THE DETECTION OF CAVITATION ON POWER ULTRASONIC PROCESSORS

GMBU

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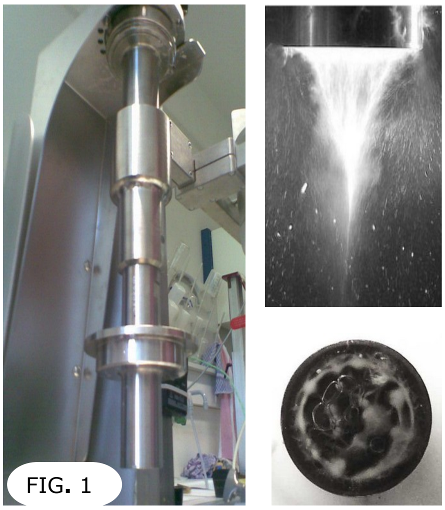

FIG. 1

GENERATION OF CAVITATION IN POWER ULTRASONIC DEVICES

The application of power ultrasound devices in chemistry, biotechnology and material science has rapidly increased during the last decades. This is the result of developing powerful ultrasonic processors and plants up to a power range of kW.

The basic element of these machines is the generation of cavitation at the tip of a waveguide (sonotrode), which is excited to longitudinal vibrations at an operating frequency of 24 kHz (FIG. 1). A major problem is the quantification of the cavitation intensity . Up to now there are only a few sensor concepts for recording the cavitation intensity in the technical process.

The reason for this is the erosive effect of cavitation which cause damage at almost every sensor immersed closely to the cavitating fluid. Moreover fluid turbidity and changing fluid properties during cavitation are reasons that rule out a non-acoustic sensor solution.

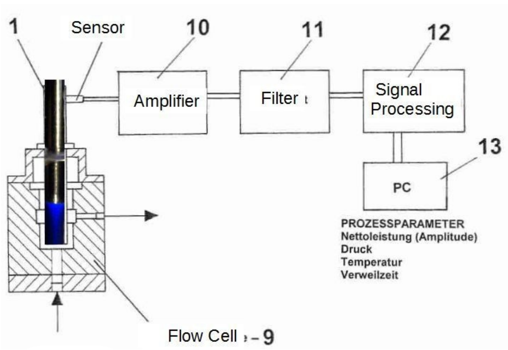

FIG . 2

THE CAVITATION SENSOR SETTING

The GMBU Acoustic Emission (AE) sensor concept enables non-invasive detection of cavitation by AEs originating due to the implosion of the cavitation bubbles. The AE is guided along the sonotrode and can be detected by a piezo sensor attached to the sonotrode (FIG. 2).

Operating the sonotrode on air, their fundamental modes and the lower and higher harmonics are detected (FIG. 3). Whereas immersing the sonotrode in water, the vibration spectrum shows an increase in noise power of up to 50 dBm in the range from 100 kHz to 10 MHz (FIG. 4). The increased noise power results from collapsing cavitation bubbles that generate AE at the sonotrode surface. Thus the entire spectrum consists of a deterministic partition (due to the sonotrode excitation) and a stochastic partition caused by the cavitation noise.

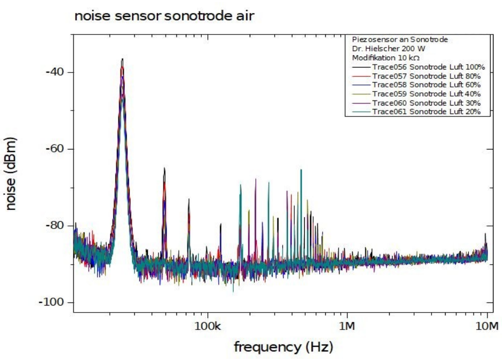

FIG. 3

THE CAVITATION SENSOR PRINCIPLE

A comparison of the noise power in the bandwidth of 1.2 till 1.4 MHz shows an average level shift of 3 dBm with a change in the amplitude of the electrical power from 20% to 100%.

Thus the averaged noise power is used as a sensor principle and correlated with the deflection of the sonotrode, which was measured with a laser vibrometer. To date, there is no standardised definition for the intensity of cavitation. In [1], the cavitation induced capillary pressure above the tip of the probe is measured (FIG. 5) and correlated with the cavitation noise recorded with the AE sensor (FIG. 6).

[1] N.V. Dezhkunov , T. G.Leighton, „The Use of a Capillary as a Sensor of Cavitation“, Nonlinear Acoustics at the Beginning of the 21st Century, ed. O.V Rudenko, O. A. Sapozhnikov, Vol. 2, pp1163, Moscow 2002.

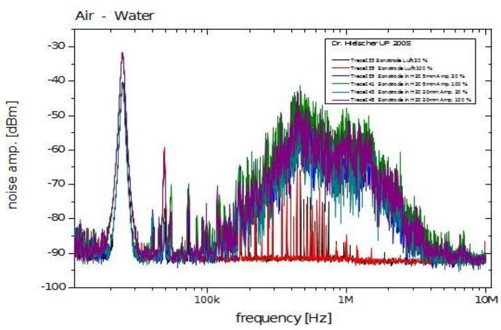

FIG. 4

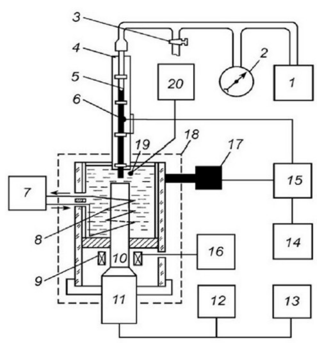

FIG. 5

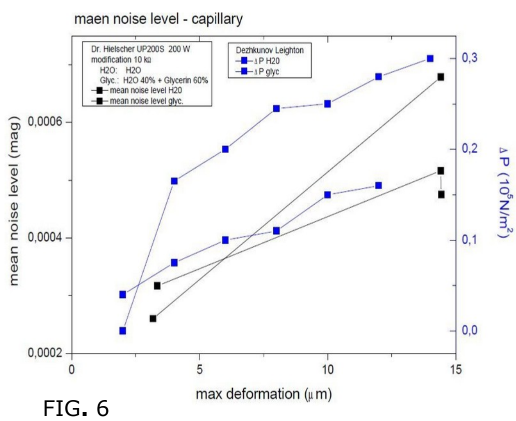

FIG. 6

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