Basics of Ultrasonic Cleaning Technology 2004-2 2012/9/18

**True ultrasonic cleaning technology - The basics are important.　　　　　　　　　　　　　　　Cavitation control is the foundation of ultrasonic cleaning technology. It is not advisable to skip over this understanding and move on to the next step. Without understanding the basics, there can be no success in applied technology.**

**Importance of Cavitation Control**

The author calls the early ultrasonic cleaning systems, in which ultrasonic cleaning is possible by placing the object to be cleaned above the ultrasonic transducer, the first-generation ultrasonic cleaning systems.
 In response to the importance of cavities in ultrasonic cleaning, the author refers to the second generation of ultrasonic cleaning equipment, which is designed to control cavities in the ultrasonic cleaning tank.
 Cavitation control in second-generation ultrasonic cleaners will be briefly discussed here.
 This is the basis of all ultrasonic cleaning system design, and I am convinced that no new era of ultrasonic cleaning design can be achieved without understanding and practicing this concept.

1. **Control of cavitation generation position**

In an ultrasonic cleaning tank (the same applies to ultrasonic spray), it is an extremely important basic technology to determine where and how cavitation is generated in a stable manner.
 The position and shape of the cavitation distribution are determined by the frequency, type of liquid, temperature, depth of liquid, placement of transducers, direction of liquid flow, temperature distribution, etc., as well as the type of material to be cleaned.
 The basic distribution of cavitation can be horizontal, vertical, grid, even, or cylindrical, etc., depending on the purpose. The ultrasonic cleaning engineer and the user must clearly define the purpose of each ultrasonic bath and share the cavitation distribution for each bath and the method of checking it. If the liquid depth is unstable or not theoretically supported, it can be assumed that the basics of cleaning design have not been established.

1. **Cavitation generation density control**

Cavities in ultrasonic cleaning do not occur on a surface. They occur at points.
 There is a distance between cavities, and multiple cavities do not occur attached to each other.
 In general degreasing cleaning, however, the spaces between cavities cause defects in so-called precision cleaning.
 Therefore, efforts are made to increase cavity density in various ways.
 Or, efforts are made to increase the distance traveled by the cavities.
 We have to make a lot of efforts to improve the ultrasonic waveform, oscillation efficiency, liquid injection efficiency, output power per unit area, attachment of vibrating elements, reduction of wasted liquid, and so on.
 The latest ideas for ultra-compact, high-speed, high-density ultrasonic cleaning are an extension of this concept.

1. **Cavitation Impact Force Control**

If the positive and negative impact force of the cavity is too weak, the cleaning cannot be performed, and if it is too strong, the object to be cleaned will be damaged, resulting in defective products. Naturally, if the impact force of the cavity cannot be controlled, it is impossible to design ultrasonic cleaning
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 Recently, ultrasonic cleaning objects have become more precise and delicate, and the range of cavity selection has become narrower.
 However, if you have a better understanding of cavities in ultrasonic cleaning, you will have a better understanding of how to control the impact force.
 In general, the impact force of a cavity is proportional to the pressure of the liquid and inversely proportional to the frequency, vapor pressure of the liquid, and amount of dissolved air. Since the impact force of the cavity is proportional to the mass of the liquid that the cavity removes (attracts) in a unit of time, once the principle is understood, it is clear what to control.
 Cavitation control in ultrasonic cleaning equipment is an important basic technology in ultrasonic cleaning design.
 It is impossible to introduce a new technology for ultrasonic cleaning without taking care of these factors, in other words, without taking care of cavity control.


 The animation on the left shows the general cavitation distribution in water ultrasonic cleaning.
 The white cloud-like state is a horizontal distribution of many gas nebula cavities.

Cavitation control is necessary to stabilize this horizontal distribution and to use it efficiently.
 However, the cleaning power is far inferior to that of the cavitation enhancement system described in the section below, and we do not recommend it.
 However, it is impossible to use the next generation of ultrasonic cleaning without clearing this state of the art technology.
 If you try to use the most advanced technology while neglecting the basics of any technology, you will encounter a lot of trouble.


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