HM 150.20
Operating principle of a Francis turbine

The illustration shows the device on the work surface of the HM 150 base module and the GUNT Media Center, tablet not included

Description

- **model of a reaction turbine**
- **transparent operating area**
- **turbine with adjustable guide vanes**
- **flow visualisation using CFD technology**
- **multimedia teaching material online in the GUNT Media Center: E-Learning course, prepared CFD simulations, worksheets, videos**

The Francis turbine is a type of reaction turbine which converts the pressure energy of the water into kinetic energy in the distributor and in the rotor. The water is fed in the distributor by means of a spiral housing. The flowing water is accelerated in the distributor by the adjustable guide vanes and directed onto the blades. The redirection and further acceleration of the water in the rotor generates an impulse which is transmitted to the rotor.

HM 150.20 is the model of a Francis turbine demonstrating the function of a reaction turbine. The experimental unit consists of the rotor, the distributor with adjustable guide vanes, a band brake for loading the turbine and a housing with a transparent front panel. The transparent cover enables to observe the water flow, the rotor and the guide vanes

during operation. The angle of attack and thus the power of the rotor are modified by adjusting the guide vanes. The turbine torque is determined by force measurement on a band brake and is read on spring balances. For measuring the rotational speed, a non-contact speed sensor, e.g. HM 082, is required. A manometer shows the water pressure at the turbine inlet.

The experimental unit is positioned easily and securely on the work surface of the HM 150 base module. The water is supplied and the flow rate measured by HM 150. Alternatively, the experimental unit can be operated by the laboratory supply.

In order to perform a virtual analysis of flow behaviour, CFD simulations are often used in practice. Such simulations allow, for example, flow visualisations in areas that cannot be visualised experimentally. In the GUNT Media Center, flow visualisations based on CFD calculations are available online. There are also multimedia teaching materials including E-Learning courses on basic knowledge and calculations. Videos show a complete experiment with preparation, execution and evaluation. Worksheets with solutions supplement the teaching material.
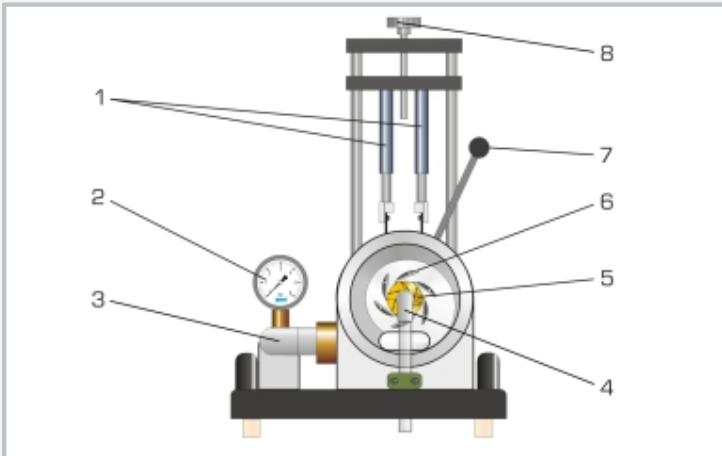
Learning objectives/experiments

- design and function of a Francis turbine
- determination of torque, power and efficiency
- graphical representation of characteristic curves for torque, power and efficiency

GUNT Media Center, develop digital skills
- E-Learning course with fundamental knowledge and calculations
- prepared CFD simulations for flow visualisation
- videos with detailed demonstration of the experiments: preparation, execution, evaluation
- assured learning success through digital worksheets
- retrieve information from digital networks

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HM 150.20
Operating principle of a Francis turbine

1 spring balance, 2 manometer, 3 water inlet, 4 water outlet, 5 rotor, 6 guide vanes, 7 adjustment of the guide vanes, 8 adjustment of the band brake
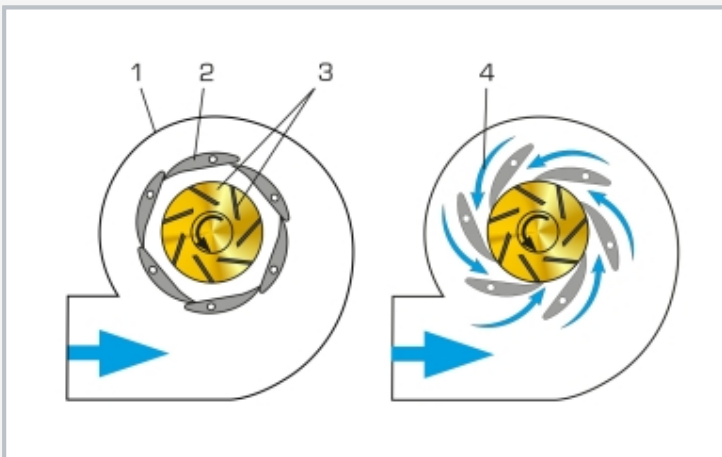
Operating principle of the Francis turbine: 1 spiral housing, 2 guide vane, 3 rotor with blades, 4 flow; on the left: guide vane position closed, Q=0, P=0; on the right: guide vane position open, Q=max., P=max.
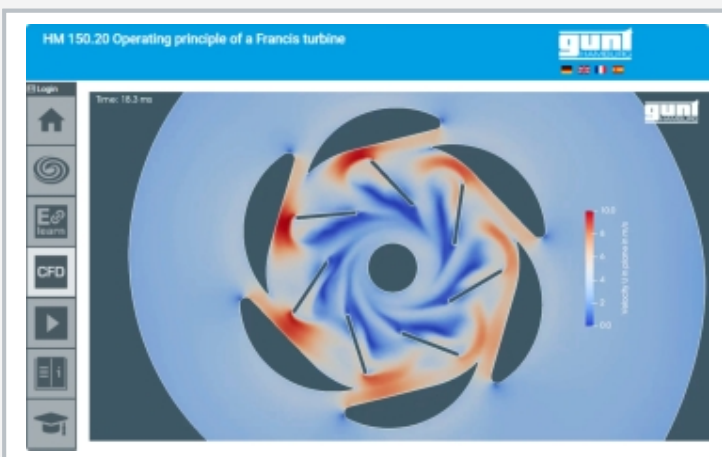
Screenshot of the GUNT Media Center

Specification

[1] function of a Francis turbine
[2] transparent front panel for observing the operating area
[3] loading the turbine by use of the band brake
[4] adjustable guide vanes for setting different angles of attack
[5] marking on brake drum for non-contact speed measurement
[6] instruments: spring balances for determining the torque, manometer shows pressure at turbine inlet
[7] flow determination by base module HM 150
[8] water supply using the base module HM 150 or via lab supply
[9] flow visualisation using prepared CFD simulations
[10] digital multimedia teaching material online in the GUNT Media Center: E-Learning course, prepared CFD simulations, worksheets, videos

Technical data

Turbine
- output: 12W at n=1100min^{-1}, approx. 40L/min, H=8m
- rotor
  - 7 blades
  - blade width: 5mm
  - external Ø: 50mm
- guide vanes
  - 6 vanes, adjustable (20 stages)

Measuring ranges
- force: 2x 0...10N
- pressure: 0...1,0bar

LxWxH: 400x400x630mm
Weight: approx. 17kg

Required for operation

HM 150 (closed water circuit) or water connection, drain;
PC or online access recommended

Scope of delivery

1 experimental unit
1 set of instructional material
1 online access to the GUNT Media Center

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Optional accessories

HM 150	Base module for experiments in fluid mechanics
HM 082	Speed sensor