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Experiments on Water Stabilization †

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Abstract: The aim of the study was assessment of groundwater stabilization. Corrosive water effects on metals include complex electrochemical and biochemical processes. None of the water components remain indifferent to the metal and can accelerate or delay its corrosion. On the basis of the conducted tests of water samples, the aggressiveness and corrosivity indicators were calculated. Conducted research included analyses of raw and treated water. Raw water was taken as groundwater. Then it was treated in individual and complex processes such as aeration, filtration and ion exchange. Water aggressiveness and corrosion level were introduced by the Langelier Saturation Index (LSI), the Ryznar Stability Index (RI), the Larsoni–Skold Index (LI) and the Singley Index (SI). Obtained results proved that used water treatment processes must be improved through additional aeration and filtration with a dolomite bed. A simple system typical for industrial water is not enough to reach stable water because of remaining aggressiveness and corrosion.

Keywords: groundwater; stabilization; corrosion; aggressiveness

1. Introduction

Water used for domestic and industrial purposes should not have aggressive and corrosive characteristics [1]. Aggressive water is able to create sediments and precipitations, while corrosive water is capable of damaging many devices and equipment that comes in contact with it [2–4].

Corrosive and aggressive features of water can be determined by direct methods, including evaluation of effects of corrosive exposure to different materials. The other means of determination are indirect methods. Such ways involve the measurement of selected physico–chemical parameters of the water and the interpretation of resulting data by corrosivity and aggressiveness indicators, which allow determination of the water's tendency to corrosively impact materials. Corrosivity indicators found in the literature can be divided into two groups [5]. The first group of indicators used to assess water corrosiveness includes the Langelier Saturation Index (LSI) and the Ryznar Stability Index (RI). The second group is based on the Larson–Skold index (LI) and Singley index (SI) [5,6].

Most of the natural groundwater has a high level of aggressiveness and corrosion. Negative effects are described as intensified corrosion, silting up of the steel water pipe system, and the destruction of equipment which is in contact with water. However, incorrectly prepared water is able to damage many devices which stay in contact with pipes, water pipe fittings, storage tanks, filters, boilers and others. The result of higher level of aggressiveness and corrosion is elevated concentration of carbon dioxide and water color change. That is why a decision was made to conduct research on the groundwater stability with analyses of water aggressiveness and corrosion indexes. The aim of the experiments was verification of water aeration and its influence on the reduction of water

aggressiveness and corrosion. The indexes (LSI, RI, SI, LI) were calculated as the indicators of negative features of water.

2. Material and Methods

The research was conducted using water treatment experimental devices located in a technologically side-lined chosen industrial plant. Such processes as primary aeration, filtration and ion exchange were realized in the analyzed water treatment plant [7]. Treated water had negative corrosive and aggressive features. Stains, rust and poor damage appeared inside the pipe system and in the water storage tank. This resulted in a greater amount of sediments and altered water color. The technological system of water treatment consisted of quartz sand filters, ion exchange columns and primary aeration.

Water samples were taken once a week over 3 months (for a total of 14 research series). Aggressiveness indicators—the Saturation Index (LSI) and the Ryznar Stability Index (RI)—and corrosion indicators—the Larsoni–Skold Index (LI) and the Singley Index (SI)—were calculated for raw water and treated water after every individual purification process.

3. Results and Discussion

Laboratory and technical experiments on the reduction of water aggressiveness and corrosion were conducted for treated groundwater from the chosen industrial plant. The analysis of the corrosivity indices (the Larson index and the extended Larson index) showed that the processes used at the station did not increase the corrosivity of water. Obtained results are presented in Table 1. Water treated in every considered process was not corrosive. However, the Larson-Skold index, which includes in its formula the parameter of alkalinity and water retention time, indicates that the water is in fact corrosive. This property ranged from primary aeration to the last process in the plant–ion exchange. The research conducted resulted in indicators calculations (Table 1) that interchangeably proved that raw water as well as treated water revealed aggressive features. Values of indexed indicators showed that the water was not useful for industrial production. Only secondary aeration may reduce the water corrosivity. Studies carried out showed that aeration time was not important, but the process itself, with even short-term aeration having an effect.

Table 1. Aggressiveness and corrosion indicators of raw water and treated industrial water.

Type of water	LSI	RI	LI	SI
Raw water	−0.34	8.24	0.22	1.04
Pre-aerated water	−0.12	7.23	0.25	0.93
Filtrated water	−0.23	7.57	0.36	0.85
Soft water	−0.83	9.03	0.28	0.81
Secondary aeration	0	7.05	0.23	0.75

Source: Authors elaboration compared to Frayne [8] and American WWA [9].

4. Conclusions

1. According to the calculated indices (LSI, RI, LI, and SI), the tested raw and treated water are characterized by elevated aggressiveness and corrosion.
2. Tested single water treatment processes are not enough for water purification and imposed water stabilization level is not reached.
3. Additional process of secondary water aeration should be taken into account, which is able to reduce water aggressiveness to necessary requirements.

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