



WATER - STEAM CIRCUIT CHEMISTRY

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July 12, 2017



WATER-STEAM CIRCUIT CHEMISTRY

To do what ?

To Avoid:

- Deposits on internal boiler tubes and steam turbine
- Corrosions due to impurities

⇒ Demineralised feed water

But:

Aggressive pure water with respect to certain materials

MATERIALS IN WATER-STEAM CIRCUIT

Water-steam materials

- Carbon and low alloy steel
- Copper base alloys (brass)
- Stainless steel
- Noble materials (titanium)

Essentials problems

- Limit the corrosion to the lowest level:
 - ✓ Carbon steels,
 - ✓ Brass alloys
 - ✓ Most used and most sensitive to corrosion

GOOD CHEMISTRY FOR

- For :

- Preserving the heritage in the long term
 - Maintaining good availability
 - Ensuring security

- To minimize:

- MAINTENANCE COSTS**

- « DEGRADED CHEMISTRY = PREMATURE DAMAGE »**

MEANS TO HAVE GOOD CHEMISTRY

HOW TO DO ?

- Produce the purest make-up water possible
- Implement satisfactory water conditioning for all materials
- Limit the contaminations of the circuits to the lowest level
- Ensure rigorous monitoring of chemical parameters and meet specifications

INVOLVEMENT OF STAFF IN POWER PLANTS

For Chemists

- To have reliable control means
- Technical support for Operation Team and control

For Operation Team

- Followed by chemical parameters with respect to alarms and chemical specifications
- Competences for the implementation of corrective actions level 1

👉 Responsiveness to incidents

- Maintain chemical treatment adapted
- Limit contamination in circuit
- To respect Chemical specification

👉 GOAL is to limit chemical corrosion and equipment preservation

CHEMICAL TREATMENT

Choice of chemical treatment

- **High-pressure boilers are conditioned with a so-called "all volatile treatment " or AVT**
- **The choice of a volatile base allows:**
 - ✓ To condition the water, but also the steam and its condensates,
 - ✓ Of not bringing salinity into a boiler capable of sequestering and / or depositing on the heating surfaces
 - ✓ Limiting local corrosions risks due to the aggressiveness of concentrated salts and the risks of creep damage due to localized overheating.

CHEMICAL TREATMENT

Choice of the chemical treatment basis

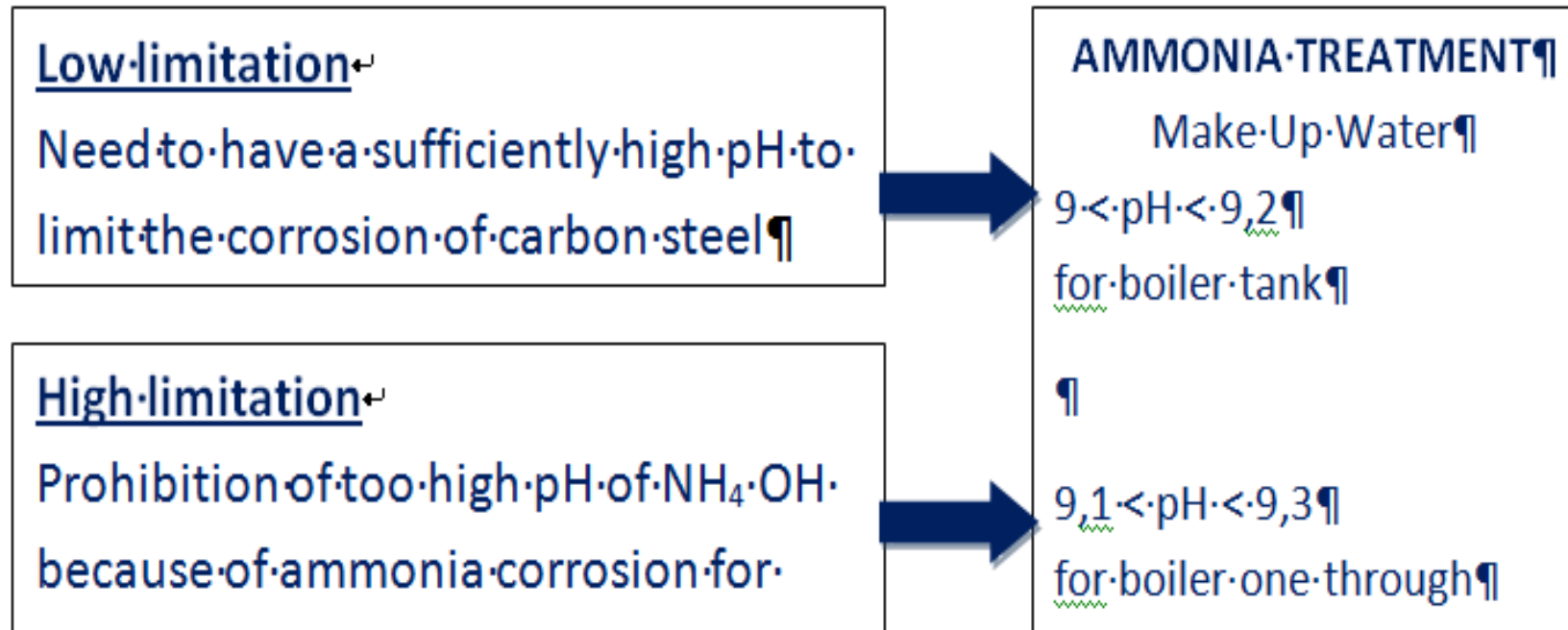
For these reasons, the tri-sodium phosphate (Na +) 3PO_4^{3-} conditioning used for low-pressure boilers is not used for the high pressure units.

The volatile conditioning is based on ammonia NH_4OH for maintaining the pH, and hydrazine N_2H_4 which gives the reducing medium character. In addition, hydrazine decomposes to ammonia in steam generator under the effect of temperature as these chemical reactions:



CHEMICAL TREATMENT

- Base of chemical treatment
- Adjusting the pH value



CHEMICAL TREATMENT

- Base of chemical treatment
- Adjusting the hydrazine injection

Two processes in competition ¶

Favorable: $\rightarrow \rightarrow \text{O}_2$ -reduction and oxides $\text{N}_2\text{H}_4 + \text{O}_2 \rightarrow \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$ ¶

Unfavorable: \rightarrow Thermal decomposition in the boiler: $\text{N}_2\text{H}_4 \rightarrow \text{N}_2, \text{H}_2, \text{NH}_4\text{OH}$ ¶

To obtain a sufficient reducing effect ¶

Moderate value for not generating too much NH_4OH ammonia (ammoniacal corrosion for copper alloy) ¶

Adjusting hydrazine content in Make-Up Water around ¶
20 to 30 ppb ¶

Hydrazine injection is not used to eliminate large air inlet but to control O_2 in water steam circuit ¶

CONTAMINATIONS IN WATER-STEAM CIRCUIT

Contaminations origin

Raw Water Inlet => Condenser

Contamination of make up water=> Silica (abnormal operation)

=> Sodium => Soda (resins)

=> Soda (regeneration circuit)

=> Acid (regeneration circuit)

Raw Water Inlet of cooling system => samples refrigeration

Cooling system with PO_4 => Waterproof of feed water pumps shaft

CONTAMINATIONS IN WATER-STEAM CIRCUIT

Contaminations origin

=> LP body Labyrinths

=> Tear membranes LP body

Air Inlet

=> Reheat water station and LP steam extraction

=> Condenser, sealing gasket ,

=> Make up water circuit, high flow rate
ineffective deaerating

Residual fouling of the circuits => Consequence of the maintenance operations (silica, fluorides, sodium, ...)

RAW WATER INLET – CHEMICAL IMPACTS

Case of Raw Water Inlet at the condenser

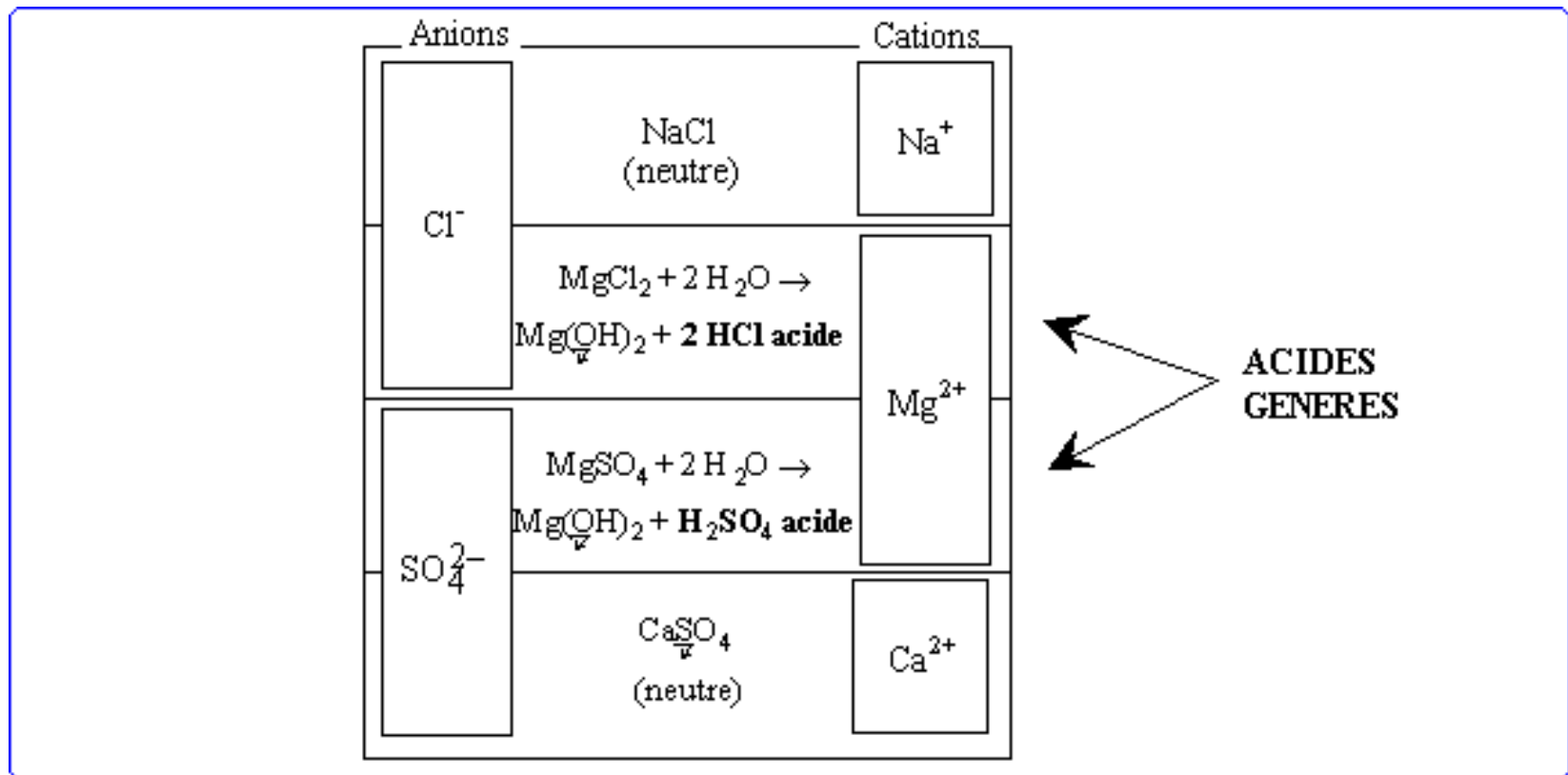
River water

1 ^{er} cas : le plus fréquent (Na > Cl)		2 ^{ème} cas (*) : le moins fréquent (Na < Cl)	
Anions		Anions	
Cl ⁻	NaCl (neutre)	Cl ⁻	NaCl (neutre)
HCO ₃ ⁻	NaHCO ₃ → CO ₂ ↑ + NaOH soude générée	HCO ₃ ⁻	CaCl ₂ + 2 H ₂ O → Ca(OH) ₂ + 2 HCl acide généré
SO ₄ ²⁻	Ca + SO ₄ → CaSO ₄ (neutre)	SO ₄ ²⁻	Ca + SO ₄ → CaSO ₄ (neutre)
	Na ⁺		Na ⁺
	Ca ²⁺		Ca ²⁺

RAW WATER INLET – CHEMICAL IMPACTS

Case of Raw Water Inlet at the condenser

Sea Water or estuary



MAIN CHEMICAL PARAMETERS – WITH TANK

The most important chemical parameters for minimizing corrosion – case of boiler with tank,

- Correct make up water pH (Guarantee of generalized corrosion phenomena),
 - Oxygen dissolved in extraction water control (to limit copper corrosion in ammoniacal medium as well as to promote the formation of passive magnetite on carbon steels),
 - Sodium in water extraction for units near sea area (to detect raw water inlet as soon as possible).
 - Acid conductivity in boiler tank (“global image“ of contaminations in boiler).
 - SiO₂ concentration in water (guarantee of hard deposits absence on the steam turbine LP blades).

MAIN CHEMICAL PARAMETERS – ONE THROUGH

The most important chemical parameters for minimizing corrosion -case of boiler one through,

- Make up water pH in outlet of polishing system
- Oxygen dissolved in extraction water control
- Sodium concentration in outlet of polishing system
- Acid conductivity of inlet economizer water
- SiO₂ concentration of inlet economizer water.

CONTROLS IN OPERATION

Principle of controls

- It is based on continuous monitoring, providing continuous information to enable corrective actions to be implemented without delay.

Quality of Controls

- Representative sampling (temperature, flow)
- Chemical automatons correctly calibrated and maintained
- Reliable retransmission

TO RESPECT CHEMICAL SPECIFICATION

Chemical specifications according boiler and turbine manufacturers

Specification for boiler tank

F GL GT 312 02 ind B

Specification for boiler one through.

F GL GT 312 01 ind C

THANK YOU