Auto-Resonant Excitation of Oscillations in Ultrasonic Technological Systems

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Abstract

Ultrasound refers in particular to technological processes in which high frequency oscillations are transfered to the working tool [1, 2]. The main feature of the processes, discovered by numerous experiments, is reduction of the static forces necessary for the process [1 - 3]. An explanation of these phenomena is given in [3] on the basis of analysis of nonlinear rheological models of technological processes of special vibro-impact machines [4]. In all the works it is noted that the efficiency of the ultrasonic technological process depends on the amplitude of the oscillations of the instrument.

In this paper the conditions for the resonance tuning of the rod system with a piezoelectric oscillator are determined. It is shown that the resonant frequency depends essentially on the location of the exciter within the waveguide structure. The resonant frequencies and amplitudes of the oscillations are determined depending of the location. It is shown that resonance regimes can be effectively realized by autoresonant excitation of oscillations [3, 5]. In this case the resonant state of the system is maintaining automatically when the parameters of the system and the conditions of the technological process are changed.

Four ultrasonic transducers have been designed and manufactured with the piezoceramic vibration exciters located at different positions on the longitudinal body of the ultrasonic transducers. Waveforms of the longitudinal vibration, amplitude of ultrasonic vibration at the end of the ultrasonic transducer face, supplied voltage to the piezorings at resonance together with the Q-factors were recorded and computed during the experiments. These experimental results were further studied and compared with Finite Element Models to achieve a deeper physical understanding of these electromechanical devices.

References

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