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Pneumatic capsule transport

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Abstract

The main advantages of the pneumatic capsule transport are: the high speed, ecological safety and the possibility to fully automate the movement. The objective of the work is to analyze the possibility to use the pneumatic capsule transport for transportation of different cargoes. The theoretical method of capsule pneumatic transport characteristics, depending on the tube material, includes the mathematical model with different types of friction. This model is based on Newton's second law of motion. The experimental device consists of a t-piece that is connected to the tube and vacuum pump through three-way valves. The capsule passes by one of the ultrasonic detector and starts the timer. The timer goes off when the capsule passes by the second detector. Specially designed program gives the opportunity to check the differential pressure in real-time mode and to get the data about the time movement of the capsule. The experimental research showed that the theoretical model can be used to calculate different types of the pneumatic capsule transport; the experimental model can be used to get kinematic data of the capsule movement and to determine the friction coefficient; the device and the software gives the opportunity to continue the research of the possibility to use the capsule pneumatic transport for transportation of different cargoes.

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Keywords: pneumatic capsule transport; friction coefficient; mathematical simulation

1. Introduction

The great Italian physicist E. Torricelli once said: "We live submerged at the bottom of an ocean of air". This "ocean" is a very convenient working medium, which is used in vacuum and compressor technology. One of them is pneumatic transport, where compressed air and vacuum technologies are used. The aim of project is the search for new opportunities for the development of capsule pneumatic transport to convey people and various cargoes.

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One of the types of capsule tube transport is evacuated tube transport with magnetic levitation train “Maglev” [1, 2] (Fig. 1). The disadvantages of projects are the high cost of creating and maintaining the tube vacuum and the track.

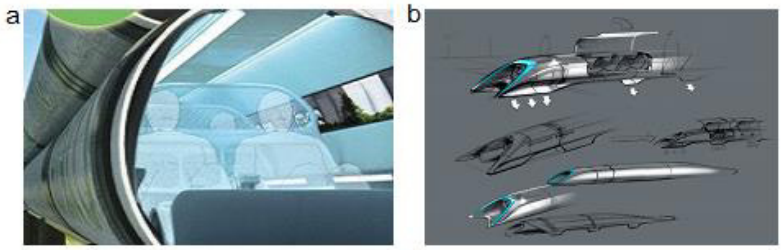

Fig.1. Daryl Oster’s (a) and Elon Musk’s (b) projects of evacuated tube transport.

Modern pneumatic container transport (Fig. 2a, b) takes its history from the idea of light (Fig. 2a) and heavy-duty (Fig. 2b) “air-mail” from 18th century [3]. The main advantages of pneumatic capsule transport are high speed, environmental safety, and the ability to fully automate the movement.

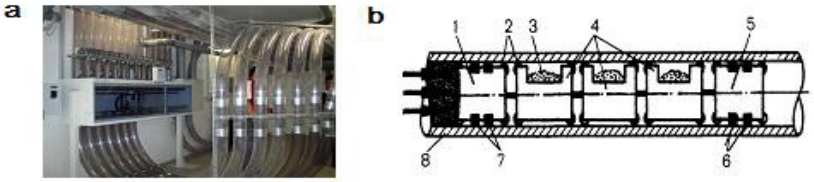

Fig. 2. Compact capsule transport (a) and large capacity transport (b): 1, 5 – pneumatic engine; 2 – wheels; 3 – cargo; 4 – carriage; 6, 7 – gland packing; 8 – duct.

To further develop the pneumatic transportation, it is necessary to study the possibility of moving goods by creating a differential pressure data for the properties of the materials used in friction pairs and pairs of bearings. The first part of research is theoretical investigation.

2. Theoretical investigation

Mathematical model of compact capsule transport (Fig. 3a) and large capacity transport (Fig. 3b) with different friction forces is based on the II-nd Newton’s Law.

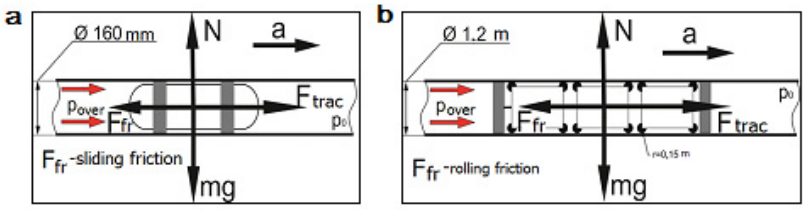

Fig. 3. Compact capsule transport scheme (a) and large capacity transport scheme (b).

Capsule acceleration time up to reference speed is the function of need capsule speed, capsule mass, tube diameter, friction coefficient and pressure drop (pressure difference before and after the capsule):