Water bridge phenomenon

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Water still has a reputation as one of tough enigmas in science. Many attempts have been made to understand or calculate the real supramolecular structure of water. Today, there are around 50 physico-chemical and mathematical models predicting anomalous properties and behavior of water to some extent, but unfortunately none of them can adequately model real water behavior.

One of interesting but not well known water properties is related to appearance of highly ordered structures in response to strong electrical field. In 1893 Sir William Armstrong placed a cotton thread between two wine glasses filled with chemically pure water. When high DC voltage was applied between the glasses, a connection consisting of water formed, producing a “water bridge” (Fig.1).

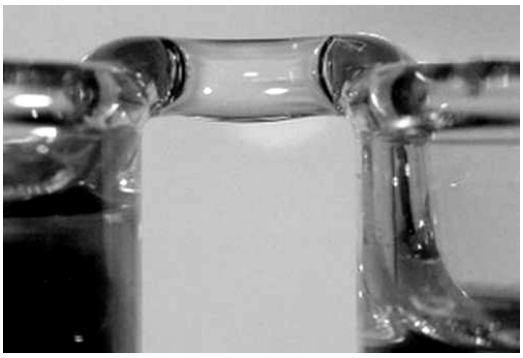

Figure 1. “A water bridge”

Few years ago such experiments were performed again by several research groups. The set-up used in our laboratory consisted of two equal beakers (250 ml) filled with Milli-Q water with two stainless steel electrodes submerged in this beakers. The one beaker was fixed, while the second was moveable in forward and backward directions. At the initial position the beakers were slightly touching each other. The water level was about 5 mm lower than beaker’s upper edge. The DC voltage was applied gradually till 10kV, resulting in 1.5-2 mA current. Experiment was performed in laboratory environment with controlled temperature, illumination and gas components.

After water connection is formed, water started to flow between two beakers. We found that mass flow was essentially two directional, so total mass flow is zero. If the beakers are moved apart, (maximal distance approx. 25 mm), and cylindrical flexible water bridge is formed. The diameter of this structure is around 1-3 mm. No electrolysis was observed during experiment, and if any ions are added to water, the bridge brakes immediately because of the rising conductivity of water. This floating water bridge can exist for around 45 min at normal conditions, and then suddenly breaks, probably due to heating up the water. The appearance of the water bridge does not significantly influence pH in both glasses. So this behavior can be explained from the point, that water is dielectric polar fluid, and in terms of this parameter water is a unique liquid.

This simple experiment can help us to understand water structure and interaction. And further studies are aimed to find out if addition of not-dissociating molecules like sugars does influence the water bridge formation. We also expect that proteins can behave interestingly in structured conditions of the water bridge. This can help us to understand water-protein interfaces better.