The pH determination of the effect of ultrasound cavitation

Fan Xinnan1,2, Zhu Changping1,2, Wang Yuming3, Shan Minglei1,2, He Shichuang1, Wang Yaojun2

(1 Department of Computer & Information Engineering, Hohai University, Changzhou, 213022, P.R.C.)
(2 State Key Laboratory of Modern Acoustics, Nanjing University, Nanjing, 210093, P.R.C.)
(3 ChangZhou College of Mechanical and Electrical Engineering, 213022, P.R.C.)

Abstract

In this paper, a new method for measuring ultrasound cavitation, pH-value measurement, is developed. By studying the effect of ultrasound cavitation in a reverberating field and comparing with the relatively ripe measuring methods of TA fluorescence and electricity, we can prove that pH-value measurement is effective for valuating ultrasound cavitation in the specific fields.

Keywords: ultrasound cavitation, pH-value, measuring method, reverberation field

1. Introduction

Ultrasound cavitation is a foundation for lots of power ultrasound. Especially, it is the major impetus for reflecting ultrasound cavitation. Ultrasound cavitation phenomenon includes a series of complicated instant changing courses, such as initiation of cavitation, action of cavitation bubble-motivity and the effect of cavitation. Though report adopting the three-dimension holographic technology with high-speed photography of 300000 times per second and reproducing cavitation field, which can announce and study cavitation course directly and vividly, has already made some progress, there is some difficulty if we use widely. At present we study ultrasound cavitation mainly by detecting various kinds of effects of ultrasound cavitation. Among lots of measuring methods[1-3], TA fluorescence method and electricity method are relatively effective. In this paper, we have made studies on the reverberation field of ultrasound cavitation adopting pH-value measurement, and also have made comparisons experiments with TA fluorescence method and electricity measurement method. The feasibility of the pH-value determination method is verified. It shows that the law given by the three methods is unanimous on the whole.

2. The basic principle of pH-value measurement

In general, N2 and O2 can’t react with each other. But due to the high-temperature and high-pressure in the cavitation, the nitrogen and Oxygen dissolved in water react with each other and produce NO, and then the No is oxidized into NO2. Further more, NO2 reacts with O2 and H2O to generat HNO3. The reactions are as follows:

\[ N_2 + O_2 \xrightarrow{\text{Ultrasound cavitation}} 2NO \]
\[ 2NO + O_2 \rightarrow 2NO_2 \]
\[ 4NO_2 + O_2 + 2H_2O \rightarrow 4HNO_3 \]

We can know the quantity of HNO3 by determining the change of pH-value of de-ionized water, thus it can reflect the situation of the Ultrasound cavitation.

3. Experimental apparatus and results

3.1. Experimental apparatus

As illustrated in Figure 1, an electrical signal of 1.7 MHz was generated by a functional generator (HP-3325B), amplified by a power amplifier (EIN-500A) and applied to a PZT piezoelectricity transducer T with diameter of 14.2mm. In addition, the square wave machine of PH-54615 type is used for measuring the
input signal of the efficiency. The sample container is a glass tube with inner diameter of 16mm. The underpart is sealed with artificial plant membrane and the distance between them is 40mm. If the sound power measured by the standard sound dynamometer (Model 75) is divided by the effective area of transducer, the result is the sound power of transducer. The sample container and transducer are all put in a pond of water removing gas.

### 3.2. Experimental results

The sample, 7.5ml fresh de-ionized water each time, is irradiated for 2min by ultrasound changed from small to large in proper order. Both pre and after irradiation, we measure the pH-value of sample with accurate pH-value meter (pHS-3C, product of Thunder Magnetism Instrument Plant of Shanghai). After that we attain the relation between the reduced amount of pH-value and sound intensity, which is shown in figure 2. If the other conditions are the same, and adopting the conductance rate meter (DDS-11A, product of Thunder Magnetism Instrument Plant of Shanghai), we can get the relation between increment of conductance rate and sound intensity as shown in figure 3. Then we compound the TA solution with the de-ionized water and measure the fluorescence value of HTA (D) with hydroxyl adopting the fluorescent spectrometer method (the preparation of sample and the procedure of measurement are the same with the document[1]), and the results are shown in figure 4. The experimental curves are shown in figure 4. The curve is the average value of the measured data of four groups, and I stands for the range of standard deviation.

### 4. Conclusions

Seen from the figure 2~3, the results given by the pH-value method are unanimous basically with those given by electricity method and TA fluorescent method. Thus, it is verified that pH-value method is another effective method to study the effect of sound cavitation. And compared with others, the pH-value method has particular advantages.

1. Compared with TA fluorescent method, pH-value method has simpler and easier characters.
2. When the temperature of sample changes largely, the pH-value method can reflect the objective laws of effect of cavitation more effectively as compared with electricity method, because pH-value method can adjust the temperature grade according to the temperature of sample.

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### 5. References