



Application Note AN-PAN-1038

火电厂冷却水的碱度(m 值)

One way to maximize heat transfer efficiency and reduce costs in a power plant is by controlling the water chemistry in the cooling circuit. This cooling water is kept alkaline to maintain the protective oxide layer on the metal piping throughout the water circuit. However, alkalinity above the recommended range increases the probability of scale formation (deposition), so it is buffered with carbonate (CO_3^{2-}) and bicarbonate ions (HCO_3^-). Titration of the cooling water to pH 4.5 gives the so-called «m-alkalinity» (methyl orange alkalinity), a measure of total alkalinity. Below this pH, there

is no more alkalinity present, only free acid (H^+), carbonic acid (H_2CO_3), and CO_2 .

This Process Application Note details the online analysis of alkalinity in cooling water. This method offers results in less than 30 minutes, meaning faster response times for out of specification readings. In combination with the power plant's Distributed Control System (DCS), online monitoring of this parameter using a process analyzer ensures that corrosion can be controlled before it affects the power plant efficiency, ultimately decreasing downtime and lowering maintenance costs.

INTRODUCTION

One way to maximize heat transfer efficiency and reduce costs in a power plant is by controlling the water chemistry in the cooling circuit (**Figure 1**). Cooling water is used to condense the exhaust steam from the turbine to water, which is then sent back to the water-steam circuit as feed water. The heat of condensation (energy) from the steam is transferred to this cooling water as it flows through kilometers of (titanium) piping in the condenser. The water chemistry depends on the type of power plant, cooling circuit design, and construction materials. Every cooling circuit has a unique design and its own analytical requirements.

The cooling water temperature is reduced either by once-through cooling, in which the water is taken from the environment and returned at a slightly higher temperature, or in a circuit in a cooling tower. Water requirements for once-through cooling circuits are much more demanding because of the large volumes needed for continuous cooling. Oxygen (among other impurities) is also prevalent in the water taken from rivers and lakes, leading to corrosion in the pipelines if not removed adequately. Continuous circulation of the cooling water increases the concentration of contaminants in the circuit but uses much less water.

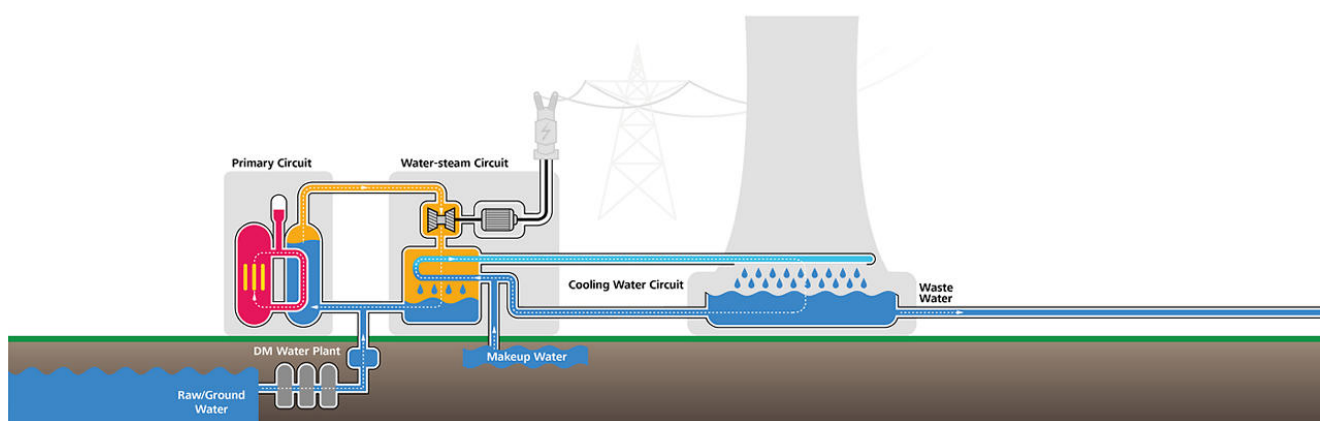


Figure 1. Schematic diagram of a thermal power plant. The cooling circuit (right) is an important attribute in two- and three-cycle power plants.

Cooling water is kept alkaline to maintain the protective oxide layer on the metal piping throughout the water circuit. Acidic water will dissolve the protective oxide layer and the metal surface. However, alkalinity above the recommended range increases the probability of scale formation (deposition). The water is therefore buffered against further pH changes with carbonate (CO_3^{2-}) and bicarbonate ions (HCO_3^-) (**Reaction 1**).

Traditionally, the water can be analyzed by laboratory titration. However, this methodology does not provide timely results and requires human intervention to implement the laboratory analysis results to the process. Online process analysis allows constant monitoring of water quality without long waiting times in the laboratory, giving more accurate and representative results directly to the control room.

Optimal water chemistry begins with an online analyzer such as the 2026 Titrolyzer from Metrohm Process Analytics. Save time and increase efficiency without manually sampling process points. Online analysis helps protect against corrosion and fouling in the cooling water circuit, allowing more uptime and

reducing maintenance costs. Titration to pH 4.5 indicated by a pH electrode gives the so-called «m-alkalinity» (methyl orange alkalinity), also a measure of total alkalinity. Below a pH of approximately 4.3 there is no more alkalinity present, only free acid (H^+), carbonic acid (H_2CO_3), and CO_2 . Therefore:

$$m - alkalinity = [HCO_3^-] + [CO_3^{2-}] + [OH^-]$$

Reaction 1. Overall reaction of m-alkalinity.

Titration is performed with 0.1 mol/L hydrochloric acid (HCl) to pH 4.5. The endpoint is detected automatically by recording the change of pH/mV signal in relation with the dosed amount of titrant. A suitable pH electrode is used for accurate indication

of this pH/mV change. In addition to the 2026 Titrolyzer, the 2035 Potentiometric, and 2060 TI Process Analyzers (**Figures 2 and 3**) can also monitor alkalinity online, guaranteeing high process efficiency and low operating and energy costs.



Figure 2. 2035 Process Analyzer – Potentiometric.



Figure 3. 2060 TI Process Analyzer from Metrohm Process Analytics.

Table 1. Thermal power plant measurement parameters * Other concentrations below the stated range can be measured by changing the concentration of the reagents.

Parameters	Range
m-alkalinity	0–110 mmol/L *
CaCO ₃	0–1000 mg/L *

CONCLUSION

Metrohm Process Analytics offers a wide range of online process analyzers to monitor power plants around the clock. From single parameter analyzers (e.g., 2026 Titrolyzer) to multiparameter analyzers (e.g., 2035 Process Analyzer – Potentiometric and

the 2060 TI Process Analyzer)—all of these solutions can measure alkalinity, helping to safeguard plant operation and optimize process cooling efficiency.

RELATED APPLICATION NOTES

AN-PAN-1003 Amine (“rich” and “lean”) and free &

total CO₂

BENEFITS FOR TITRATION IN PROCESS

- **Increased longevity** of valuable company assets
- Monitor **multiple sample streams** (up to 10) for more savings per measurement point and results
- **Safer working environment** and automated sampling
- **Fully automated diagnostics** – automatic alarms for when samples are out of specified parameters



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CONFIGURATION



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