IL-5: Physical, Chemical and Biological Effects of Ultrasound in Water Solutions

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During usage of cavitation for treatment of aqueous solution we must consider following factors:

1.Physical – solubility of gases in cavitational field doesn't behave according to the law of Henry, but is described by exponential. Concentration of gases in water (as well in either organic or nonorganic substances), under below limit pressure, is lower then equilibrium, but under high pressure is bigger than equilibrium. High dispergation of gases and reduction of bubble size to 10^{-9} mm, which is proportionate to size of colloidal particles, are additional proofs of that statement. Should also be noted that cavitation destroys (for certain period of time) cluster structure of water (this effect was also observed for complexes of organic compounds (or their radicals) with ions of variable valency metals).

2.Chemical – it is widely known that influence of cavitation treatment at aqueous solutions leads to formation of H and OH radicals. But depending on nature of present gas (oxygen) H radicals transforms into HO_2 radicals and oxidizing ability of cavitation increases. Oxidation of organic compounds by oxygen in aqueous solutions is described by reaction equation of first order, and synergism of oxygen and cavitation influence can be observed. But if biological objects are present in the system then oxidation of organic compounds is described by kinetic equations order of which is near 2. This fact proofs competitive course of biological and chemical oxidation with advantage of last.

3.Biological – speed of bacterial pollution inactivation in water under cavitational treatment is described by kinetic equation of first order, which doesn`t change depending on the presence of organic compounds impurity. But at first stage disaggregation of microorganisms colonies (their growth) is observed, and then their deactivation (death). Mathematical model that adequately describes both this processes is proposed. Nature of gas also plays significant role, not only OH radicals or hydroperoxide, which is proved by disinfection activity of gases row. As well as during oxidation of organic compounds we can observe synergism of oxygen and ultrasound treatment. But for cavitational treatment for water disinfection is observed post-effect of ultrasound treatment – in treated water growth of bacterial particles was observed only after 24 hours after cavitation treatment.