Labor Windkanal/Strömungsmesstechnik

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Further Development of the Laboratory Experiment About the Flow Around a Sphere for the Module Blunt Body Aerodynamics (ASK)

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1. Goals

Practical experiments in several laboratories accompanying the lectures are an indispensable part of the application-oriented training and education at Universities of Applied Sciences. Therefore the experiment regarding flow around a sphere for the course Blunt Body Aerodynamics (ASK) is revised and improved within the scope of this bachelor thesis. The further development includes the test bench and the LabVIEW software associated with the experiment.

Fig. 1: Final test rig FEP-WMR06 with open surface.

2. Improvements to the Test Setup

The overall goal is to determine the drag coefficient of the sphere. Therefore, the resistive force of the sphere must be calculated. Due to the setup (Fig. 2) the measured resistive force F_{K+H} is also influenced by the mounting stem. Therefore, a substitute stem must be produced (Fig. 3). It's length is identical to the effective length of the actual stem, which is marked by the dotted line in Fig.2. Therefore it can be used to determine the resistive force F_H of the mounting stick by conducting aerodynamic force measurements.

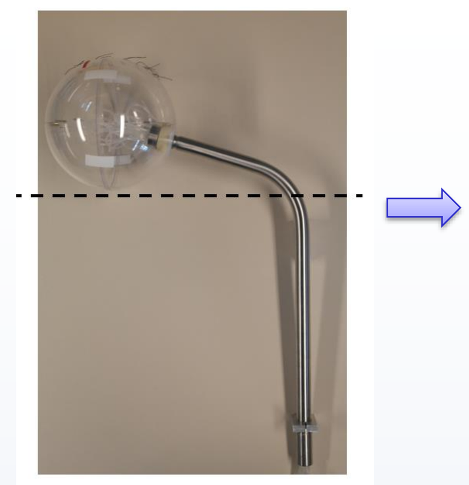

Fig. 2: Sphere with stem

Fig. 3: Mounting stem

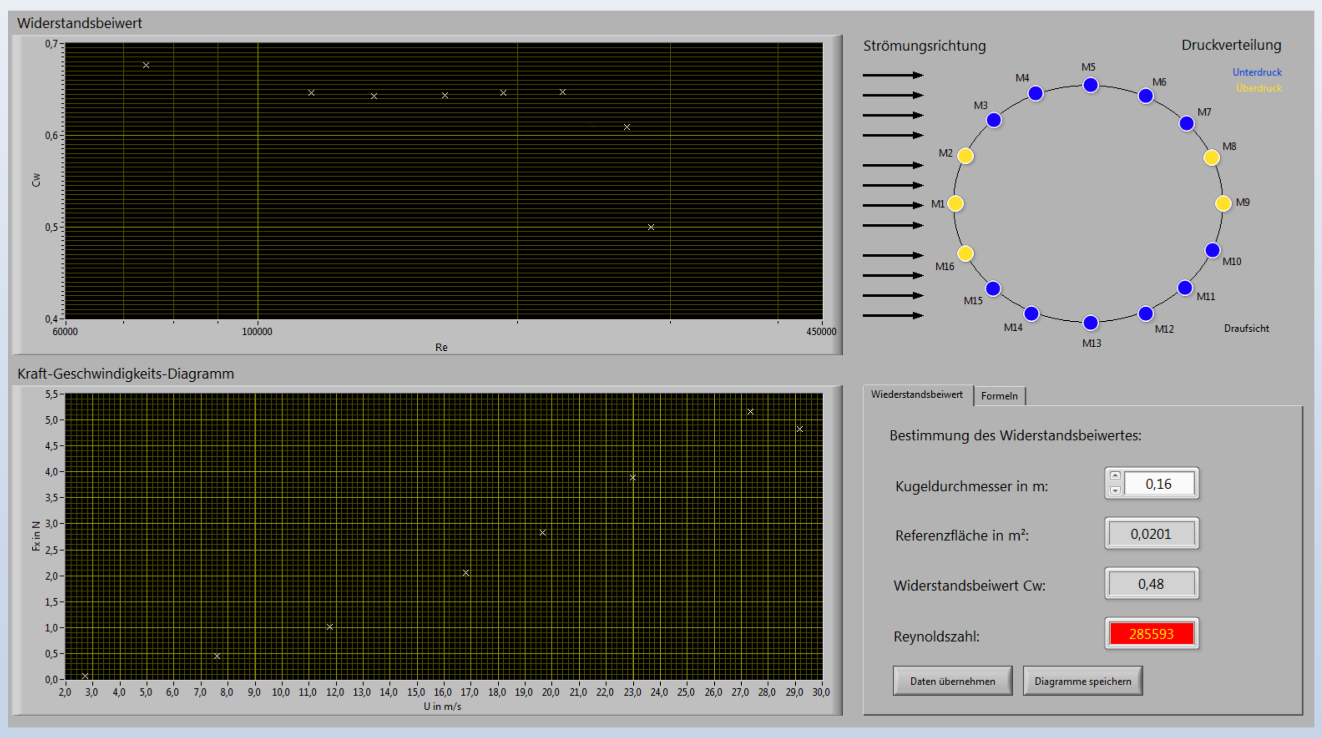

Fig. 4 shows one of the newly introduced graphical user interfaces of the revised LabVIEW program. The upper screen shows the pressure distribution and the C_W -diagram.

Fig. 4: LabVIEW graphical user interface "Drag coefficient sphere"

The graph on the bottom left represents the force-velocity diagram. The sphere diameter, the reference surface, the C_W-value as well as the Reynolds number are included on the bottom right.

3. Flow Visualization

Fig. 5 shows the smoke tunnel in the laboratory for wind tunnel flow measurements (LWS). The created photograph is presented in Fig. 6.

Fig. 5: Smoke Tunnel in the laboratory LWS

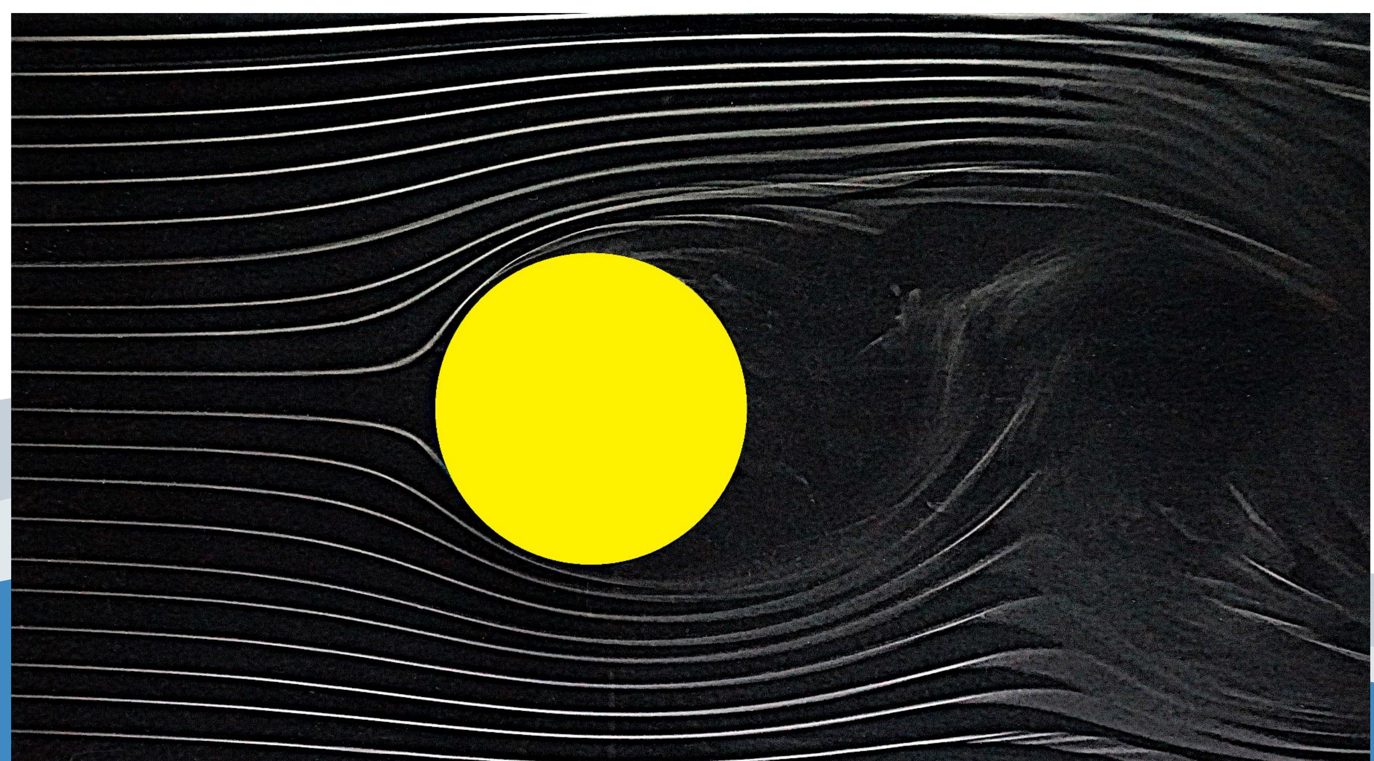

Fig. 6: Flow visualization around a cylinder

4. Measurement Results

Fig. 7 includes the force graphs. The red lines show the drag force for subcritical and supercritical flow around the sphere including the mounting stem F_{K+H}. The blue graph represents the resistive force of the mounting stem F_H while the green line shows the resulting force of the sphere on its own considering the following equation: $F_K = F_{K+H} - F_H$

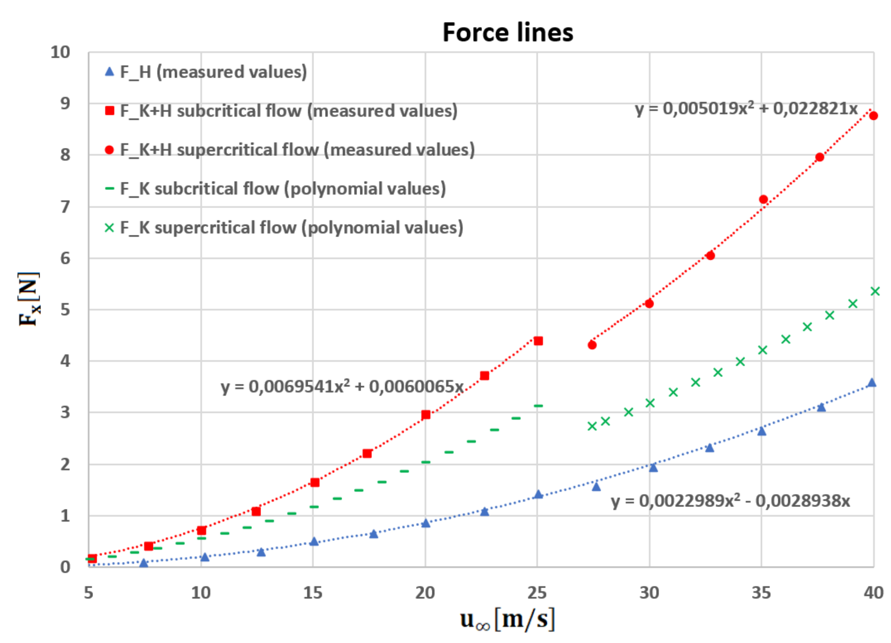

Fig. 7: Force graphs for different constellations

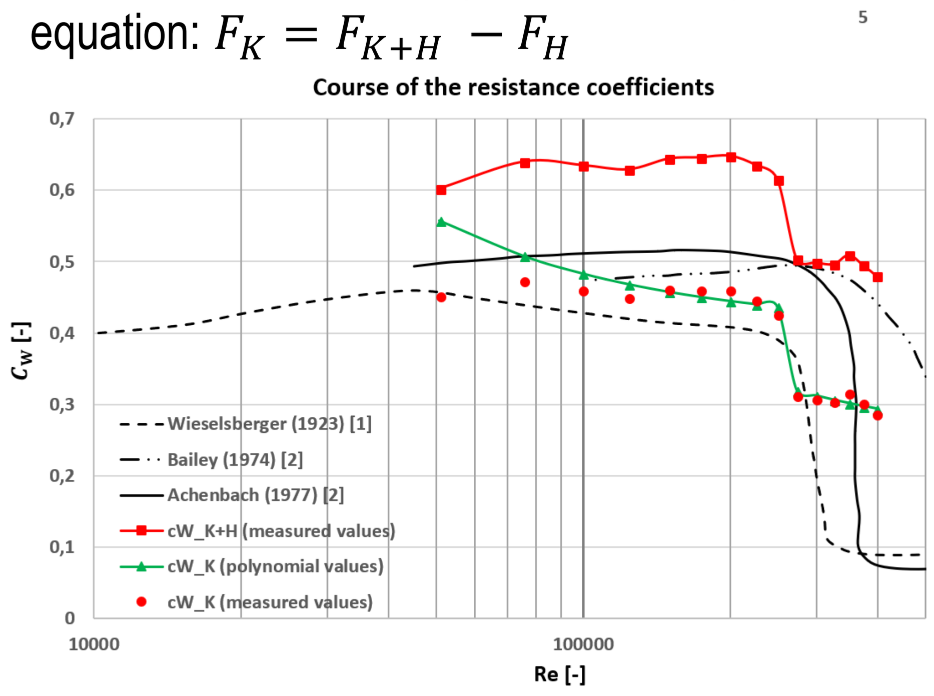

Fig. 8: Course of the resistance coefficients of the sphere with the stem $C_{W_{K+H}}$ and the sphere on its own C_{W_K}

The generated data help to determine the course of the drag coefficients (Fig. 8). The red graph once again represents the sphere including the mounting stem while the green graph shows the resistance coefficient of the sphere on its own, calculated by the polynomial functions depicted in Fig. 7.

5. References

[1] Böswirth, Bschorer, *Technische Strömungslehre*, Wien und Ingolstadt, 2014
[2] Bohl, Elmendorf, *Technische Strömungslehre*, Heilbronn, 2008