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ACOUSTIC METHODS

Developing a Method for Ultrasonic Quality Control of Plastic Products Obtained by Rotary Moulding Method

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Abstract—Rotational moulding of plastics is rapidly developing in the world today. However, with this method of processing, "microbubbles" can occur in the walls of products, considerably impairing their quality. In this paper, the method of ultrasonic testing (UST) is applied to assess the quality of plastic products. With the help of an echo method at a working frequency of 2.5 MHz, samples of various degrees of quality were analyzed. It has been revealed that the propagation speed of an ultrasonic signal does not depend on the degree of product quality and is 2330 ± 10 m/s. It has been found that the larger the surface roughness parameter Rz of the products (from 2.5 to 20 μm), the smaller the amplitude of the bottom signal Aa becomes. An underheated sample is determined by the values of parameter Aa from −6.0 to −15.0 MHz. A reference sample was established ($\rho = 0.942$ g/cm^3) for calibrating the flaw detector; for this sample $Aa = 0$ dB at an operating frequency of 2.5 MHz. The relationship between the density/heating of products and the amplitude of the bottom signal has been revealed. The possibility of detecting internal defects of products by ultrasonic inspection has been proven. A new method is proposed for identifying suitable articles in production using which it is possible to determine the degree of product quality.

Keywords: ultrasonic testing, plastic products, rotational molding, product quality control

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INTRODUCTION

Rotational molded products are characterized by long service life, chemical resistance, and low cost. However, due to the complexity of the geometric shapes of products (the presence of a large number of radii, transitions, etc.) and their relatively high cost (for destructive testing/cutting of products, costs can amount to hundreds of thousands of rubles), the use of nondestructive testing methods for controlling the quality of the manufactured products remains relevant.

During rotational molding, the distribution of raw material over the inner surface of the mold cavity occurs, and the simultaneous heating of the mold causes its melting with the formation of a thin coating in the form of a shell [1]. At the second stage of the process, liquid bridges are formed between the fusing plastic particles, trapping air bubbles, which should disappear at the next stage of compaction, and all this occurs at high temperatures above the melting point of polyethylene [2]. If these bubbles remain, then the manufactured products will have a low impact strength [3]. When the product is overheated in the mold, thermal oxidative destruction of the material and deterioration of its mechanical properties occur [4].

Currently, manufacturers of products using the rotational molding method are forced to check a small number of products from each batch to maintain a high level of product quality. This creates great difficulties for several reasons. First, it is a lengthy and costly process; secondly, there is always a chance that a defective product will not be identified at the control stage. The impact strength of finished containers is the most important characteristic for controlling the product quality; this is influenced by process conditions [1, 5]. The sources [6, 7] describe methods for quality control of manufactured products based on monitoring the modulus of elasticity, hardness, and viscosity of material. Thermal destruction of material causes an increase in the viscosity of polyethylene; this can be detected by analyzing the melt flow [8] or the geometry of parallel plates [9].