HM 230 Flow of Compressible Fluids

*** Investigation of flow in compressible fluids**

*** Varied range of experiments for studying incompressible, subsonic and transonic flow**

*** de Laval nozzle generates velocities up to Ma 1**

Technical Description

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 sucks in air from the environment. At the intake the air flow is accelerated in a measuring nozzle. Further down the measurement section the air flows through interchangeable measuring objects. Sucking in the air and the arrangement of the measuring objects on the suction 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 volume flow 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 volume flow, pressure and speed are captured by sensors and displayed digitally.

The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.

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 using nozzle and volume flow using orifice
- record calibration curve for orifice
- record fan characteristic curve at different mass flows and speeds

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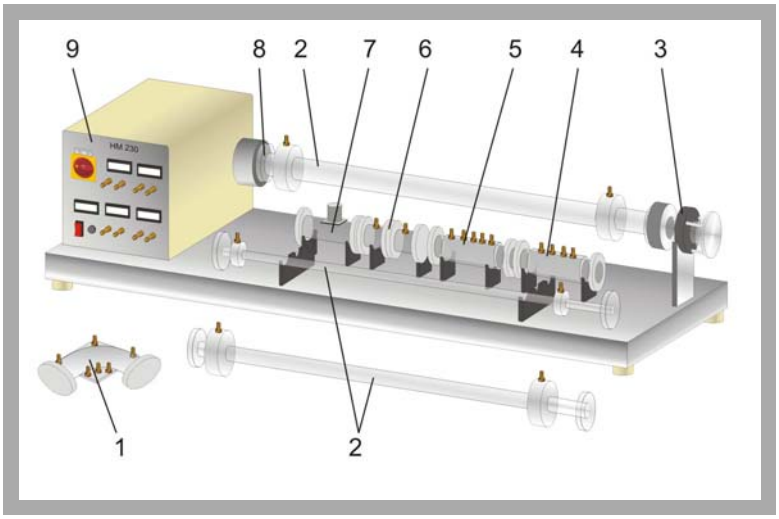
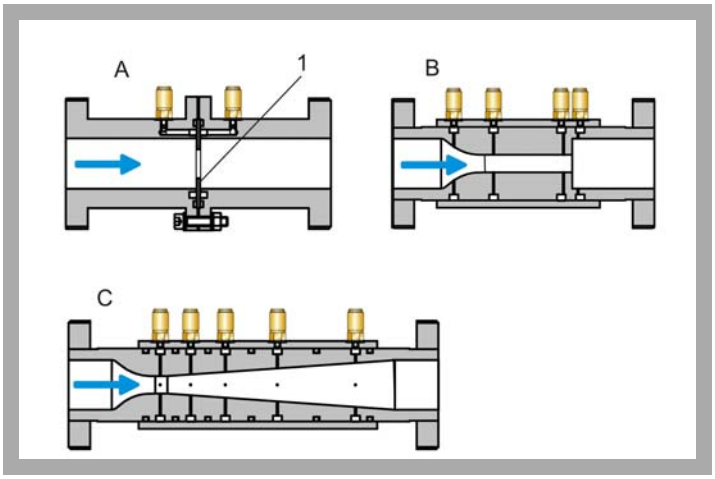
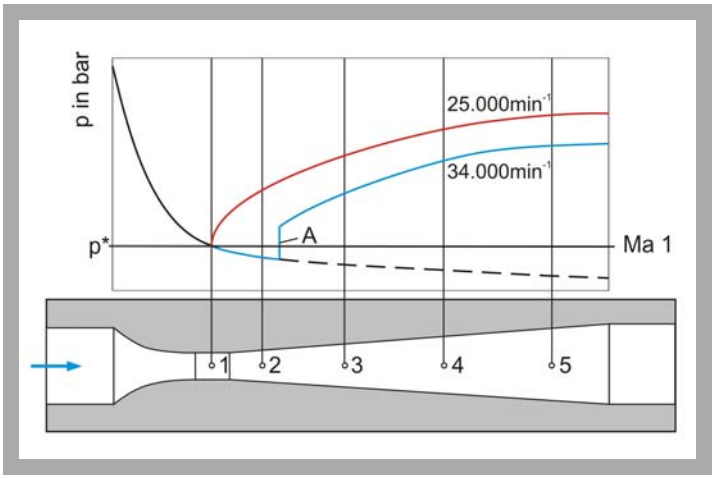


1 pipe elbow, 2 pipe section, 3 measuring nozzle, 4 nozzle with sudden enlargement, 5 nozzle with gradual enlargement (de Laval nozzle), 6 orifice, 7 throttle valve, 8 suction opening, 9 switch cabinet with display and control elements (integrated radial fan)



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



Pressure curves in the nozzle with gradual enlargement (de Laval nozzle) in compressible flow; 1-5 pressure measuring points, p* critical pressure ratio, A shock wave

Specification

[1] investigate flow of compressible fluids
[2] incompressible, subsonic and transonic air flow
[3] variable speed on the radial fan for adjusting the mass flow
[4] minimised turbulence by sucking 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
[7] pressure losses in incompressible flow in pipe elbows and various pipe sections
[8] pressure curve at subsonic and transonic nozzle flow
[9] orifice for determining volume flow by differential pressure measurement
[10] record fan characteristic curve using a throttle valve
[11] digital displays for volume flow, speed and pressure

Technical Data

Radial fan
- max. speed: 37.000min^{-1}
- max. intake air flow: 206m³/h
- max. head: 271mbar
- max. power consumption: 1,6kW

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

Measuring ranges
- speed: 0...99.999min^{-1}
- volume flow: 0...0,0500m³/s
- pressure: 1x 0...25mbar; 1x 0...200mbar; 1x 0...1.000mbar

Dimensions and Weight

LxWxH: 1.750x600x345mm
Weight: approx. 50kg

Connections

230V, 50/60Hz/CSA, 1 phase or 120V, 60Hz/CSA, 1 phase or 230V, CSA, 3 phases

Scope of Delivery

1 experimental unit
1 set of measuring objects
1 set of tools
1 set of instructional material

Order Details

070.23000 HM 230 Flow of Compressible Fluids

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