Utilisation of the Pistoning Effect to optimize Tunnel Aerodynamics

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INTRODUCTION

In Europe about 40 single-tube tunnels with two-way traffic can be counted with a total length of about 200km below the ground. In these types of tunnels huge air velocity gradients occur due to collisions between the forthcoming air streams of the two lines. These swirls cause an increased driving resistance, leading to a higher fuel consumption and emission of carbon dioxide.
Aimed at reducing this aerodynamic drag of vehicles in tunnels our project deals with integrating partition elements to decrease this driving resistance. Furthermore, we make use of the so-called pistoning effect which could contribute to a fewer fuel consumption as well. This effect should be investigated as well as the impacts on a cleaner and safer drive.

THE PROJECT

Using aerodynamic simulation methods and fluid dynamic calculations we focus on the one hand how the relative velocity can be reduced by accelerating the air flow through the pipe, and on the other hand how reducing the swirls in the middle of the tunnel can reduce the fuel consumption. On a material aspect we deal with the selection of an appropriate building material for a partition wall which should fulfill several legal obligations regarding fire protection and construction design aspects.
Based on these results, suitable existing tunnels in Europe are chosen that allow the integration of our partition wall. With these case studies we aim at creating a detailed tunnel model where exact calculations can be performed.

IMPACT

Counting all possible European tunnels which are convenient for our project`s application a significant reduction of the CO2-production can be reached. Besides, separated lines may result in a reduced accident rate, according to statistics from European tunnels. E.g., among other aspects, drivers are not disturbed by forthcoming car headlights. With our project, we optimize existing tunnels in a relatively simple way to contribute to a significant and sustainable reduction of CO2.