JOURNAL OF ENGINEERING annals OF FACULTY OF ENGINEERING HUNEDOARA

THE CREATION AND DISPOSAL OF INCRUSTATION IN WATER PIPES

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Abstract:
Water determined for industrial use is necessary to treat to required level of quality. The frequent problem that might arise from raw water is the creation of water incrustation. In some industrial branches, mainly in energetics, it causes a lot of problems. The creation of incrustation in water pipes causes financial losses, increases energy costs and risk of machine fault. Nowadays there are different methods for removal or eventually prevention of scale creation. The most commonly used principle is using ion exchangers in the processing utilization of magnetization or galvanic water treatment.
Keywords:
Incrustation, calcium, magnetization, carbon dioxide

1. INTRODUCTION

The utilization of water at present is very wide, besides the fact that it is used as drinking water and service water supply for population [1], it plays a crucial role in various industrial branches. For some processing it must fulfil the conditions as for current consumption, because it includes a lot of minerals. These minerals or solution substances cause by means of its properties some problems in processing. In the energy industry the concentration of calcium ions in feed water is critical as the calcium ions might cause so-called water scale in high-pressure boilers. Furthermore there are, for example, laundries and some kind of food processing, where specific concentration of ions, which are contained in water, could cause bad taste properties.

2. OCCURRENCE OF CALCIUM IN WATER

The Calcium as element is often wide-spread in nature. It gets to water by leaching of limestone $CaCO_3$, gyps $CaSO_4.2H_2O$ and other minerals. The higher concentration of calcium in underground waters depends on dissolved CO_2, which considerably increases a solution of minerals on carbonated base. The anthropogenic source of calcium can be some industrial waste waters from processing in which the acids are neutralized by lime or limestone. The waters are concentrating by calcium also at deacidification (disposal of aggressive CO_2) in ground waters by calcium hydroxide or filtration through some deacidification materials like $CaCO_3$.

The calcium occurs in water mainly as a simple ion Ca^{2+}. Depending on the total composition of water, different associates e.g. $CaCO_3^{\circ}(aq), CaHCO_3^{+}$, $CaOH^{+}$ might be created. The amount of some associates might be increased in the strongly mineralized waters e.g. in mining waters or waters after precipitation by lime and sodium carbonate. The higher concentration of dissolved calcium can be in solution sustainable only by sufficient concentration of dissolved carbon dioxide.

$$CaCO_3(s) + H_2CO_3^{*} \rightarrow Ca^{2+} + 2HCO_3^{-} \quad (1)$$

It results from the equation (1) that at the specific concentration of free carbon dioxide $H_2CO_3^{*}$, $CaCO_3$ is not dissolved nor segregated from water. This carbon dioxide is by the equation (1) in equilibration with ions Ca^{2+} and HCO_3^{-} and it is called balanced carbon dioxide. If the concentration of free carbon dioxide is lower than concentration of balanced carbon dioxide, the water has tendency to segregate $CaCO_3$(s) and makes incrustation. The other way, if the concentration of free carbon dioxide is higher than equilibration concentration, then there is redundant carbon dioxide in the water that can dissolve $CaCO_3$ and the water has aggressive effect [2].

3. THE CREATION OF INCRUSTS IN THE WATER PIPE

At the heating by the equation (1) $CaCO_3$ might be precipitated, which ~~is~~ sediments as sludge or can make solid incrusts in water pipes, where in some cases it might result in the congestion of water pipe. The incrusts that arise at higher temperatures and higher pressure are especially problematic – in processing of steam boiler (scale crust), which arise by the growth of crystal soluble poorly as ions CO_3^{2-} and SO_4^{2-} sometimes with SiO_2. These are mainly on boiler walls where water vapour and supersaturated solution of salt are created. There are three basic types of incrusts: 1, Carbonated; 2, Sulphated; 3, Silliceous.

The incrustation of silicates can be created only at high pressures. These incrusts act as isolators, which causes worse transmission through the boiler wall. What is hazardous about incrusts is that the wall under the layer of sediments can be superheated and therefore, it looses its fortress and can come to permanent deformation. Out of date but still existing is the definition of water hardness in (German Hardness) °dH. One German degree corresponds to 10 mg calcium oxide in 1 litre of water [2].

4. THE REMOVAL OF INCRUSTATION

At present there exist different manners how to prevent the creation of water scale. In practice it is called water softening by: 1. thermic; 2. chemical; 3. ionexes

Thermally (by boiling) only carbonate hardness can be removed from water – ions Ca^{2+} and Mg^{2+} linked with anions HCO^{3-}. The water precipitation by softening: By adding $Ca(OH)_2$, $Ca(HCO_3)_2$ can be removed from water, $Mg(HCO_3)_2$ (carbonate hardness) and CO_2.

One of the most widely used methods is exploitation of ion exchangers on the base of very acid cation exchanger, which removes from water ions Ca^{2+} and Mg^{2+}, and they are replaced by ions Na^+. The regeneration is made by NaCl. The reclaim, which contains ions Ca^{2+} and Mg^{2+} is taken away to waste. Ion exchangers are polymeric materials that contain in their skeleton functional groups, which are able to replace ions. As character of functional groups they are dividing to cation exchanger and anion exchanger. The standard ion exchangers are made by suspension polymerization by which create fraction from 0,3 to 1,2 mm that are modify for different applications by sieve analysis. For demineralization (removal Ca^{2+} and Mg^{2+}) are used very acid cation exchangers on gel base [3].

One of the modern technologies for water treatment is utilization of magnetization. The manner of fluid flow in magnetic field of equipment enables fluid to obtain properties that defend sedimentation of minerals and dissolve arisen minerals. The fluid, which flows through magnetic field in magnetic cell, physical properties of fluids change, but not their chemical contain. In the water minerals are influenced by magnetic field. The mineral, which occurs in the treated water, behaves as unstable. It's not able to link up electron coupling with other element and therefore, not crystallize. It is not creating mineral sediments – water scale and incrustation on water pipes [4].

Another innovation is galvanic water treatment. The principal is based on change of crystalline structure of calcium. In the water pipe galvanic system is installed, which includes very clear zinc anode. The galvanic voltage causes that the fragments of calcium from acicular structure are changed on globular form aragonite that has not ability to sediment in water pipes [5].

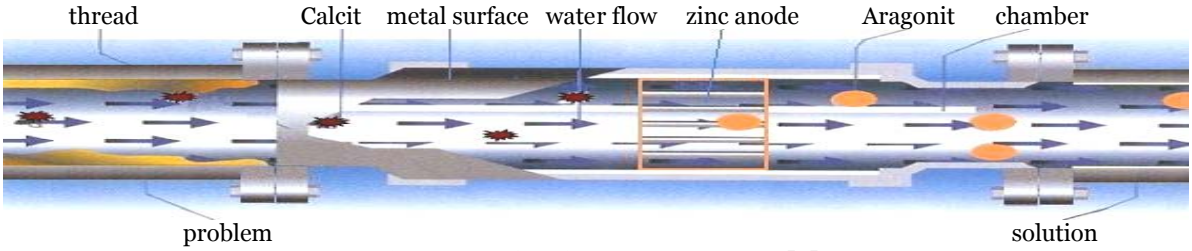

Figure 1. Galvanic water treatment [5]

5. CONCLUSION

Each of present methods has got its advantages and disadvantages. The last two mentioned methods that are magnetic water treatment and galvanic water treatment have a future, because they decrease operating costs for technologies and using of chemicals.

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