HM 172

Supersonic wind tunnel with Schlieren optics

Description

- **pressure curves and pressure losses at subsonic and supersonic flow**
- **interchangeable walls in the measuring section for velocities up to Mach 1,8**
- **schlieren optics for visualisation of Mach lines and shock waves on drag bodies**

Subsonic and supersonic flows behave differently. Thus for example, a contraction in cross-section of the flow at subsonic speed causes an increase in velocity, and at supersonic speed causes velocity to slow down. Understanding these fundamental phenomena of supersonic flows helps in the design of e.g. gas and steam turbines, jets or rockets.

HM 172 is an "Eiffel" type open wind tunnel used to study the aerodynamic properties of various drag bodies at subsonic or supersonic flow.

A fan draws in air from the environment through the supersonic wind tunnel. There is a subsonic nozzle located at the air inlet, in which the intake air accelerates. The carefully designed contour of the subsonic nozzle with integrated flow straightener ensures a uniform velocity distribution with little turbulence in the subsequent measuring section. In the closed measuring section, the air is accelerated further and flows around a drag body (rocket, projectile, double wedge and wedge). Further down the supersonic wind tunnel, the air flow in slowed down in supersonic and subsonic diffusers and comes through a suction filter into the fan. Here, the air is compressed and then emitted back into the environment. A sound damper at the air outlet limits the sound level.

Interchangeable walls with different contours are used in the measuring section to generate flow velocities up to Mach 1,8.

The Schlieren optics supplied allow direct observation of the supersonic flow and the resulting shock fronts. Pressures are detected with sensors, transmitted directly to a PC via USB and analysed there using the software supplied. Additionally, the pressure is displayed on a manometer at the measuring point. The continuous method of operation means there is enough time available for observation and taking measurements.

Learning objectives/experiments

- pressure curves in supersonic nozzles (Laval nozzle)
- pressure curves and losses in tunnel flows with Mach >1
- observe shock waves in drag bodies using Schlieren optics
- determining the Mach number from the angle of the shock waves
- comparison of theory and experiment

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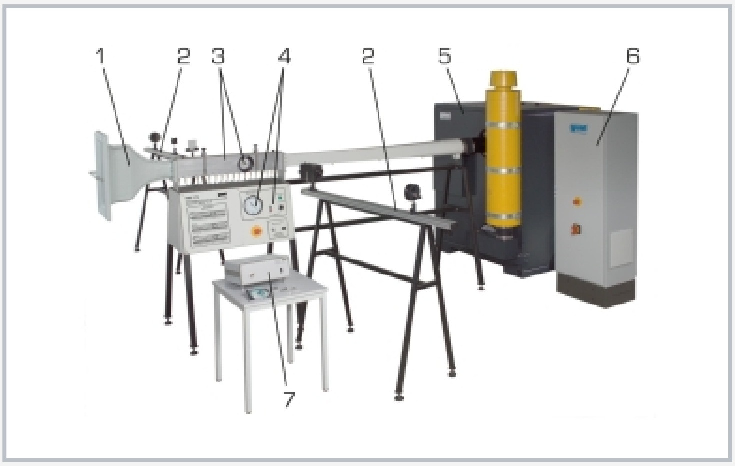
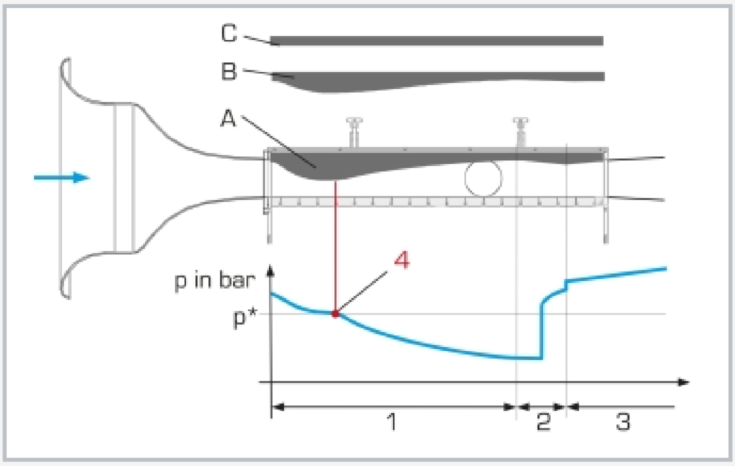
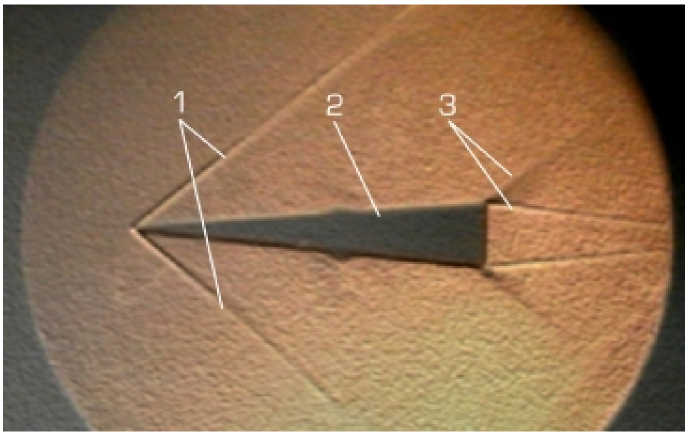


1 supersonic wind tunnel, air inlet, 2 Schlieren optics (two piece), 3 measuring section with two sight windows, 4 control panel with manometer, 5 fan, 6 switch cabinet, 7 data acquisition for pressure



Measuring section with interchangeable walls: A Laval contour: Ma 1,8, B Laval contour: Ma 1,4, C straight contour: Ma less than 1
1 supersonic nozzle, 2 supersonic diffuser, 3 subsonic diffuser, 4 narrowest point in the nozzle; p* critical pressure ratio, blue pressure curve in the measuring section



Shot of a Schlieren image: 1 mach lines form a cone-shaped shock front (Mach cone), 2 wedge drag body, 3 shock fronts at the end of wedge

Specification

[1] investigation of pressure curves in supersonic flow
[2] visualisation of Mach lines and shock waves using Schlieren optics
[3] continuously operating, open supersonic wind tunnel, low pressure principle
[4] positive displacement fan with variable speed
[5] interchangeable walls in the measuring section produce velocities up to Mach 1,8
[6] drag bodies: rocket, projectile, double wedge and wedge
[7] manometer for displaying the pressure in the measurement point
[8] GUNT software for data acquisition via USB under Windows 10

Technical data

Positive displacement fan, variable speed
- sound-dampened, max. 84dB(A)
- power consumption: 55kW

Supersonic wind tunnel
- cross-section of the measuring section: 100x25mm
- interchangeable walls for measuring section
  - 1x straight contour: Ma>1
  - 2x Laval contours: Ma 1,4 and Ma 1,8

Schlieren optics
- halogen lamp with 50W and 100W
- 2 adjustable parabolic mirrors
- adjustable slit diaphragm
- screen for Schlieren optics

Drag bodies
- wedge, double wedge, projectile, rocket

Recommended ambient conditions:
40% rel. humidity at 25°C

400V, 50Hz, 3 phases
LxWxH: 3500x810x1720mm (wind tunnel)
LxWxH: 1420x1600x1750mm (fan)
LxWxH: 1710x580x1450mm (Schlieren optics)
Weight: approx. 1550kg (total)

Required for operation

PC with Windows recommended

Scope of delivery

1 supersonic wind tunnel
3 walls for measuring section
1 Schlieren optics (two piece)
4 drag bodies
1 CD with GUNT software + USB cable
1 fan
1 set of instructional material