Labor Windkanal/Strömungsmesstechnik

OSTBAYERISCHE TECHNISCHE HOCHSCHULE REGENSBURG

Decrease of the interference drag of a circular cylinder on a flat wall

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https://hps.hs-regensburg.de/las39261/

1. Outline

The bachelor thesis „Decrease of the interference drag of a circular cylinder on a flat wall" deals with the flow mechanical phenomenon of interaction between two bodies. Apart from variations in the flow pattern there occurs also a difference in the aerodynamic drag. The greatest influence on the changed drag force is caused by the interference drag. This additional drag is formed when for example a cylinder interferes with a flat wall and shows up as a so-called horseshoe vortex.

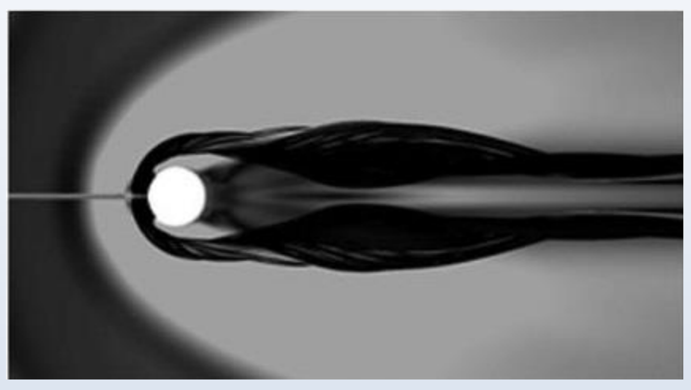


Fig. 1: Top view of a horseshoe vortex around a cylinder by flow visualization [1]

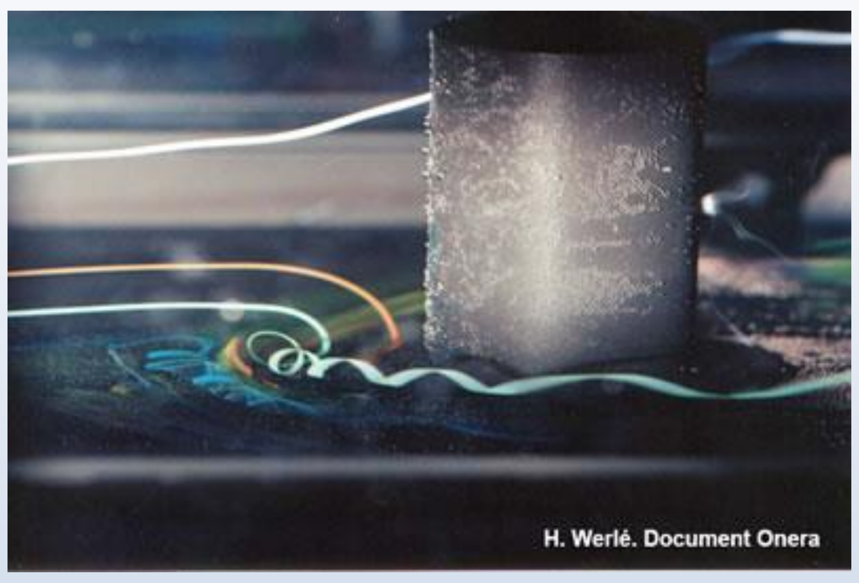


Fig. 2: Side view of a horseshoe vortex around a cylinder by flow visualization [2]

This vortex originates at the junction between cylinder and flat wall. The current streams against the leading edge of the cylinder, is deflected downwards, hits the wall and rolls up together with the current on the ground to a vortex. It is called horseshoe vortex because of the form it builds around the cylinder.

[1]: http://www.onera.fr/en/separation-in-threedimensional-flow-critical-points-separation-lines-and-vortices (visit date: 10.06.15)
[2]: Wei Huang, Li Yan: Progress in research on mixing techniques for trans-verse injection flow fields in supersonic crossflows, 2013

2. Creation of the experiment set-up

One part of this thesis was the creation of a experiment set-up to measure the interference drag between cylinder and flat wall in the Regensburg Wind Tunnel at OTH Regensburg.

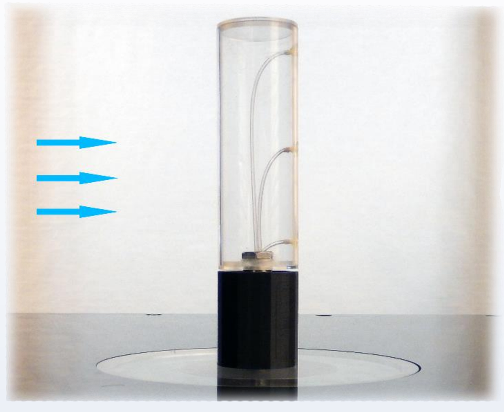


Fig. 3: Measurement of the drag force of the cylinder

For the first experiment a cylinder with three pressure holes on the base was manufactured. The black shielding protects the holder of the cylinder from the onset flow. The plate is also undocked from the force measurement. Consequently only the drag force of the cylinder is measured.

For the second test a flat plate and its mount structure for adjusting have been produced. The surface of the plate is on the same level as the table surface. As a result only the friction drag of the plate is measured.

Fig. 4: Measurement of the drag force of the flat plate

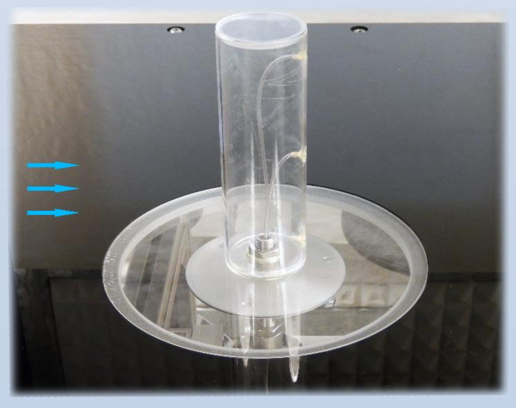


Fig. 5: Measurement of the drag force the combined version

In the third experiment the cylinder was mounted on the plate to measure the total drag force including the interference drag.

3. Interference drag

To determine the significances of the interference drag, the individual drag forces of the cylinder and plate are subtracted from the combined drag force. The result is the interference drag, which evolves from the interaction between several objects by manipulation of their flow pattern.

The experiments yield a drag increase of 3,39%. This means that the interference drag between cylinder and wall is **3,39%** of the total drag force.

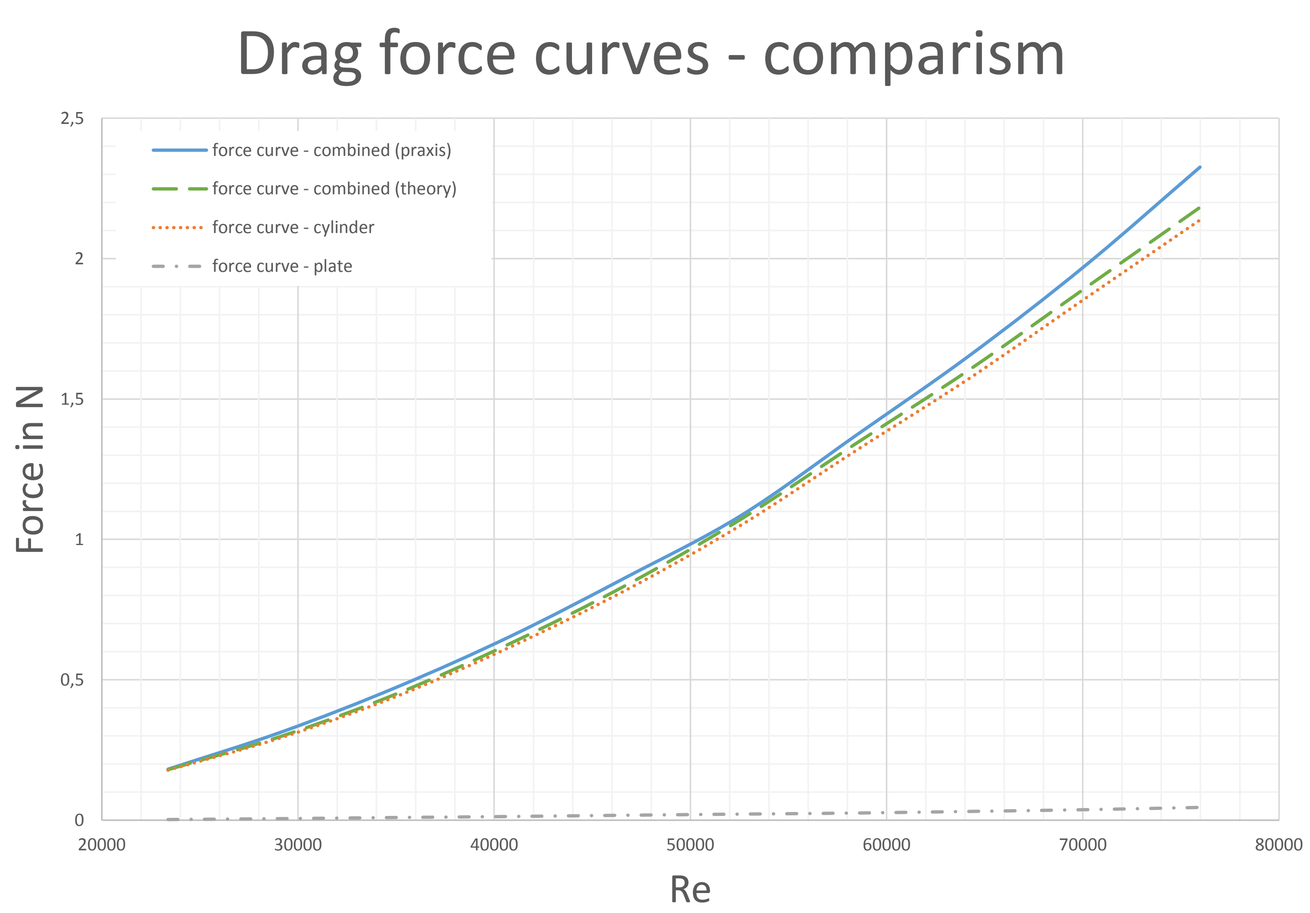


Fig. 6: Comparism between the drag force curves of the cylinder, plate and the combined version in theory and praxis

4. Optimization results

After determination of the interference drag the reduction is following.
Because of effecting at the junction of cylinder and plate all of the measured methods are placed in this area.

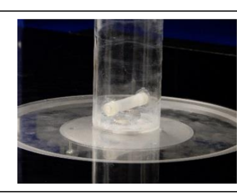
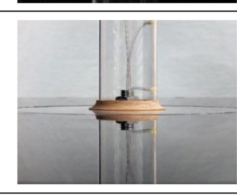
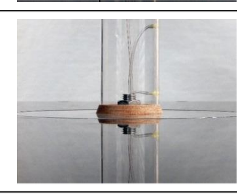
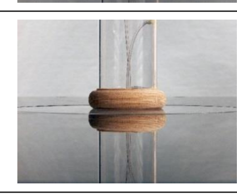
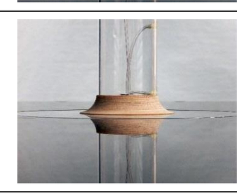
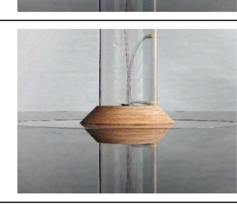
	**1. Suction** Improvement of 2,76%
	**2. Small radius** Improvement of 2,74%
	**3. Small ramp** Improvement of 2,17%
	**4. Bulge** Improvement of 0,75%
	**5. Large radius** Deterioration of 1,05%
	**6. Large ramp** Deterioration of 1,71%

Fig. 7: Comparison of the C_D-value of all modifications influencing the drag force

The greatest improvement was gained with the suction (passive ventilation). But compared to the other modifications it is dependent on the flow direction. The small radius, the small ramp and the bulge achieved also a reduction of the C_D-value and consequently a decrease of the interference drag between a cylinder and a flat wall. The large radius and ramp effected a deterioration of the C_D-value.