Abstract

Reduction of aerodynamic drag is one of the primary areas enabling the reduction of operating costs and the environmental impact of vehicles, regardless of the type of propulsion system. This dissertation focuses on the issue of aerodynamic drag in commercial vehicles with a rectangular body shape. The scientific problem addressed in this work involved finding an effective way to reduce aerodynamic drag and the propulsion power required to maintain a constant speed of a truck. The author presented a method of active flow control developed and patented by themselves, which involves creating an additional air barrier that separates the rear of the vehicle from the turbulence and low-pressure zones formed behind it.

The proposed aerodynamic system is based on a paradigm shift regarding the use of air streams as a source of force. Instead of directly using them to generate thrust that propels the vehicle, the streams are used to neutralize the drag force acting on the rear zone of the vehicle.

The verification process of the proposed solution was conducted through computational fluid dynamics (CFD) in three stages. The first stage involved creating a flow model of a light truck, which served as a reference model for analysis and determination of aerodynamic forces. The second stage focused on exploring various geometric and flow variants of the main components of the aerodynamic system and determining optimal configurations. In the third stage, the selected configurations were applied to the flow model of the truck, and the aerodynamic drag of the modified vehicles was compared with the reference model.

The results indicate the effectiveness of the proposed method, surpassing the capabilities of contemporary passive solutions. Under certain conditions, the force generated by the air stream pileups exceeds the theoretical thrust of these streams. This effect is amplified in the vehicle, where nearly double the efficiency was achieved by reducing drag with an air barrier compared to the theoretical thrust force of the air streams used to create it.

From an energy perspective, the main challenge lies in the method of delivering air to power the aerodynamic system. Air intake should be conducted in such a way as to reduce aerodynamic drag in other zones of the vehicle, particularly in the frontal zone, where air stream pileups occur. The conducted research

and calculations demonstrated that air intake from this zone is theoretically possible and beneficial however, the exact implementation of this process requires further study.

The results of the conducted research indicate the practical applicability of the new technology, opening new perspectives in the field of commercial vehicle aerodynamics. Continued research may significantly improve the energy efficiency of commercial vehicles, reduce CO_2 emissions, and lower operating costs, which is of significant importance in the context of current global efforts towards sustainable development and environmental protection.