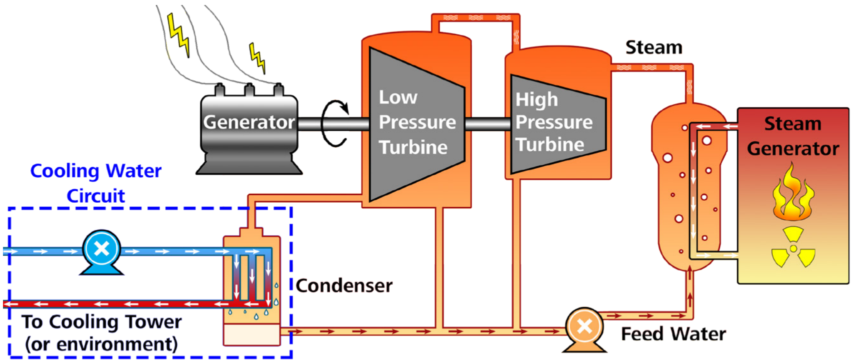
Process Application Note AN-PAN-1038

Power Generation: Analysis of the M-Number (Alkalinity) in cooling water

One way to maximize heat transfer efficiency and reduce costs in a power plant is by controlling the water chemistry in the cooling circuit. 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.



Schematic diagram of a thermal power plant. The cooling circuit (left) 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^-).

Optimal water chemistry begins with an online analyzer such as the Titrolyzer ADI2016 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 = $[HCO_3^-] + [CO_3^{2-}] + [OH^-]$.

Application: Titration is performed with 0.1M 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 as indication of this pH/mV change.

Typical Range: 1–10 mmol/L M-Alkalinity or 0–1000 mg/L $CaCO_3$

Keywords: M Alkalinity, PM Number, buffer capacity, carbonate, power plant, 2016, 2035, 2045TI
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