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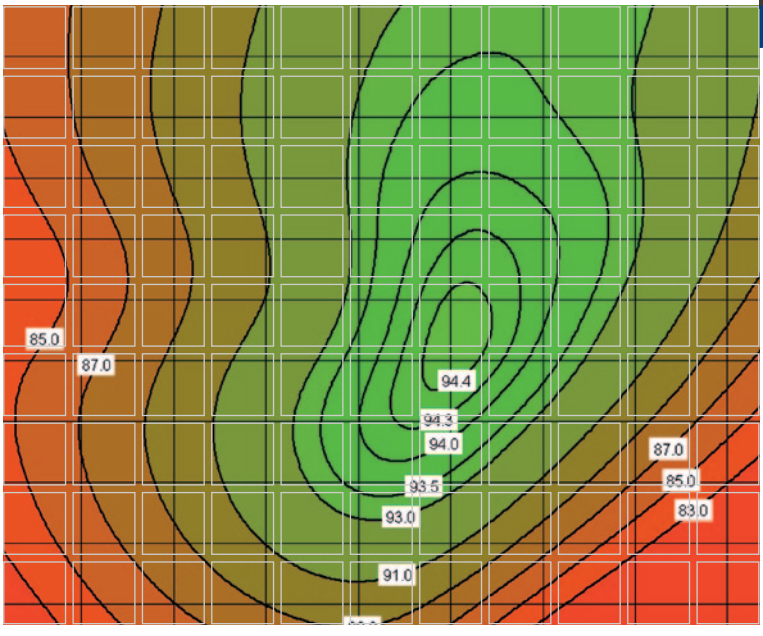

Thermodynamic efficiency measurements

Plant measurements
according to IEC 62006, IEC 60041

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▶ The only means to accurately define and optimise the efficiency of plants and assemblies are specific efficiency measurements.

With its expertise in thermodynamic efficiency measurements the Institute of Hydraulic Fluid Machinery (HFM) at the Graz University of Technology – as an independent research institution – is able to offer operators of hydro power plants and industrial clients an accurate tool for the analysis of turbine, pump and pump turbine efficiencies. Highly precise and reliable measurement results provide the basis for acceptance and approval measurements, plant evaluations, optimisations and the calibration of integrated flow rate measurement equipment. Improvements in plant efficiency provide higher profits, lower costs and competitive advantages.

Univ.-Prof. Dr. Helmut Jaberg, TU Graz
Head of the Institute of Hydraulic Fluid Machinery (HFM) and
Head of the study programme 'Master of engineering – hydropower'

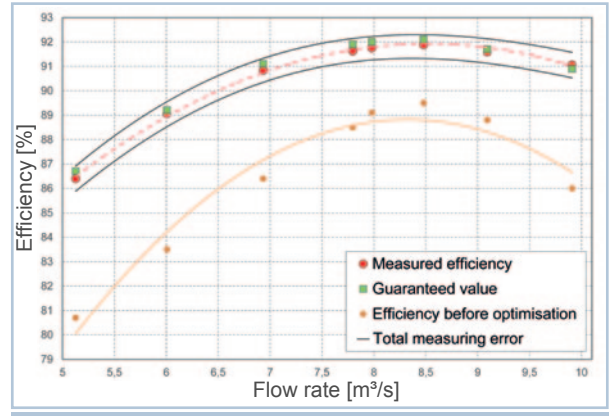

Fig.: Efficiency defined by means of thermodynamic measurement with error band compared to guaranteed values

Independent expertise in measurements

The Institute of Hydraulic Fluid Machinery (HFM) at the Graz University of Technology with its many years of experience is one of the l**eading experts for hydraulic issues** in application-oriented mechanical engineering: **turbines, pumps and pump systems**.
As part of the Graz University of Technology we are a totally independent institution. Benefit from our know-how and get a **neutral, unbiased and reliable assessment** of your plant.

Measurements according to IEC standards

All our efficiency measurements are based on internationally acknowledged IEC standards (International Electrotechnical Commission).

- Field acceptance tests to determine the hydraulic performance of hydraulic fluid machinery (turbines, pumps) are realised according to the standard **IEC 60041**.
- For measurements on small hydro power plants additionally **IEC 62006**, especially developed for such purposes, is applied.

Our measurement system conforming to the applicable standards comprises an online visualisation device to indicate the efficiency development during the measuring process thus providing the **highest levels of traceability and accuracy**. The downtime of a plant necessary for the implementation of the measurements can be minimised and **expensive follow-up measurements can be avoided**.

Targets

The identification of efficiencies is an essential part during the **analysis and optimisation process of existing hydropower or industrial plants** as it provides the necessary data for an exact determination of a plant's profitability (**RoI – Return on Investment**).

- Verification (review/authentication) of plant specifications guaranteed by a manufacturer by means of acceptance/approval measurements
- Identification of decreases in efficiency and of necessary maintenance, repair and replacement works
- Verifications before and after comprehensive revision and repair works
- Inventory of the current situation in order to set out optimisation potential
- Inspection and calibration of integrated measurement equipment
- Trouble shooting in the event of oscillations, pressure fluctuations and noise emissions

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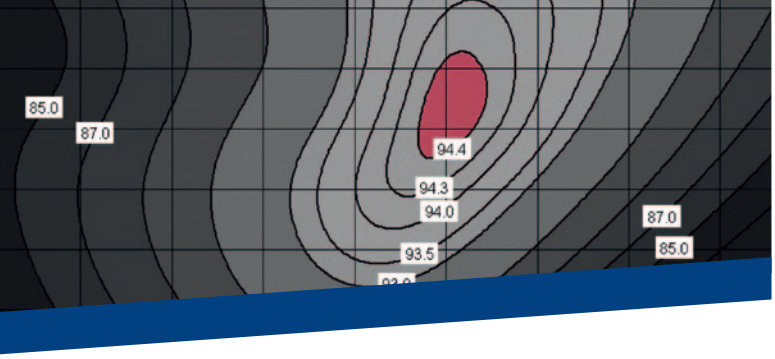
References & Inquiries
www.hfm.tugraz.at/THDWM



Plant efficiency

By means of the so-called thermodynamic method, the absolute efficiency of a plant can be accurately defined within the **performance range of kilowatt sizes up to multi-digit megawatt sizes**.

Method

The measuring procedure is based on the flow losses in a turbine or pump. The minimum increase of the tail water temperature can be measured within a range of a thousandth of one degree Celsius. As the maximum error in measuring the temperature difference is 0,001 °C, **efficiency can be determined with an uncertainty of only 0,4%**.

Preparation and measurement campaign

The planning and the performing of the measurements are realised together with the client whereas the determination of the point of connection for the sensors is essential for measurement accuracy. **All necessary fixtures, installations and auxiliary devices can be designed and manufactured by our institute.**

Analysis

The first evaluation of the measurement results is already carried out on site. The final measurement report consists of measurement logs, graphical presentations of the measurement results, such as e.g. the hydraulic turbine efficiency in reference to the performance or the flow rate, or considerations on systematic and random errors at certain measuring points.

Thermodynamic efficiency measurements

Fields of application:

- Individual adaption of measurement setups to plant characteristics and development of customised software for individual plant applications
- Francis and Pelton turbines
- Pumps and pump turbines

Measuring conditions:

- Applicable to heads of >100 m, upon agreement even to lower ones.
- Measuring point with 1“ pipe thread on the pressure side
- Accessibility of tail water / draft tube

Accuracy of the absolute efficiency:
0.3% to 1% (systematic + random errors)

Our measuring chain:

- High precision temperature sensors (accuracy 0.001 °C)
- Time-synchronous sampling with 40 MHz
- Real-time measurement system with stand-alone feature and online monitoring of the efficiency

Design and manufacturing of necessary measurement installations and auxiliary devices.

Plant measurements worldwide.

Other methods realised acc. to IEC standards

Flow rate:

- Acoustic flow measurements
- Current metre measurements
- Gibson method

Transient measurements:

- Oscillations
- Pressure pulsations

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