Analysis of the effectiveness of a freight transport vehicle at high speed in a vacuum tube (Hyperloop transport system)

D.S. Pellicer *, E. Larrodé

University of Zaragoza,
María de Luna Street no. 3, 50018, Zaragoza, Spain.

Abstract

This paper shows the development of a numerical analysis model, which enables the calculation of cargo transport capacity of a vehicle that circulates through vacuum tubes at high speed and analyzes its effectiveness in transport. The simulated transportation system is based on the use of vehicles that move in vacuum tubes at high speed, which is commonly known as Hyperloop, but assuming the vehicle for cargo containers. For the specific vehicle proposed, which does not include a compressor and levitates on magnets, the system formed by the vehicle and the vacuum tube is conceptually developed, establishing the corresponding mathematical relationships that define its behavior. To properly model the performance of this transport system, it has been necessary to establish the relationships between the design variables and the associated constraints, such as the Kantrowitz limit, aerodynamics, transport, energy consumption, etc. Once the model was built and validated, it was used to analyze how it affects the variation of the transported load (in our case number of containers), the speed of operation and the length of the tube, with the total and specific consumption of energy. Once the most efficient configuration was found in regard to energy consumption and transport effectiveness, the complete system was calculated. The results obtained constitute a first approximation for the pre-design of this transport system and the built model allows different alternatives to be compared according to the design variables.

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* Corresponding author dasapezu@unizar.es

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* Corresponding author dasapezu@unizar.es