HM 230
Flow of compressible fluids

Description

- investigation of flow in compressible fluids
- varied range of experiments for studying subsonic and transonic flow
- de Laval nozzle generates velocities up to Ma 1

Compressible fluids change their density due to pressure change in the flow. Flows with velocities less than Ma 0.3 are regarded as incompressible and the change in density is negligible. At higher velocities, the density has to be included in calculations. These conditions must be taken into consideration when designing e.g. turbo compressors, jets and fast planes.

The HM 230 experimental unit is used to investigate air flow in various ranges of velocity.

A radial fan with infinitely variable speed control draws air in from the environment. At the intake the air flow is accelerated in a measuring nozzle. Further down the measuring section the air flows through interchangeable measuring objects. Drawing in the air and the arrangement of the measuring objects on the intake side of the fan minimise turbulence when flowing into the measuring objects. All measuring objects are made of transparent material and provide excellent insight into the inner structure.

Pressure losses are studied in a pipe elbow, various pipe sections and a nozzle with sudden enlargement. The nozzle with gradual enlargement (de Laval nozzle) provides an introduction to the topic of transonic flow. The volumetric flow rate is measured in an orifice using a differential pressure manometer. The orifice is fitted with four interchangeable orifice disks for different measurement ranges. The fan’s characteristic curve can also be recorded by using a throttle valve.

The measured values for volumetric flow rate, pressure and speed are displayed digitally.

Learning objectives/experiments

- pressure losses in pipes and pipe elbows
- flow in convergent/divergent nozzles
- supersonic flow in the de Laval nozzle
- determine the speed of sound in air
- compare calculation methods for incompressible and compressible flow
- use complete continuity equation
- determine mass flow rate using nozzle and volumetric flow rate using orifice
- record calibration curve for orifice
- record fan characteristic curve at different mass flow rates and speeds
**HM 230**

**Flow of compressible fluids**

![Experimental setup diagram](image)

**1** pipe elbow, **2** pipe section, **3** measuring nozzle, **4** nozzle with sudden enlargement, **5** nozzle with gradual enlargement (de Laval nozzle), **6** orifice, **7** throttle valve, **8** suction opening fan, **9** switch cabinet with display and control elements (integrated radial fan)

**Measuring objects**

- **A** orifice, **1** interchangeable orifice disks
- **B** nozzle with sudden enlargement
- **C** nozzle with gradual enlargement (de Laval nozzle)

**Specification**

1. investigate flow of compressible fluids
2. subsonic and transonic air flow
3. variable speed on the radial fan for adjusting the mass flow rate
4. minimised turbulence by drawing in air and optimum arrangement of the measuring objects
5. transparent measuring objects with connectors for pressure measurement provide insight into the internal structure
6. measuring nozzle for determining the mass flow rate
7. pressure losses in subsonic flow in pipe elbows and various pipe sections
8. pressure curve at subsonic and transonic nozzle flow
9. orifice for determining volumetric flow rate by differential pressure measurement
10. record fan characteristic curve using a throttle valve
11. digital displays for pressures, velocity and speed

**Technical data**

**Radial fan**

- max. speed: $31000 \text{min}^{-1}$
- max. volumetric flow rate: $226 \text{m}^3/\text{h}$
- max. head: 318 mbar
- max. power consumption: 1.8 kW

**Measuring objects**

- pipe section: 1m
  - Ø 16, 24, 34 mm
- 90° pipe elbow
- 2 nozzles, inner diameter: 12...34 mm
  - with sudden enlargement
  - with gradual enlargement (de Laval nozzle)
- orifice with orifice disks
  - Ø 12, 19, 25, 32 mm
- throttle valve: Ø 34 mm

**Measuring ranges**

- speed: 0...999999 m/s
- pressure:
  - 1x 0...25 mbar
  - 1x 0...600 mbar
  - 1x 0...1000 mbar
- velocity: 0...65 m/s

**230V, 50Hz, 1 phase**

**120V, 60Hz, 1 phase, 230V, 60Hz, 1 phase**

**UL/CSA optional**

LxWxH: 1750x600x390 mm

Weight: approx. 58 kg

**Scope of delivery**

1. experimental unit
2. set of measuring objects
3. set of tools
4. set of instructional material

G.U.N.T. Gerätebau GmbH, Hanskampring 15-17, D-22885 Barsbüttel, Telefon (040) 67 08 54-0, Fax (040) 67 08 54-42, Email sales@gunt.de, Web www.gunt.de

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