

Modelling of flow modes in membrane dispensers of automatic packaging machines

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Introduction. The efficiency of bulk food packaging depends on the design and flow characteristics of the dosing device. Diaphragm dosing devices that do not have traditional moving parts reduce energy consumption, reduce wear and tear, and increase reliability. To ensure dosing accuracy, it is important to model flow dynamics taking into account the properties of different products.

Materials and methods. To calculate and compare the flow characteristics of a membrane dosing device, a mathematical model of the flow of a bulk product through a measuring chamber was used. The calculations are based on the adapted Torricelli differential equation, taking into account friction losses between the particles of the bulk medium and the walls of the metering device. The area of the outlet, gravitational acceleration, friction coefficient and current product height were taken into account. Three types of bulk food materials with different physical and mechanical properties were considered as objects of study: buckwheat, rice, and millet.

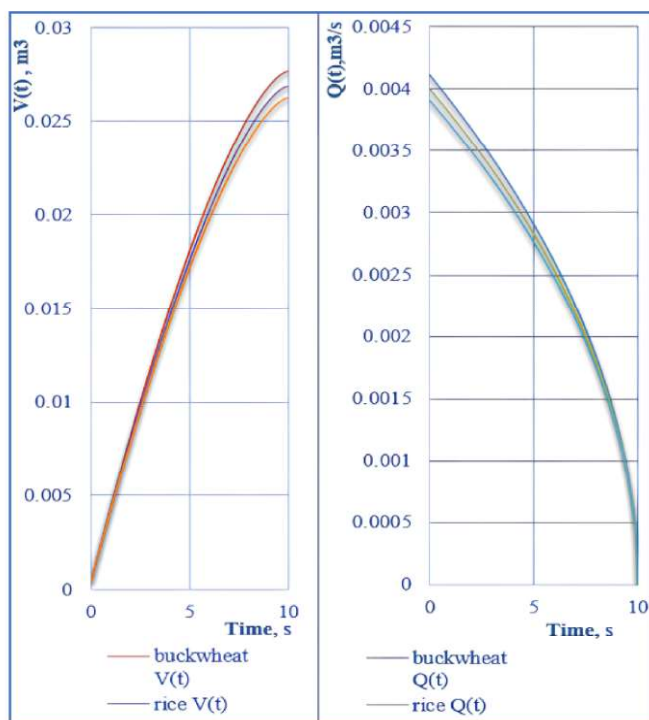


Fig. 1. Comparative characteristics of the flow process in a membrane dosing unit for three types of products: a) instantaneous flow rate $Q(t)$; b) volume of product flowing out during time t , $V(t)$.

The graphs show that buckwheat has the highest flow rate due to its low friction coefficient (0.28), rice has a slightly lower flow rate and millet flows out the slowest due to its high coefficient (0.36). Within 10 seconds, the volume of the buckwheat dose exceeds that of millet by 12-15%, which is important for accurate packaging.

Conclusions. The simulation showed the effectiveness of the membrane dosing unit for packing bulk products with different properties. For stable feeding, the effect of friction should be taken into account. When working with products such as millet, it is advisable to adjust the air supply or change the geometry of the chamber. The results are useful for creating versatile packaging systems.