PLASMA DRAG REDUCTION METHODOLOGY FOR EFFECTIVE ENERGY USAGE — PROMETHEUS

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Aerodynamic drag accounts for more than 20% of the total energy loss of heavy duty vehicles and around half of this drag is induced by the tractor when considering a zero degree yaw angle. The flow separation in the region of the A-pillars substantially increase the overall drag of the truck under side-wind conditions. Active methods with feedback control would probably improve the situation when considering that trucks on the road are subjected to varying yaw angles. Dielectric Barrier Discharge (DBD) plasma actuators have shown effectiveness in controlling flow separation for geometries such as airfoils or cylinders by 'injecting' momentum in the streamwise direction close to the separation line [**1**, **2**]. However, they are only effective for low flow velocities and the effect of actuation is strongly dependent on the relative position between the separation line and the position of the actuator. To overcome these limitations an array of DBD plasma actuators creating streamwise vortices similar to those induced by physical vortex generators (VGs) has been suggested as an alternative [**3**]. Recently, based on previous work performed within the Linné FLOW Centre [**1**, **2**, **3**], a DBD-VG array has been mounted on the A-pillar of a 1:6 scale truck model and balance measurements in an aerodynamic wind tunnel have been performed to directly assess the drag for various velocities and yaw angles, with the actuators on and off [**4**]. This proof-of-concept experiment resulted in significant drag reduction under actuation that increases with the yaw angle. Above 5 degree yaw even net drag reduction, i.e. when also taking the power consumption of the actuator into account, was achieved.

Building on the success from the proof-of-concept experiment, the project PROMETHEUS (Plasma drag ReductiOn METHodology for effectiveEnergy USage) has been initiated with the aim to develop and optimise plasma actuators for the purpose of aerodynamic drag reduction on heavy duty trucks. In this project various geometrical (length and spacing) and operational parameters (duty cycle) will be investigated in order to find an optimal balance between control performance and actuator power consumption. The presentation will provide an outline of recent efforts in flow control on truck aerodynamics in light of the aforementioned progress within the Linné FLOW Centre in collaboration with Scania CV AB and present the planned work within PROMETHEUS.

References

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Figure 1: a) A 1:6 scale model of a truck in the "Lola Cars International 50% Scale Wind Tunnel". The right A-pillar is equipped with DBD-VG array. b) A close-up of the actuators under actuation, the violet light show the plasma. Reprinted from Vernet et al. [**4**].