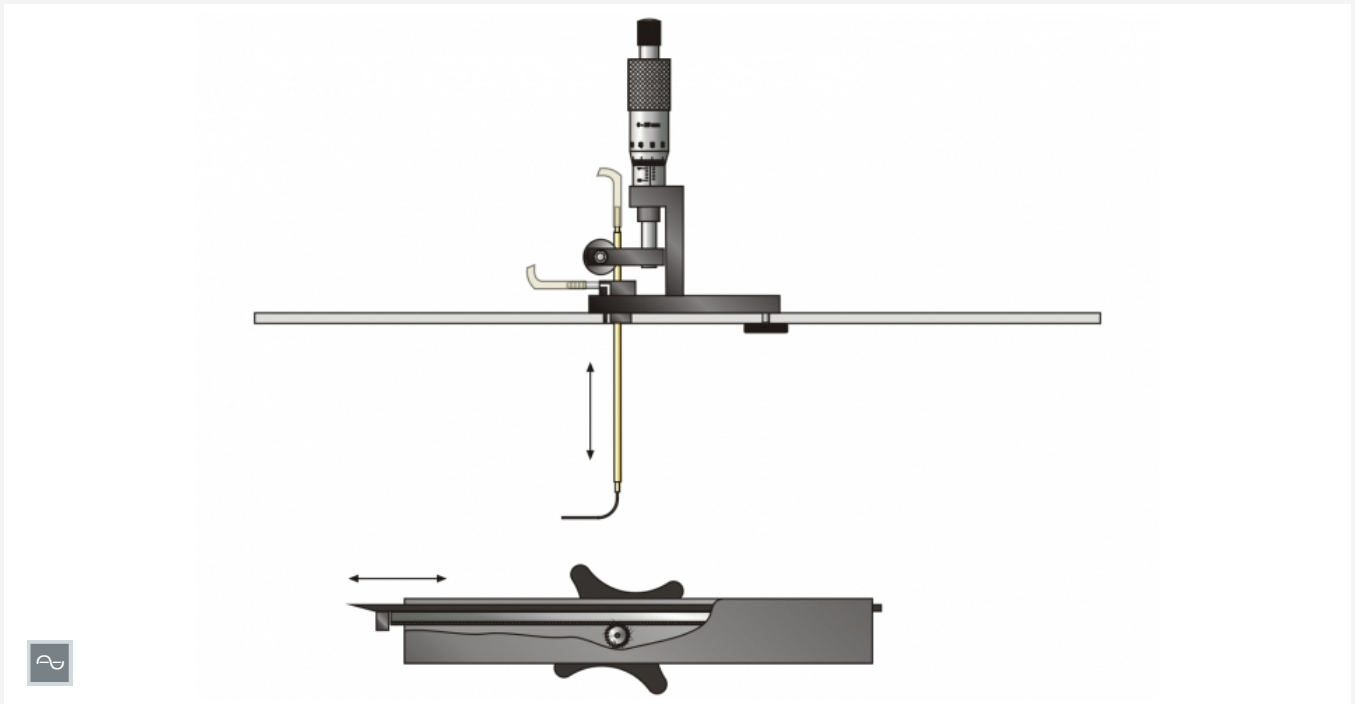


# HM 170.24

## Boundary layer analysis with Pitot tube



### Description

- investigation of the boundary layer on a flat plate with flow along the plate
- two plates with different surfaces
- Pitot tube for measuring the total pressure

During incident flow of bodies fluids such as air “stick” to the surface of the body and form the so-called boundary layer. The kind of flow within the boundary layer – laminar or turbulent – significantly affects the drag. The findings from studying the boundary layer are taken into consideration when designing aerofoils (aircraft construction), turbine blades (turbine construction) and hull, rudder and propeller blades (shipbuilding).

The HM 170.24 experimental unit – used in the wind tunnel HM 170 – allows the boundary layer on a flat plate to be studied. For this purpose, the plate is inserted into the measuring section of the wind tunnel. The air flows along the plate, parallel to the surface. Two plates with different surface roughnesses are available to demonstrate the effect of surface conditions on the boundary layer.

A vertically movable Pitot tube, adjusted using a micrometer screw, measures the total pressures at various distances from the plate surface. The plate can be moved horizontally, to enable the recording of total pressures along the flow. An additional measuring point measures the static pressure. Both measuring points are connected to a manometer. The velocity can then be calculated from the displayed dynamic pressure. To indicate the pressure, the following units are optionally available: inclined tube manometer included in HM 170, differential pressure manometer HM 170.53, electronic pressure measurement HM 170.55 or system for data acquisition HM 170.60.

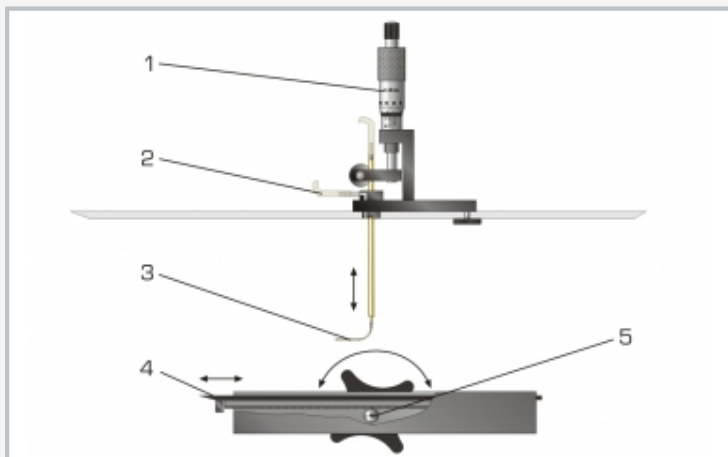
The measured values for the dynamic pressure depending on the distance of the Pitot tube to plate front edge can be displayed graphically by using the system for data acquisition HM 170.60 and the electronic displacement measurement HM 170.61.

### Learning objectives/experiments

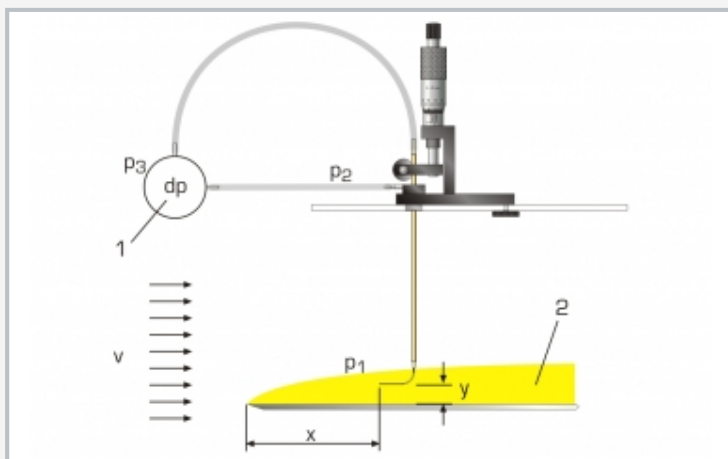
- measure total pressure with Pitot tube
- measure static pressure
- determine velocity via dynamic pressure
- study the vertical velocity profile at the measuring point
- study the boundary layer thickness
- influence of surface roughness on the boundary layer

# HM 170.24

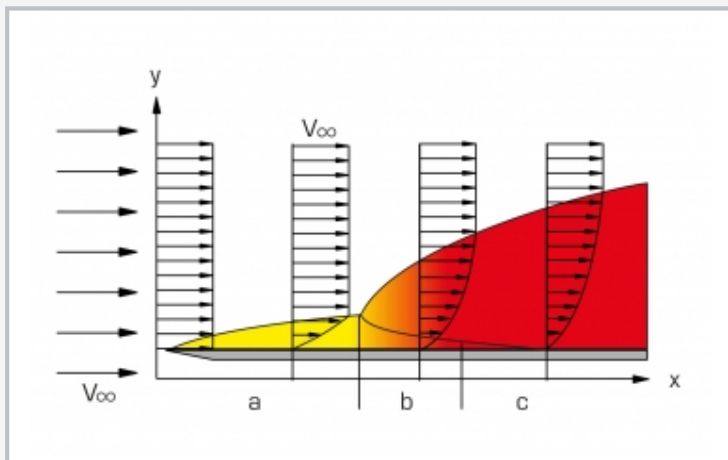
## Boundary layer analysis with Pitot tube



1 micrometer screw for vertical adjustment of the Pitot tube, 2 measuring point for static pressure, 3 Pitot tube, 4 plate, 5 toothed rack with hand wheel for moving the plate horizontally



Measuring the dynamic pressure: 1 differential pressure measurement, 2 boundary layer;  $p_1$  total pressure,  $p_2$  static pressure,  $p_3$  dynamic pressure;  $x$  horizontal distance between the front edge of the plate and Pitot tube,  $y$  vertical distance between plate and Pitot tube,  $v$  flow



Structure of a boundary layer on a flat plate:  $y$  boundary layer thickness; a laminar flow, b change into turbulent flow, c turbulent flow;  $v$  flow velocity

### Specification

- [1] investigation of the boundary layer on a flat plate with flow along the plate
- [2] accessory for the wind tunnel HM 170
- [3] 2 plates with different surface roughnesses
- [4] Pitot tube for measuring the total pressure at the plate
- [5] additional measuring point for measuring the static pressure
- [6] horizontal adjustment of the plate using toothed rack
- [7] vertical adjustment of the Pitot tube using micrometer screw
- [8] the following units can be used for dynamic pressure indication: inclined tube manometer included in HM 170, differential pressure manometer HM 170.53, electronic pressure measurement HM 170.55 or system for data acquisition HM 170.60
- [9] displaying measured values on the PC using the software in HM 170.60 and the electronic displacement measurement HM 170.61

### Technical data

- 2 plates with scale
- aluminium, anodized black
  - LxW: 250x279mm, thickness: 3mm
  - chamfer: 15°
  - smooth surface: 25 $\mu$ m
  - rough surface: 400 $\mu$ m
  - horizontal adjustment: 180mm

### Pitot tube

- inner diameter: 0,7mm
- vertical adjustment: 25mm

### Micrometer screw

- resolution: 0,01mm

LxWxH: 600x400x120mm (storage system)

Weight: approx. 5kg

### Scope of delivery

- 1 experimental unit
- 2 plates
- 1 storage system with foam inlay
- 1 set of instructional material

# HM 170.24

## Boundary layer analysis with Pitot tube

### Required accessories

070.17000	HM 170	Open wind tunnel
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### Optional accessories

070.17050	HM 170.50	16 tube manometers, 600mm
070.17053	HM 170.53	Differential pressure manometer
070.17055	HM 170.55	Electronic pressure measurement for HM 170
070.17060	HM 170.60	System for data acquisition
070.17061	HM 170.61	Electronic displacement measurement