

# HM 430C

## Francis turbine trainer



### Description

- **characteristics of a powerful Francis turbine**
- **optimal view of the operating area of the turbine**
- **adjustable guide vanes for setting the output**

The Francis turbine belongs to the reaction turbines which convert pressure energy of the working medium into kinetic energy in the guide vanes and in the rotor. Francis turbines are used for medium heads. The turbine power is controlled by adjusting the guide vanes. In practice, Francis turbines are used in run-of-river power plants and in pumped storage plants.

HM 430C enables examinations of the function and operating behaviour of a Francis turbine. The dimensions of the trainer guarantee realistic measured values. The closed water circuit consists of a tank with optional cooling, a centrifugal pump and a flow control valve for adjusting the inlet pressure. The transparent operating area of the turbine enables an optimal view of water flow, rotor and guide vanes during operation.

By adjusting the guide vanes the angle of attack, the cross-section and thus the output of the turbine are changed. An asynchronous machine is used as a generator for loading the turbine. A pump with variable speed via frequency converter provides for an energy efficient operation.

The speed of the turbine is recorded by means of an inductive, non-contact position sensor at the generator shaft. The generator is equipped with a pendulum bearing and with a force sensor to determine the torque.

The pressures at the inlet and outlet of the turbine, the temperature and the flow rate are recorded by sensors. The measured values are displayed digitally and can be processed further on a PC.

The output data of the examined turbine are determined and can be represented by characteristic curves.

### Learning objectives/experiments

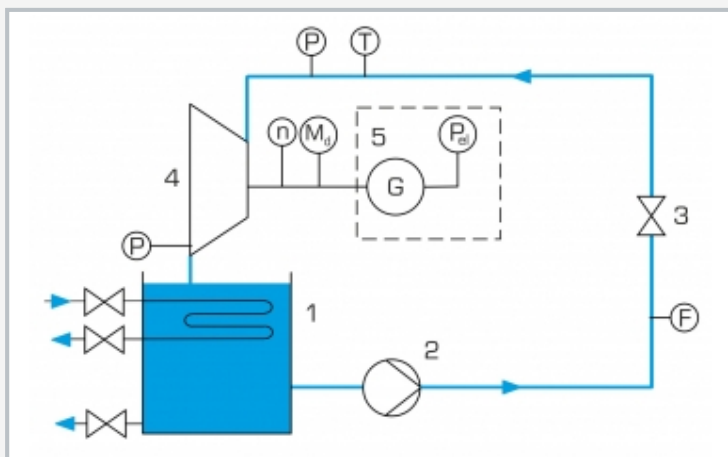
- investigation of the conversion of hydraulic into mechanical energy
- determination of the mechanical power and hydraulic power of the turbine
- determination of efficiency
- recording of characteristic curves
- investigation of the influence of the guide vane position
- velocity triangles

# HM 430C

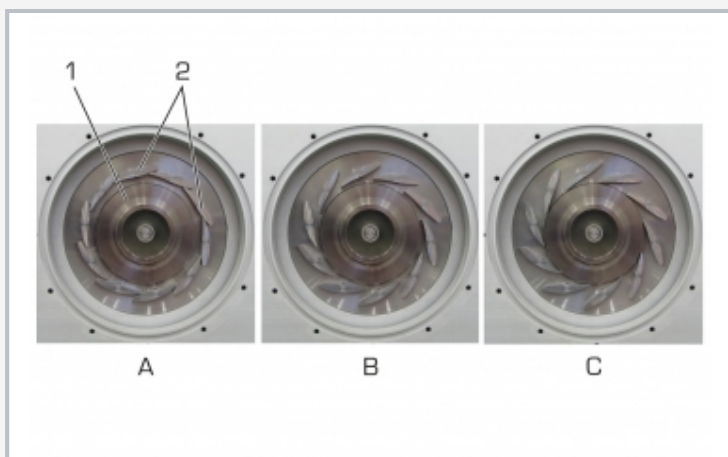
## Francis turbine trainer



1 asynchronous machine, 2 pump, 3 tank, 4 pressure display at turbine outlet, 5 turbine, 6 adjustment of guide vanes, 7 pressure display at turbine inlet, 8 flow control valve, 9 switch cabinet with displays and controls



1 tank with optional cooling, 2 centrifugal pump, 3 flow control valve, 4 Francis turbine, 5 generator; P pressure, T temperature, F flow rate, n speed,  $M_d$  torque,  $P_{el}$  electrical power



Front view of the Francis turbine: 1 rotor, 2 adjustable guide vanes; guide vane position: A closed, B half open, C open

### Specification

- [1] investigation of a Francis turbine
- [2] closed water circuit with pump, motor, flow control valve and tank with optional cooling
- [3] pump with variable speed via frequency converter
- [4] adjustment of flow rate via flow control valve
- [5] loading the turbine by use of the asynchronous machine as generator
- [6] rotor and guide vanes of the turbine completely visible
- [7] adjustable guide vanes for setting different angles of attack
- [8] non-contact speed measurement at the generator shaft and force sensor for measuring the driving torque
- [9] digital display for temperature, flow rate and reserves (additional manometer within scope of supply), speed, torque and electrical power of generator
- [10] GUNT software for data acquisition via USB under Windows 8.1, 10

### Technical data

#### Francis turbine

- hydraulic power: 2,1kW at 1500min<sup>-1</sup>
- mechanical power: approx. 1,4kW at 1500min<sup>-1</sup>
- rotor, D: 120mm, 15 blades
- 10 guide vanes, angle of attack adjustable: 0...23°

#### Centrifugal pump, multistage

- variable speed
- power consumption: 5,5kW
- max. flow rate 900L/min
- pump head 42m

#### Tank: 550L

#### Asynchronous machine as generator

- output: 2,2kW at 1440min<sup>-1</sup>
- Measuring ranges
- temperature: 0...100°C
  - pressure (inlet): ±1 bar (turbine)
  - pressure (outlet): 0...6bar (turbine)
  - flow rate: 0...1000L/min
  - torque: 0...20Nm
  - speed: 0...3000min<sup>-1</sup>
  - power: 0...2200W (generator)

400V, 50Hz, 3 phases

400V, 60Hz, 3 phases, 230V, 60Hz, 3 phases

UL/CSA optional

LxWxH: 2350x1050x2050mm

Weight: approx. 580kg

### Required for operation

PC with Windows recommended

### Scope of delivery

- 1 trainer
- 1 GUNT software + USB cable
- 1 set of instructional material