amounts of makeup water are required to replace evaporative, drift, and blowdown losses in recirculating cooling water circuits. The cooling water chemistry is primarily maintained to inhibit scale formation and microbial growth (fouling) as well as control corrosion.

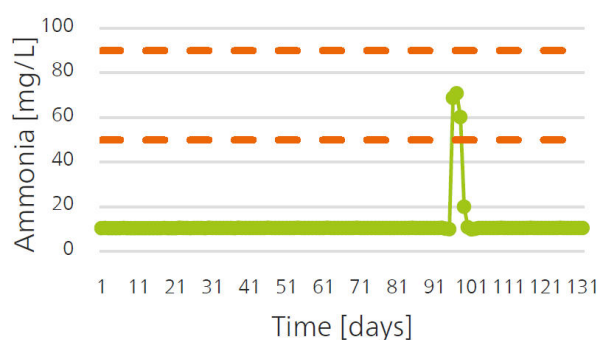


**Figure 1.** Example schematic of a wet recirculating cooling water system for a thermal power plant.

Copper (Cu) alloys are now used almost exclusively in condensers of the water-steam circuit. The drawback is the susceptibility of copper and its alloys to **corrosion** by  $\text{NH}_3$ . Ammonia is also nutritional for microbes, which cause **biological fouling**. Ammonia stripping towers can be implemented on site to remove a significant percentage of  $\text{NH}_3$  via water-to-air stripping, otherwise water treatment is necessary. The cooling tower itself can strip the volatile  $\text{NH}_3$  at optimal pH levels. According to the Electric Power Research Institute (EPRI), in systems with copper alloys an upper limit of 2

Corrosion of Cu and its alloys can be inhibited by adding **triazoles** to form sparingly soluble compounds on the surface of the metal. Routine system chlorination against biological fouling will reduce ammonia levels somewhat as chloramines are formed. Corrosion products and other impurities can be removed by chemical cleaning. However, it is clear that ammonia is detrimental to the cooling water circuit and must be treated or otherwise removed before Cu corrosion can occur. **Metrohm Process Analytics** offers multiple online process analyzers which can measure  $\text{NH}_3$  in cooling water of power plants, alerting the Chemical Distribution System (CDS) to add more corrosion inhibitors, chlorine, or other treatment chemicals to the circuit before extreme damage can occur.

$\text{mg/L NH}_3$  must be adhered to in order to prevent severe corrosion. The result is increased Cu concentration in effluents or other discharges, which is of environmental concern. Corrosion can also cause leaks and catastrophic failure in the piping. Small leaks and cracks combined with the large pressure differential between the steam circuit and the cooling water circuit will contaminate the high purity water in the boiler, causing major problems and necessitating a shutdown for plant maintenance.



**Figure 2.** Trend chart of ammonia ( $\text{NH}_3$ ) showing a spike in concentration over a period of 130 days, which could lead to possible corrosion. The dashed lines are control measure guides, which can be changed depending on your process requirements.

## APPLICATION

Online monitoring of the ammonia content is possible with either the **2060 Process Analyzer** or with the **2026 Titrolyzer** from Metrohm Process Analytics (**Figure 3**). An ammonia ion-selective electrode ( $\text{NH}_3$ -ISE) is used in this application for quick, simple, and accurate online analysis of  $\text{NH}_3$  concentrations in cooling water. After sampling, a Total Ionic Strength Adjustment Buffer (TISAB) solution is added to adjust the pH to 11 or higher, and the  $\text{NH}_3$  concentration in the sample is determined using the dynamic standard addition method.

**Typical range** 0–100 mg/L  $\text{NH}_3$



**Figure 3.** Some of the Metrohm Process Analytics analyzers capable of determining the ammonia concentration online. Left: 2060 Process Analyzer, right: 2026 Titrolyzer.

## REMARKS

Lower concentrations of ammonia can be analyzed online with **colorimetric or ion chromatographic methods**, also available from Metrohm Process Analytics. Other online applications are available for the energy and power industry such as: silica in boiler feed water, calcium and sulfate in the flue-gas

desulfurization process, boric acid in cooling water Pressurized Water Reactors (PWRs), ultratrace measurements of iron (Fe) and Cu, rich/lean amine concentration and  $\text{CO}_2$  captured in Carbon Capture Plants, and many more.

## FURTHER READING

[Monitoring corrosion in power plants: online ultratrace analysis of Fe and Cu](#)

[2026 Ammonia Analyzer](#)

[Power generation: Analysis of the m value](#)

[\(Alkalinity\) in cooling water](#)

[Online monitoring of sodium in industrial power plants](#)

## BENEFITS FOR TITRATION IN PROCESS

- **Safe working environment** and automated sampling
- **Protect valuable company assets** (e.g. pipes, PWR, and turbines, which are prone to corrosion)
- **Save money** by reducing downtime: analyzer sends alarms for out-of-specification values which inform the operator sooner



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## CONFIGURATION



### 2026 Titrolyzer

2026 Titrolyzer 通过高精度滴定管系统和高性能电极进行电位滴定。不同滴定类型,包括酸/碱、氧化还原和沉淀滴定。自寻式拐点技术可用于大多数应用。在一些内联传感器不奏效的情况下也可以使用分析仪测量 pH 值。

此外, 2026 Titrolyzer 可通过高精度滴定管和高性能离子选择性电极来执行动态标准加入法。该方法采用动态差分法将标准加入量与实际样品浓度相适应。此外还请注意 ISE 斜率值涉及到多个范围。这意味着 ISE 离子选择性电极可用于较低或较高的测量范围。伴随的温度测量消除了温度对分析结果的可能影响。

有几个市场与 2026 TITROLYZER 很是契合:如化工,石化,半导体,环境,采矿,钢铁/金属和饮用水。

选定的应用包括:

- 酸性或碱性溶液
- 氯化物
- 过氧化氢
- 硬度
- 氰化物
- 铜
- 氟化氢
- pH
- 等等



## 2060 Process Analyzer

2060 Process Analyzer 是一种在线湿化学分析仪,适用于无数应用。此过程分析仪提供了一个新的模块化概念,由一个称为«主机柜»的中心平台组成。

主机柜由两部分组成。上部包含触摸屏和工业计算机。下部含有柔性取样部,其中放有用于实际分析的硬件。如果主取样部容量不足以应对分析挑战,那么主机柜可以扩展为多达四个额外的取样部机柜,以确保有足够的空间来应对具挑战性的应用。附加机柜的配置方式使每个取样部机柜可以与具有集成(非接触式)液位检测的试剂柜组合使用,以增加分析仪的正常运行时间。

2060 Process Analyzer 提供不同的湿化学技术:滴定法、卡尔费舍尔滴定法、光度测定、直接测量和标准添加法。

为满足所有项目要求(或满足您的所有需求),可提供样品预处理系统,以确保分析解决方案可靠。我们可以提供任何样品预处理系统,如冷却或加热、减压和脱气、过滤等。