P-31: Kinetic Regularities and Features of Ultrasound Cavitation in Water Systems Containing Organic and Biological Wastle

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Ultrasound cavitation is a very effective method for dispergation of heterogeneous particle and widely used in technological processes. Its application in chemical and biological processes is limited by a rise of many different reactions under the high energy with a formation of great quantity of products.

The aim of our investigation was comparison of the influence of ultrasound cavitation on the destruction of Saccharomyces cerevisiae colonies in dispersion and products of their decomposition decrease of chemical oxygen demand of bacteria dispersion, creation of ultrasound treatment model, complex of bacterial and glucose decomposition.

Glucose (Aldrich), dry yeast (technical standart TU U 158-00-383320), distilled water were used for experiments. Ultrasound transducer UZDN-2T with working frequency of 22 kHz and power of 40 W was used. The yeast cells were suspended in distilled water. The influence of ultrasound was measured for 4 different concentrations of yeast cells at different treatment time and at 36^0C. Each sample was treated in four sonication times of 15, 30; 45 and 60 minutes. Samples were analyzed before and after treatment for determination of COD and the Most Probable Number (MPN) of organisms present. Chemical oxygen demand (COD) was studied by standard method (EPA method 410.4). The MPN was determined by surface planting on the meat-peptone agar medium before and after treatment. Two plates were used for each dilution and incubated at 37^0C for 48 h.

Our results shows that the treatment of bacterial dispersion by ultrasound leads to cells aggregates destruction with formation of smaller size aggregates and single bacteria in a short time of sonication and whole decomposition of cells after an hour sonication. The mechanical destruction of cells proceeds in the absent of oxygen and an increase of oxygen concentration in bacterial dispersion leads to a noticeable decrease of medium chemical oxygen demand. A mathematical model of ultrasonic degradation of yeast aggregate was proposed, which adequately describes this process.

$$\ln(1 - 4\pi NR^2/(N_1S_1) = \ln(1 - 4\pi N_0R^2_0/(N_1S_1) - kt$$

where N_0 and R_0 are the initial concentrations of aggregates in dispersion and their radius; k is the constant of new surface area formation

The rate constants k of process of bacterial agglomerate destruction for different initial concentration of bacteria in dispersion are close each to other. Correlation coefficient of the straight lines is higher than critical (0.878). Therefore the mathematical model describes the process of decomposition of bacteria aggregates with new surface formation.

Oxidation of organic compounds in the absence of bacterial contaminants during ultrasonic treatment described by equation of the first order reaction The investigation of bacteria oxidation during sonication showed that this process proceeded according to the second order reaction

Moreover oxygen concentration inside microorganisms is lower than outside of them. It is a need to note that the oxidation rate of glucose is higher than microorganisms' dispersion at equal concentrations Correlation coefficient is equal to 0,999 and rate constant of oxidation of organic soluble products is equal to $5{,}558\cdot10^{-9}$ l/mol·s and $1{,}457\cdot10^{-8}$ l/mol·s for bacteria oxidation in air and at oxygen bubbling by dispersion corresponding.

Obviously, it is connected with the fact that the radicals $HO^{\bullet}$ and $HO^{\bullet}_2$, formed as a result sonolizu water in the presence of oxygen consumed in two directions:

– inactivation of bacteria, leading to their death and increased concentration of organic substances in solution;

– oxidation of organic matter, the first path is dominant.

References

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