Parameter Monitoring of Ultrasonic Apparatuses at the Application of Different Working Tools

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***Abstract* – The article is devoted to research of the influence of geometrical parameters (aperture angle) of rod type UOS tools on the parameters of the vibration characteristics of ultrasound systems and technological devices in general. Received power characteristics and data on the measured electrical parameters are provided.**

***Index Terms* – Ultrasound, working tool, opening angle, measuring.**

I. INTRODUCTION

IN MODERN CONDITIONS the tasks of energy-saving and power efficiency are actual, as they have never been before. That is why, the main aim of researchers and designers of technological apparatuses is a search and an introduction of new methods of the reduction of process loss, the increase of efficiency of carried out technological processes and applied equipment. During any electronic or mechanical transformation there are losses of initial energy action. A part of these losses is unavoidable due to physical limits, but others can be and should be removed. This is a task for the developers of new technologies and equipment. This article is devoted to solving of one of such tasks.

II. EXPERIMENTAL STUDIES

At the development of different ultrasonic equipment there is a need to design piezoelectric vibrating systems. The main requirements made to the ultrasonic vibrating systems are stable operation at designed frequency, satisfactory resonant properties (high quality factor), providing of required amplitude of mechanical vibrations or intensity of ultrasonic action.

Introduction of ultrasonic vibrations into liquid media often carries out by the using of changeable mushroom-shaped working tools. The form and the size of working tools essentially influence on efficiency of introduction of vibrations into media.

In this connection there is a necessity to study influence of geometric parameters (opening angle) of rod-type working tools on the parameters of the ultrasonic vibrating systems and performance specifications of the ultrasonic technological apparatuses in the whole.

The draft of the type of studied working tool is shown in Fig.1.

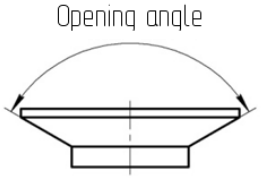

Fig. 1. Draft of working tool

Research technique is to determine energy of acoustic vibrations introduced into liquid media by changeable tools of different form. It was carried out a number of calorimetric measurements for various working tools [1]. On base of results the intensity of ultrasonic vibrations introduced into liquid and the efficiency of ultrasonic action were calculated. The measurements were performed at different power levels of ultrasonic action (20, 40, 60, 80, 100 %).

The results of intensity calculation of ultrasonic action are shown in Fig.2.

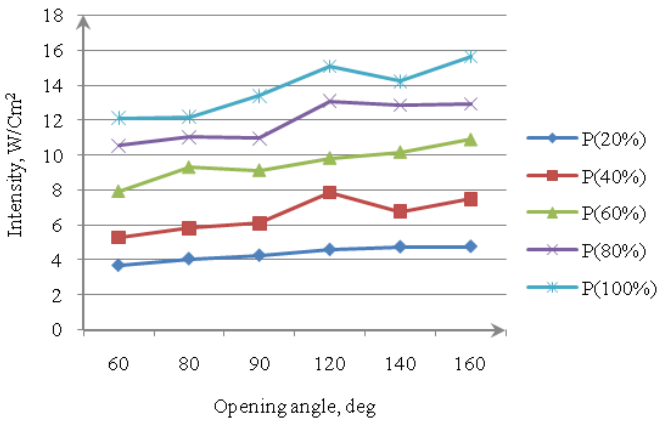

Fig. 2. Dependences of intensity of ultrasonic action from the opening angle of working tool for different power levels of ultrasonic action

The analysis of dependences shows, if the opening angle increases, intensity of ultrasonic vibrations rises in spite of radiation surface increases. Besides when the opening angle is 120° maximum intensity was observed at several power set points. It is obviously, the opening angle of the tool influences on the conditions of introduction of ultrasonic energy into liquid media.

Fig.3 shows obtained dependences of the efficiency coefficient of the ultrasonic technological apparatus from the opening angle of the tool.

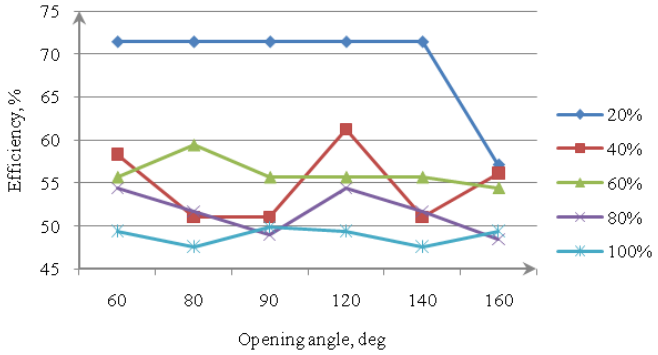

Fig. 3. Dependences of the efficiency coefficient of the apparatus on the opening angle of working tool at different power levels of ultrasonic action

Based on presented dependences it is possible to see the influence of opening angle of working tool on the efficiency coefficient of the ultrasonic apparatus. At low powers (set point is 20%) the opening angle almost does not influence on the efficiency coefficient (at its changes from 60° upto 150°). Its value has maximum and it achieves 72%. At high power set points (40% and more) it can be observed essential influence of the opening angle of working tool on the efficiency coefficient of the ultrasonic apparatus. It should be noted, clearly defined maximum is observed when power set point was 40% and the opening angle was 120°.

Besides of energy measurements in the same conditions of ultrasonic action it was carried out number measures of equivalent RLC parameters of the ultrasonic vibrating system, presented in the form of serial vibrating RLC electric circuit [2]. On the one hand, knowing of these parameters is important for solving problems of matching of the ultrasonic vibrating system with the electronic generator, on the other hand, continuous measurement of these parameters allows to control the processes taking place in ultrasonic field [3],[4],[5]. The results of measurements are shown in Fig.4, Fig.5, Fig.6.

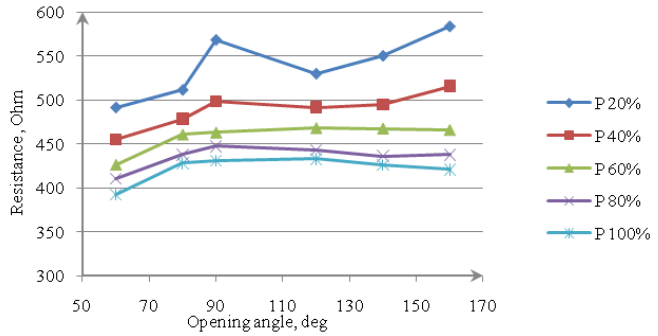

Fig. 4. Dependence of active electrical resistance of the ultrasonic vibrating system on opening angle of working tool at different power levels

From the dependences presented in Fig.4 it follows, that opening angle of working tool mostly influences on real part of electrical impedance at low power levels (power set point is 20% and 40%). Besides that it should be noted general tendency for the increasing of real part of electrical impedance of equivalent circuit with the growth of opening angle of working tool. It should be pointed out, the essential gain of real part of electrical impedance occurs during the change from the tool with opening angle of 60° to the tool with an angle of 80°.

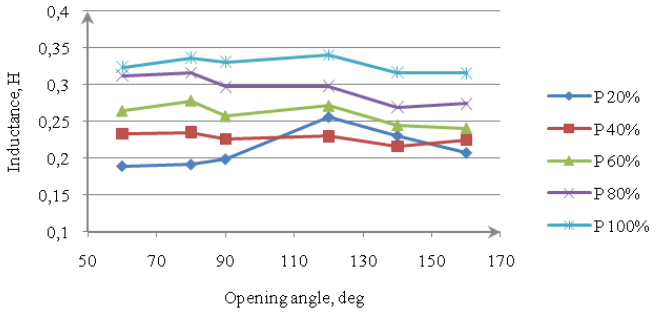

Fig. 5. Dependence of equivalent inductance of the ultrasonic vibrating system on opening angle of working tool at different power levels

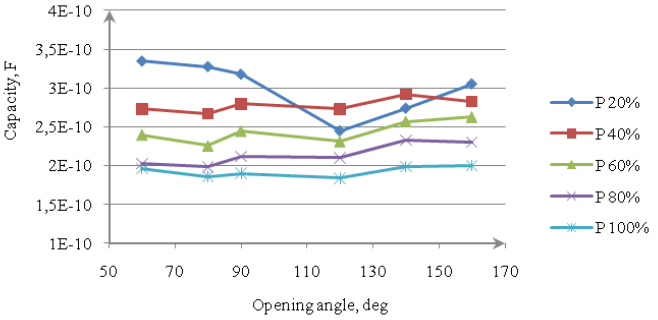

Fig. 6. Dependence of equivalent capacity of the ultrasonic vibrating system on opening angle of working tool at different power levels

The analysis of curves shown in Fig.5 and Fig.6 allows to conclude the opening angle of working tool insignificantly influences on imagine component of resistance of the ultrasonic vibrating system. However it should be noted for the tool with opening angle of 120° with maximum on the diagrams of intensity and efficiency coefficient, if power set point is 20%, it is observed essential changes of imagine part of parameters.

III. CONCLUSION

Carried out measurements were showed the geometric parameters (opening angle) of changeable working tool influenced both on electric parameters of the ultrasonic vibrating systems and on energy characteristics of the ultrasonic apparatuses in the whole. It gives the necessity of more detail studies for the optimization of the operation of ultrasonic apparatuses in the whole.

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