

P 1.8.5

Introductory experiments in aerodynamics

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Determining the volume flow with a Venturi tube – measuring the pressure with the precision manometer (P 1.8.5.2)

The study of aerodynamics relies on describing the flow of air through a tube using the continuity equation and the Bernoulli equation. These state that regardless of the cross-section *A* of the tube, the volume flow

$$\dot{V} = v \cdot A$$

v: flow speed

and the total pressure

$$p_0 = p + p_S \text{ where } p_S = \frac{\rho}{2} \cdot v^2$$

p: static pressure, *p_S*: dynamic pressure, *ρ*: density of air remain constant as long as the flow speed remains below the speed of sound.

In order to verify these two equations, the static pressure in a Venturi tube is measured for different cross-sections in the first experiment. The static pressure decreases in the reduced cross-section, as the flow speed increases here.

The second experiment uses the Venturi tube to measure the volume flow. Using the pressure difference $\Delta p = p_2 - p_1$ between two points with known cross-sections *A₁* and *A₂*, we obtain

$$v_1 \cdot A_1 = \sqrt{\frac{2 \cdot \Delta p \cdot A_2^2}{\rho \cdot (A_2^2 - A_1^2)}}$$

The third experiment aims to determine flow speeds. Here, dynamic pressure (also called the “pressure head”) is measured using the pressure head sensor after *Prandtl* as the difference between the total pressure and the static pressure, and this value is used to calculate the speed at a known density *ρ*.

Cat. No.	Description	P 1.8.5.1-2	P 1.8.5.3	P 1.8.5.4-5	P 1.8.5.6
373 04	Suction and pressure fan	1	1	1	1
373 09	Venturi tube with 7 gauge points	1		1	
373 10	Precision manometer	1	1		
373 13	Pressure head		1		1
524 010	Sensor CASSY			1	1
524 066	Pressure sensor S, ± 70 hPa			1	1
524 200	CASSY Lab			1	1
300 02	Stand base, V-shape, 20 cm	2	1	1	
300 11	Saddle base		1	1	2
300 41	Stand rod, 25 cm	1		1	
300 42	Stand rod, 47 cm	1	1		
301 01	Leybold multiclamp	2	1	1	
	<i>additionally recommended:</i>				
	1 PC with Windows 95/NT or higher			1	1

Note: In the first three experiments, the precision manometer is used to measure pressures. In addition to a pressure scale, it is provided with a further scale which indicates the flow speed directly when measuring with the pressure head sensor. In the last three experiments the pressure is measured with a pressure sensor and recorded and evaluated using the computer-assisted measuring system CASSY.