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ABOUT THE CURVILINEAR PROFILE OF ACCELERATING DEVICES

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With the help of variation method based on the Euler-Lagrange equation have been determined the shapes of the guiding blades of centrifugal accelerating devices in which solids move between two specified points of the centrifugal field within minimal time limits. Detailed mathematical conversions have been done during solving the initial differential equation. Three forms of final brachistochrone equations have been received. The properties of this curve have been determined depending on the values of the constant in the Euler-Lagrange condition and the conditions for existence of actual solutions have been described depending on the value of integration constants.

Brachistochrone curves corresponding to three ranges of constant values requiring a minimum of initial integral while determining the minimum of time for body moving from one point of the centrifugal field to another one have been constructed. The curves have been constructed both in absolute and relative coordinates. Simplified brachistochrone equations for the most abundant case in practice when the initial relative velocity of a moving particle can be neglected have been obtained. The parameters boundaries of the investigated curves under which their curvature can cause considerable frictional forces and even jamming of the material in the guiding blades have been determined. In this regard the conclusion has been made that for acceleration of solid particles the shape of the blades should be as close to the rectilinear as possible. The curvilinear profile of the blades can be justified in case of liquid or gaseous material accelerationl, for example, in centrifugal pumps and ventilators.

The search for extremums of functionals has been carried out since the appearance of the differential and integral calculus. In the science history are visible traces of these searches in solving of a great variety of problems. One of these problems is the task of finding the curve shape of the fastest descent into the gravity field which was tried to be solved by Galileo back in the 16th century. I. Bernoulli was the first to have solved this problem in 1696. After I. Bernoulli the problem of brachistochrone in the field of gravity was solved by Isaac Newton, Jacob Bernoulli, G.V. Leibniz, G.F. Lopital, E.V. Cirnhaus, everyone of which solved it by its own method.

The field of gravity at the surface of the Earth can be considered as a parallel force field. However, one can consider the motion of particles under the action of a wide variety of forces in force fields of various configurations, for example, in electromagnetic fields.

The centrifugal field arising in the rotating system refers to the central fields. Centrifugal rotor mechanisms are widely used as ventilators, pumps and compressors as well as for conveying speed to hard particles, for example in shot blasting machines for cleaning or hardening parts surfaces, mineral fertilizer spreaders, drying, separating and mixing devices. The acceleration of the material particles in all these cases is performed with the help of rotating rotor blades. The same principle is also used in the construction of a scattering centrifuge [1], where self-jointing of particles occurs during their rotation relative to their own centers of gravity during taking-off from the rotor, and in other constructions. In all these cases, the shape of guiding blades is of great importance depending on the tasks to be solved the most important of which are the provision of the required productivity, the velocity of particles at the outlet, or minimal deterioration of the blades surface. Therefore, the problem of finding the shape of brachistochrone in a centrifugal force field is still topical and of practical importance. This is an issue not only of the corresponding apparatus performance but first of all it concerns the interaction of the sliding mass with the base material.

An attempt to find the brachistochrone equation in a centrifugal field was undertaken in 1982 [2]. The equations in polar coordinates were obtained and the limits of their applicability for practical purposes were determined. In this paper, some refinements are given and a more detailed solution of the problem of brachistochrone in a centrifugal field as well as the research results of this curve properties for various initial parameters are presented.

The conducted studies show that the profile of the accelerating blades of centrifugal devices in the form of brachistochrone can hardly be considered the most rational. The curvature of the blade at the exit from the rotor, although decreasing in comparison with the curvature at the beginning of the motion, leads however to an increase of the normal force and hence also of the frictional forces.

Therefore, the use of blades in centrifugal accelerating devices in the form of brachistochrone or in the form of another curved profile can be justified only in certain cases, for example, in the structures of centrifugal pumps, ventilators or turbines.

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DEVELOPMENT AND RESEARCH OF COUNTERFLOW JET MIXERS OF LIQUID COMPONENTS IN AGRICULTURAL PRODUCTION

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The process of mixing of the liquid components is quite widespread in agricultural production, for example, in the preparation of uterine (working) solutions of pesticides for spraying gardens, seed dressing, fertilizer solutions for plant nutrition, preparation of animal drug solutions, etc.Among the many designs of mixers for liquid components, the most common devices with mixers. The mixing processes in such devices are well studied, the technological processes for their manufacture are developed and their production is established, but these devices have high energy and material consumption. Today, the development and implementation of the production of mixing apparatuses, which will ensure high-quality mixing of liquid components with minimal energy and time, is very relevant. Reducing energy consumption while maintaining or improving the quality of mixing liquids is possible due to the use of counterflow jet mixing. After analyzing the existing designs of jet mixers [1-3], we developed a scheme of the mixing apparatus (Figure 1). The basic theoretical dependencies of the mixing process are determined, the optimal location of nozzles is theoretically determined [4]. The experimental research technique has been developed [5]. The influence of factors on optimization criteria is determined. To conduct experimental studies of the process of mixing the liquid components, an experimental mixing device and an experimental setup were developed and manufactured (Figure 2). The vortex pump 1 creates the necessary supply pressure of the main component. Pressure control is carried out using a pressure gauge 2. Through the supply channel 3, the main component enters the counter-current jet mixer 5. The admixed component enters the mixer from tank 4 through the supply channel 6. After mixing in a counter-current jet mixer, the mixed product is discharged through channel 8. The quality of mixing is controlled using a conductivity meter 7. The mixing process was studied for liquids whose densities differ significantly ($\rho_m \gg \rho_a$) and for liquids whose densities are close ($\rho_m \approx \rho_a$).

To conduct experimental studies as liquids, significantly differing in density, we used GOST 2874-82 tap water with a temperature of 20 ºC (290 ºK) and sugar syrup (sugar content 50%). The