Generator Stator Cooling Circulating Water

Alkalinity Adding Device Introduction

(AKL0000)

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CONTENTS

1. General

Pure water, with its high heat capacity, good non-conductivity and easy availability, is widely used as a cooling medium for large-capacity generators. The copper stator coils of turbine generators are cooled by passing water through hollow wires, which is one of the most traditional methods that have been used for a long time. In power plants, the cooling water for the generator comes from the demineralized water or condensate of the plant. This cooling water can achieve a low conductivity, but its PH value can only barely reach about 7, and most of the time it is lower than 7, so that the generator stator copper hollow conductor is always in the area of weak acid corrosion rate is high, and there is a certain degree of erosion of the system. With the gradual increase of generator capacity, especially in 600MW above, due to the stator coil voltage to ground, coil current density increases, we gradually found that the stator coil waterway copper hollow conductor internal scaling phenomenon is also more and more frequent, and the cooling water on the copper wire.

Corrosion is also becoming more visible, especially with poor water quality control.

Thermal power plant generator cooling water system water quality control is related to the unit's operational safety, corrosion will produce precipitates plug generator hollow wire rod, affecting the normal operation of the generator, a phenomenon that has been commonplace in many domestic power plants. Once the stator coil hollow wire of the generator is blocked due to corrosion, it is necessary to stop the machine for dredging, and it also creates a problem.

It has caused great economic losses.

At present, the vast majority of generators in China use copper hollow conductor water cooling, in the face of a large number of generator sets, how to find a solution to the corrosion of cooling water on the copper wire, not only to improve the operating efficiency of generators, and

And it also saves social wealth and contributes to the development of the national economy.

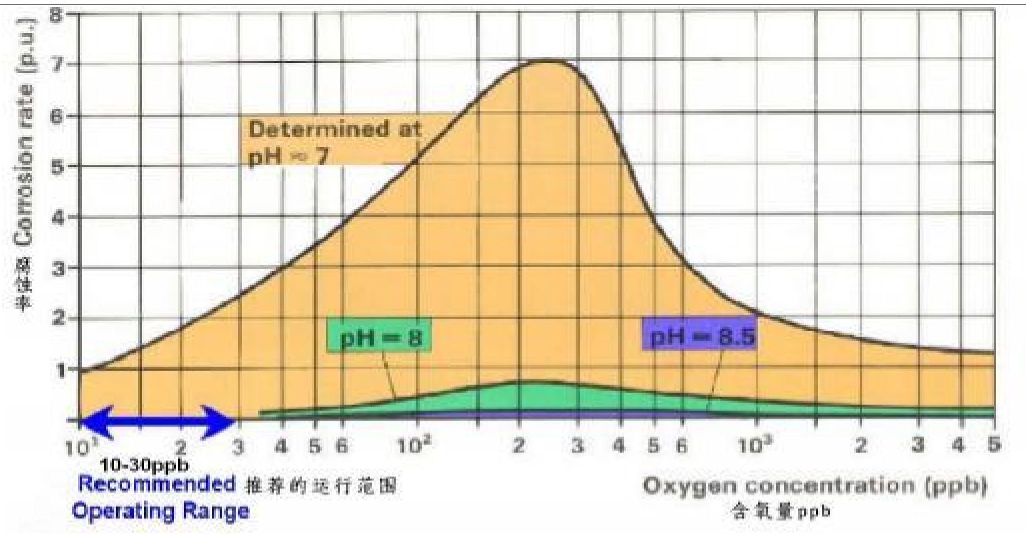
2. Corrosion of copper wires by water quality

At present, despite the use of low oxygen content cooling water in the generator cooling water system, it is not possible to completely eliminate the corrosion of copper wires in the stator water system. Water quality on the corrosion of copper wire also depends on the water quality parameters and different

Similarly, the corrosion relationship of cooling water quality on copper wires can be seen in the attached Figure-1.

According to the literature and tests, PH is the main factor causing corrosion among the water quality parameters. According to the relevant experts research, from the above attached figure-1 can be seen, the water PH value between 7.0 ~ 7.5, the most obvious corrosion of copper wire, and in the PH value increased to 8.5-9.0 region of the alkaline cooling water and oxygen content in the case of 10-30ppb operation, cooling water corrosion of the copper winding can be almost negligible, and the reliability of the generator and the utilization will be greatly improved. At present, large foreign generator manufacturing companies have been gradually in the use of copper wire as a cooling tube in the water system of large generators adopt

Add NaOH to control the PH value of the cooling water, so as to control the corrosion of the cooling water on the copper wire.

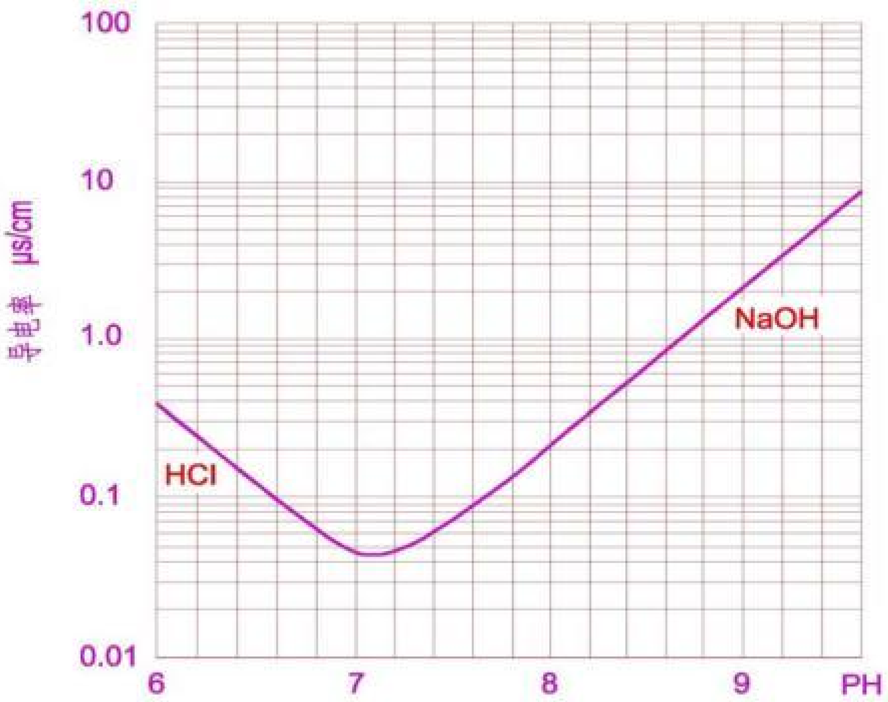


Attachment-1 Relationship between cooling water quality and corrosion of copper wires

3. Relationship between PH and conductivity

The conductivity of stator cooling water is determined by the effect of anions and cations on the conductivity respectively. There is a relationship between the conductivity and the PH value in pure water that meets the following conditions, and this relationship is consistent with the relationship between the conductivity and the PH value in Figure 2.

PH relationship curve.



在18℃水温时导电率和PH的关系

✧ The entire water system is a closed loop system;

✧ The water system tanks are sealed with N_2 to isolate the water from oxygen;

✧ The water system has an ion exchange unit to maximize the removal of impurity metal ions from the water;

In pure water, when the addition of sodium hydroxide is used to control the PH value, there are $Na^+$and Cu^+ in the cooling water,

H^+ and a few other cations at very low levels, as well as anions dominated by OH^-.

The water system has an anion and cation mixed-bed water treatment process, which can effectively remove the ions from the water under normal conditions, and since no Cu+ ions are added to the device, the corrosion rate of the copper pipes of the cooling water pipes is not as fast as it should be.

Thus Cu+ ions are effectively controlled at very low levels in this water system.

In practice, the Cu+ content is so low that its effect on conductivity and pH is negligible.

In addition, a dilute solution of sodium hydroxide is continuously injected into the low-conductivity cooling water, so that the concentrations of Na+ and OH- ions are continuously increased. Since the concentration of OH- ions is increasing, it effectively inhibits water

Ionization makes the ionic concentration of $^{H+}$ much smaller than the OH- ionic concentration.

For these reasons, we can derive the relationship between the conductivity of cooling water and the ion concentration:

K=(∧Na+*[Na+]+∧H+*[H+]+∧Cu+*[Cu+]+∧OH-*[OH-])*10 3

In the above equation ∧Na+ , ∧H+ , ∧Cu+ , ∧OH-are the molar conductivities of each ion, Na+ , H+ , Cu+ , OH- are the molar concentrations of the individual ions.

Since Cu+ ions are negligible and the content of H+ ions is extremely low, the above equation can be simplified as follows.

K=(∧Na+ *[Na+]+∧OH-*[OH-]) *10 3

From the above equation it can be seen that the conductivity of stator cooling water is mainly determined by the concentration of sodium hydroxide.

The control range for cooling water PH is 8.5 to 9.0:

The ion product of water is: $Kw = 1 \times 10^{-14}$

Therefore the concentration range of OH- in water should be:

$[OH^-] = 10^{-5.5} \sim 10^{-5}$ g ions/liter

At a PH value of 8.5:

Conductivity = $[L_{na+} + L_{OH-}] * 10^{-5.5} * 10^3 = [50.11 + 197.6] * 10^{-5.5} * 10^3 =$ 0.783μS/cm

At a PH value of 9.0:

Conductivity = $[L_{na+} + L_{OH-}] * 10^{-5.0} * 10^3 = [50.11 + 197.6] * 10^{-5.0} * 10^3 =$ 2.477μS/cm

The above data and the curves in Figure-2 are in general agreement.

From this we need to point out that only in specific working conditions conductivity and PH there is a certain relationship, once the water system is not in a completely closed and isolated state, due to the oxygen ions in the air will be dissolved in the water, the content of Cu^+ etc. will rise, and its impact on the conductivity and PH value can not be ignored, the stator cooling water of the

Conductivity is also not determined by the concentration of sodium hydroxide anymore.

So why do some generators still have corrosion problems, even though the conductivity has met the operational requirements.

That would explain it.

4. Solutions to reduce copper corrosion

Since the power plants realized that the low PH value of generator cooling water would have a corrosive effect on the copper wires of the generators and some power plants actually encountered the impact of corrosion on the safe operation of the generators, as well as the revision of the national standard GB/T 7064, the power plants have been able to realize the corrosive effect on the copper wires of the generators.

Since the change, the domestic control of generator cooling water quality mainly has the following aspects:

4.1 Adding corrosion inhibitors to water systems

This was an earlier method of control, as it was later found to have major side effects, and long-term use would make water quality worsened, so it is no longer used.

4.2 Water quality control using small mixed-bed technology + intermittent water exchange operation

With this control method, except for the conductivity of stator cooling water which meets the standard requirements, the PH is still low and the concentration of copper ions exceeds the standard. Since the PH value of stator cooling water cannot be improved, there is no fundamental solution to stator wire rod corrosion.

The problem of etching.

4.3 Ultra-purification treatment units for internally cooled water with special types of resins and special construction

This control technology can stabilize the PH value of cooling water between 7.78-7.85, but it is not the same as the present

GB/T 7064 national standard requires the PH value of 8-9 compared to, not yet meet the requirements, just the corrosion of copper wire has

What has been slowed down, there is no fundamental solution to the problem.

4.4 Vacuum methods are used to remove O2 from the make-up water of the chilled water system and ion exchange methods are used to improve the chilled water quality.

The PH value of the water stops the oxygen corrosion of the generator's copper wire rods and ensures that the copper content of the cooling water meets the standard.

This method is to improve water quality from another angle, in addition to the copper content, conductivity to meet the standard, the PH value of the cold water is also in the range of 7.0 ~ 7.3 between the same does not fundamentally solve the problem of copper corrosion, and

And, this method requires a high degree of watertightness of the water system, which is practically more difficult to achieve.

4.5 Alkalization of cooling water systems by direct PH control

This method may seem intuitive, but due to the instability of PH meter detection, the control of alkali addition is often not

Enough stability, followed by the cooling water quality is not stable, the corrosion of copper wire still exists a certain risk.

5. The most fundamental solution to copper corrosion - conductivity-controlled cooling water ultra-purification microprocessing technology

This device uses the addition of NaOH to control cooling in a large generator water system using copper wires as cooling tubes.

The PH value of the water, thus controlling the corrosion of the cooling water on the copper wire.

5.1 Fundamentals

The ultra-purification microprocessor for generator cooling water is based on the relationship between PH value and the corrosion rate of copper wires as shown in Attachment-1, and operates when the PH value is increased to alkaline cooling water in the region of 8.5-9.0 and when the oxygen content is in the range of 10-30ppb.

Cooling water corrosion of copper windings is almost negligible based on the requirements to achieve the PH value, in the ion excha

A sodium hydroxide dosing unit is installed at the outlet of the apparatus to increase the pH value of the effluent. The sodium hydroxide solution is injected through the

The pump performs the dosing.

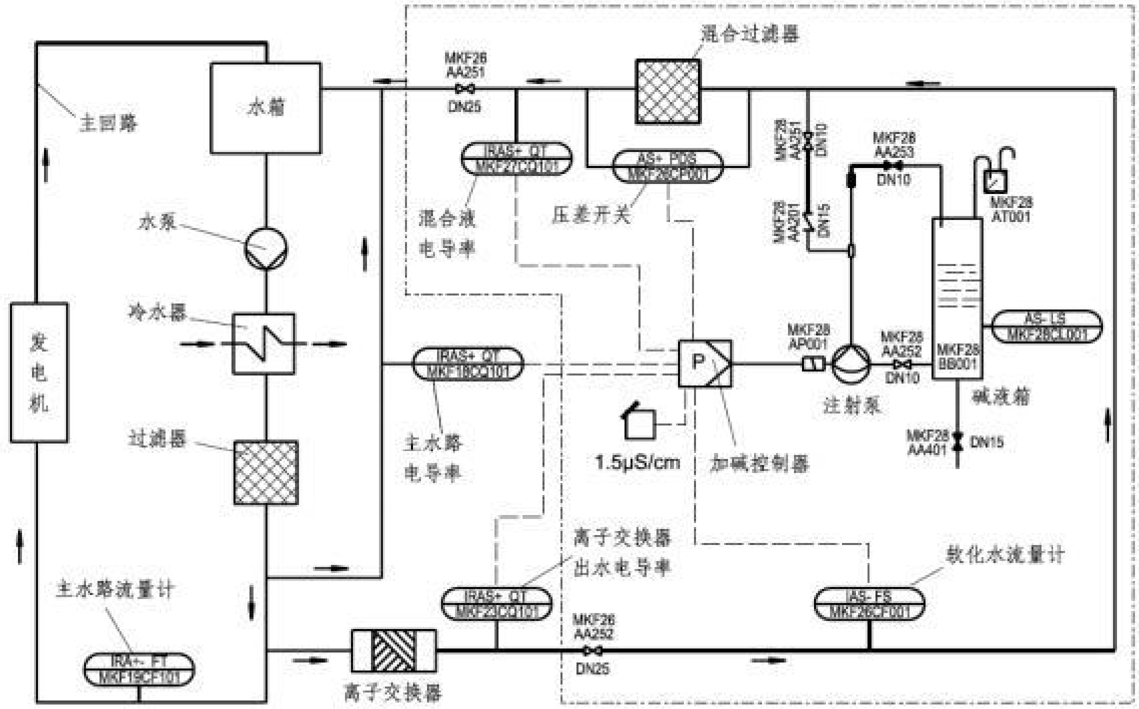
This generator cooling water ultra-purification microprocessor is characterized by utilizing the conductivity and PH in the attached Figure-2 pure water.

By controlling the conductivity of the cooling water, the PH value of the cooling water can be indirectly controlled by controlling the corresponding relationship between the values of the cooling water and the conductivity of the cooling water.

The control flowchart of the generator cooling water ultra-purification microprocessor is shown in Annexure-3.

Generator cooling water ultra-purification microprocessor dosing point is located at the outlet of the ion exchanger, in the ion exchanger outlet of the replenishment point of the cooling water is the purest, mixed cooling water conductivity depends only on the sodium hydroxide solution.

The concentration of the liquid makes it easy to control the injection rate of the alkali-adding syringe pump by numerical changes in the conductivity of the mixture.



5.2 Technical parameters of ultra-purification microprocessors for generator cooling water:

Supply voltage/power:	220VAC/80W
Volume of stator cooling water being treated:	(6-10) m^3
Piping design pressure:	1.0MPa
Conductivity before treatment:	<5μS/cm
Control range for cooling water conductivity:	(0.7-2.0) μs/cm
PH control range	8.5-9.0 (18°C)
Cooling water conductivity rated control setpoint:	1.5μs/cm
Medium temperature:	<50°C
Lye tank volume:	200L
Control of copper ion content:	≤20 μg/L

Normal softened water flow rate: (2.0-4.0) m3/h

Overflow section pipe material: stainless steels

5.3 Components of ultra-purification microprocessors for generator cooling water:

This unit consists of a lye dosing program control cabinet (including PLC controller, system control touch screen, signal isolator and other electrical auxiliary parts, etc.), an ion exchanger, c o n d u c t i v i t y meters × 3 (two of which are located in the generator cooling water supply unit), a lye tank, CO_2 filters, a lye dosing syringe pump, a mixing filter, a flowmeter, etc. The unit is designed to be used for the dosing of lye in a variety of applications.

These components are assembled on a common base plate.

1) Electrical control cabinet: protection level reaches IP54 or above, the front panel is equipped with a system control touch screen, to realize the

The operation of the system can be observed on site. Contains control system program, control elements, etc. inside.

2) PLC controller data acquisition, analysis and processing system: it will be

collected by a variety of instrumentation data (such as conductivity, flow, differential pressure, etc.) summarized by the PLC microcomputer processing system after the comprehensive processing to the sodium hydroxide (NaOH) solution injection pump to send commands to determine the injection pump should be injected into the system the amount and rate of the solution, and automatic control of the continuous micro-control of the injection of diluted sodium hydroxide (NaOH) solution to the system. NaOH) solution to stabilize the system.

The alkaline PH range is set. PLC is Siemens brand.

3) Data logging system: In addition to the data analysis system, the unit is equipped with a data logging system. A series of process data for monitoring and controlling the quality of the chilled water is recorded and stored for future reference and use.

Can be used for comparison.

4) Conductivity Meter: There are three conductivity data involved in the control of this system.

MKF27CQ101 - Conductivity of mixed lye. The mixed base conductivity is the control signal for the syringe pump, which is compared to the control setpoint of 1.5μs/cm to obtain a signal that controls the syringe pump dosing frequency.

signal, thereby controlling the injection volume of the syringe pump to achieve the conductivity control requirements.

MKF23CQ101 - Ion exchanger effluent conductivity. Displays the operating status of the ionic resin and provides an alarm to shut down the syringe pump when the conductivity of the ion exchanger effluent rises to 1.0μs/cm. The conductivity of the main water line can be maintained at a set value of 1.0-2.0μs/cm during syringe pump fill, and the conductivity will be in the range of 0.5-1.0μs/cm when the syringe pump stops filling, and will ultimately be the same as the conductivity of the ion exchanger effluent.

Same.

MKF18CQ101 - Conductivity of the main water line cooling water (into the generator coil). When the conductivity of the main water circuit is at

At high or low levels, the control system issues a command to stop the alkali dosing unit.

5) Alkali tank: a solution tank for sodium hydroxide ($NaOH$) solution, made of alkali resistant white PE plastic.

The lye tank consists of a large number of tanks, which can be stored in quantities sufficient to cover several months' supply. The lye tank is also equipped with a low level alarm.

Alert signal.

6) Syringe Pump: A diaphragm-type syringe pump for sodium hydroxide (NaOH) solution that draws the solution from the lye tank.

The liquid is injected into the generator cooling water circuit and the lye is mixed and first enters the generator cooling water tank.

7) Mixing filter: mix the solution after adding alkali, reduce the range of conductivity fluctuation of the whole system, easy to add alkali

The system accurately controls the dosing rate and also acts as a catcher for the ion exchanger.

8) Ion Exchanger: The ion exchanger continuously removes excess ions from the water to purify the cooling water.

Easy PH control of the entire system. The ion exchanger uses a resin suitable for alkaline solution conditions.

9) system control touch screen: located in the control cabinet door, is the core of the

entire system display equipment, can be ideal, vivid display of the entire ultra

-purification microprocessor workflow and work status. Through the

touch screen can also be in

The line sets the control parameters of the system.

5.4 Control signals for generator cooling water ultra-purification microprocessors

ECS	Content	warning value	corresponds English -ity, -ism, -ization
MKF18CQ101	Conductivity of the main water circuit	<1.0μS/cm	Alarm to protect syringe pump
		>2.5μS/cm	Alarm to protect syringe pump
MKF23CQ101	Ion exchanger effluent conductivity	>1.0μS/cm	Alarm to protect syringe pump
MKF27CQ101	Conductivity of mixed lye	<1.0μS/cm	Alarm to protect syringe pump

		>3.0μS/cm	Alarm to protect syringe pump
MKF28CL001	NaOH Alkali tank level	<120mm	Alarm to protect syringe pump
MKF26CF001	Ion exchanger effluent flow	<15.0l/min	Alarm to protect syringe pump
MKF26CP001	Mixing filter pressure drop	>70kPa	Alarm to protect syringe pump
	Fault signal of alkaline adding device	Syringe pump stops	To the power plant computer system
	Signal for operation of alkali adding unit	running normally	To the power plant computer system

5.5 Structural arrangement of ultra-purification microprocessors for generator cooling water:

6. Concluding remarks

Generator cooling water ultra-purification microprocessor is a product developed according to the advanced technology of famous foreign generator manufacturing companies, combined with the actual situation of domestic generator operation. It can effectively and smoothly control the water quality of generator cooling water, through the precise control of the conductivity of generator cooling water, so as to control the PH value of the cooling water in the range of 8.5-9.0, alkalize the water quality, so as to sufficiently reduce the degree of corrosion of cooling water on the copper hollow conductor, and to reduce the possibility of corrosion of pollutants deposited in the hollow copper wire. As the cooling water is in the weak alkaline water

water quality range, even if a small amount of air enters the system, the effect of creating an accident on the engine is greatly reduced.

Injecting diluted NaOH solution into the stator cooling water system and controlling it precisely according to the system's needs is the most effective measure to solve the corrosion of copper wires caused by cooling water quality. Similar technology by the actual operation, has been fully proved.

The reliability and feasibility of the technology.