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Reasons for Reduced Redox Potential in the Thawed Water and Rainwater

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Introduction

Drinking water plays very significant role in people's life. First of all, the human body is ~ 70% water. Therefore the properties of drinking water are very impotent. It is known one of the main indicators for water quality is redox (ORP) potential. The water with a reduced ORP value is considered more useful. It is suggested that one of the reasons for obtaining a reduced ORP is a change in a structure of water. This is a quite possible; however, the water structure is practically not measurable parameter. In article [1] the first place in determining the water ORP value is the presence in it of oxidants and reducing agents. The ORP = 0 in neutral water with pH = 7 in the absence any dissolved chemicals. In drinking water in contact with air oxygen dissolves. Oxygen is an oxidizer and it will determine the ORP value. Drinking water at room temperature saturated with air oxygen has an ORP ~ 600 mV.

It was shown in article [1] that when hydrogen is introduced into water, the process of oxygen consumption in the reaction with hydrogen begins. The ORP value becomes negative when oxygen fully consumed and ORP will be determined by the concentration of dissolved hydrogen. Thus in pure water without any chemical the ORP value is determined by the air oxygen concentration. It is known the reduced ORP value has rainwater and thawing water. It is suggested the reduced ORP is associated with structural changes in water that occur during freezing and thawing. However, in our opinion this is not so. Everything is explained by the concentration of dissolved oxygen. Our paper is devoted to the proof of this assertion.

Let us consider the processes of freezing and thawing water. First, the concentration of dissolved gases in water (including oxygen) increases with decreasing temperature. But in the ice itself the concentration of dissolved gas (oxygen) is zero. That is, when freezing, gas is released from the water. If the water freezes quickly, the gases released do not have time to get out, and they remain in the ice in the form of bubbles. When thawing, especially fast, the ice partially melts and the gas bubbles evaporate into the atmosphere. As a result, water is reduced in oxygen concentration.

Consider the following experiment. Take a 0.5 – liter plastic bottle and fill it with drinking water from the tap. We close the bottle with stopper and put the bottle in the freezer at a temperature of –20 °C. Next day we take out the bottle from the refrigerator and open the stopper. Next we are watching the bottle. After 1 to 2 hours the ice begins to melt noticeably. In the neck of the bottle appears water. Gas bubbles start to emerge from the water. That is, the dissolved gas exits the water, and water is provided with a low concentration of air (oxygen). The concentration of dissolved oxygen in water was measured with a Clark electrode. Value of $ORP_{Ag/AgCl}$ was measured with a platinum electrode relative to Ag/AgCl electrode. The device Expert-001 (Ekonics Firm, Russia) was used. The oxygen concentration in source tap water was $[O_2]$ = 5.4 ± 0.2 mg O/L. Redox potential of tap water was $ORP_{Ag/AgCl}$ = 610 ± 50 mV. In the freshly thawed water the oxygen concentration was $[O_2]$ = 0.2 ± 0.1 mg O/L, the redox potential $ORP_{Ag/AgCl}$ = -145 ± 30 mV.

Consider the rainwater. Rain clouds are formed at a height where atmospheric pressure is low, and oxygen concentration is also lowered. Failing to the ground, raindrops do not have time to absorb a noticeable amount of oxygen. Therefore the rainwater will have a reduced ORP as well as thawed water. For analysis during the rain a sample of rainwater was collected. The next values are obtained: $[O_2]$ = 1.1 ± 0.2 mg O/L, $ORP_{Ag/AgCl}$ = - 45 ± 15 mV.

Conclusion

The mechanism of reducing the ORP in thawed water and rainwater is the same. The ORP value is determined by the concentration of dissolved oxygen.

Reference

1. Piskarev IM, Ushkhanov VA, Aristova NA, Likhachev PP, Myslivets TS (2010) Establishment of the redox potential of water saturated with hydrogen. Biophysics 55(1): 13-17.