HM 150.20
Operating principle of a Francis turbine

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

Description

- **model of a reaction turbine**
- **transparent operating area**
- **turbine with adjustable guide vanes**
- **loading by band brake**

Water turbines are turbomachines utilising water power. 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.
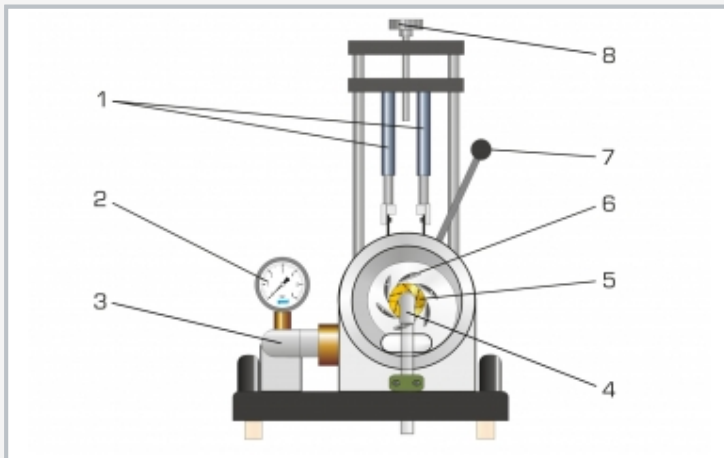
The experimental unit consists of the rotor, the distributor with adjustable guide vanes, a band brake for loading the turbine and a housing with a transparent front panel. The transparent cover enables to observe the water flow, the rotor and the guide vanes during operation. The angle of attack and 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.

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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
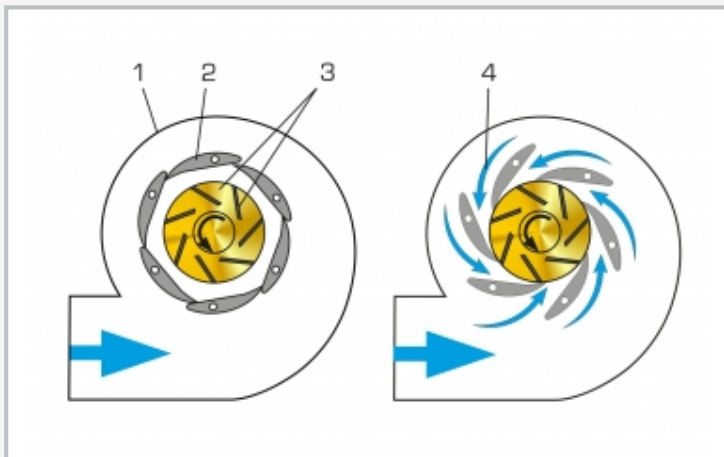
Operating principle of the Francis turbine: 1 spiral housing, 2 guide vane,
3 rotor with blades, 4 flow; on the left: guide vane position closed, Q=0, P=0;
on the right: guide vane position open, Q=max., P=max.
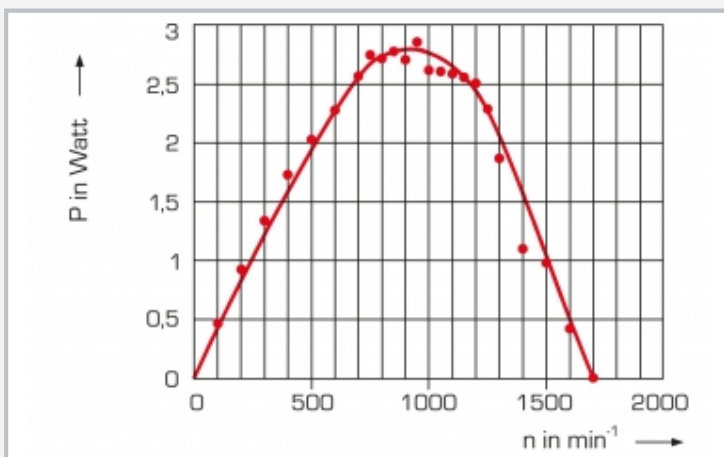
Characteristic curve for power output on the turbine shaft;
P turbine power output, n speed

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

Technical data

Turbine
- output: 12W at n=1100min^{-1}, approx. 40L/min, H=8m
- rotor, 7 blades
  blade width: 5mm
  external diameter: 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

Scope of delivery

1 experimental unit
1 set of instructional material

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Optional accessories

070.15000	HM 150	Base Module for Experiments in Fluid Mechanics
070.08200	HM 082	Speed sensor

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