

# Characterizing the non-chemical water treatment – advanced biological and electrochemical approaches

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Non-chemical treatment of water and aqueous solutions represents a growing trend worldwide. On the one hand it is motivated by reduction of chemical substances in water used for drinking, agricultural and technical purposes. The clear goal is to avoid harming the environment; multiple regulative directives in EC, USA, China, Japan, Russia and other countries impose hard limitations on using chemistry in water preparation. On the other hand, water plays the most important role in metabolism of biological organisms. The non-chemical treatment is related to productive and therapeutic purposes, it concerns biological systems and infoceutical products that impact regulative mechanisms of different organisms. The spectra of non-chemical treatment include hydrodynamic cavitation, light/laser processing, treatment with modulated electric and magnetic fields and other approaches. Detection and analysis of non-chemical treatment represents an important mechanism for controlling technological processes, estimating the quality of products. It ranges from detecting the fact of treatment and existence of effects after a certain period of time up to characterization of treatment. Generally, it represents an important social, technological and scientific problem.

Detection and characterization of non-chemical treatment is a highly nontrivial task. Most of laboratory methods of chemical analysis cannot be applied since it does not change the chemical composition of fluids. Moreover, the non-chemical treatment produces only weak physical changes, their detection lies on boundary of modern measurement technology. Development of measurement approaches for weak emissions/effects started in 80s of XX century, currently, there are two known approaches: 1) electrochemical and optical methods that measure ionic properties such as the number and mobility of ions, frequency response, dynamics of ion-production mechanisms, statistical properties of molecular and quantum noise and other effects; 2) biological approaches that involve different target organisms and allow testing a specific biological response, in particular complex reactions on chemical and infoceutical substances and their combination. Both have own advantages and disadvantages and are complementary to each other.

In this presentation we introduce the non-chemical water treatment based on concrete technological and infoceutical examples. Electrochemical approaches are based on impedance and excitation spectroscopy -- impedance, correlation and phase of electrochemical dynamics present a 9-component vector that seems to be specific for different non-chemical treatments. Additional advantages are a high repeatability of results and a fast measurement time that enables an express analysis in field conditions. Biological methods are based on microorganisms (yeasts), plants (phytosensors) and laboratory animals as target biological organisms. Beside inhibition/stimulation results, these methods allow charactering a specific biological reaction in clinical tests and pharmacological research. Several from these methods are already on the stage of innovations and products in a global market and allow performing replication studies. The performed measurements over last years demonstrate surprising results towards different specific reactions of ion-producing mechanisms and biological organisms on „pure water” without any chemical additives that was non-chemically treated. These results raise several open questions about contribution of other, e.g. quantum, mechanisms to these phenomena.