

MEASUREMENTS OF HYDRAULIC MACHINE EFFICIENCY USING GIBSON METHOD

Key words: hydropower plant, hydraulic machines, efficiency measurements, flow rate measurements, discharge measurements, pressure-time method, Gibson method

Each unit of hydropower plant equipped with penstock of a length exceeding $4D$ (four times of its internal diameter) is suitable for application of the Gibson method to measure the flow rate through the turbine. In the toughest conditions, with no access to the pipeline shell from the outside, special manifolds for receiving the pressures in measuring cross-sections can be prepared from the inside of the penstocks, after draining the pipeline.

Values of flow rate are calculated from pressure signals by means of the *GIB-ADAM* code, developed by Dr A. Adamkowski, several times validated in laboratory and *in situ* conditions (in years 2003-2010 the Gibson method was successfully applied in energy efficiency research on many hydropower units in Poland: hydropower plants Zarnowiec, Solina, Dychow, Zydowo, Niedzica, Koronowo, Zur, Pilchowice, as well as in Mexico: hydropower plants Angostura, Infiernillo, Chicoasen, Aquamilpa, Malpaso, Temascal, Villita, Villita, Cobano, Novillo, Santa Rosa, Bacurato).

Pressures or water levels are measured using high precision transducers, class 0.2% or better.

Active power, generated by a tested hydro-set, is measured by means of the power transducers, class 0.2%. Mechanical (on the turbine shaft) power is calculated from measured active power value with taking account of generator efficiency.

Measured values of turbine efficiency uncertainties, determined for tested conditions, are usually contained between 1.2 % and 1.5%.

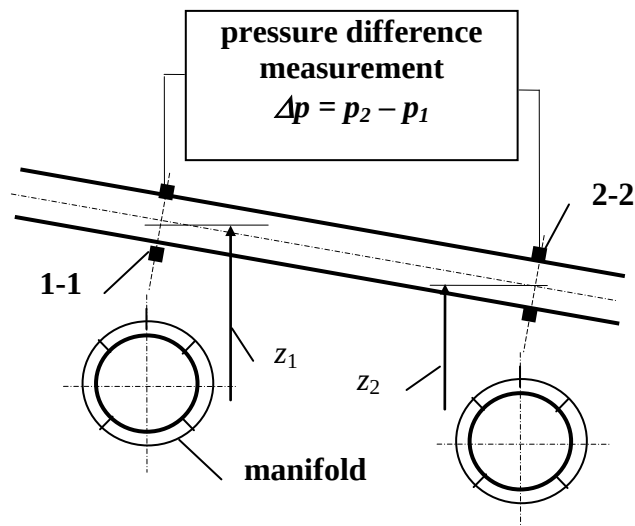


Fig. 1. Pipeline segment with marked measurement sections used in the Gibson method.

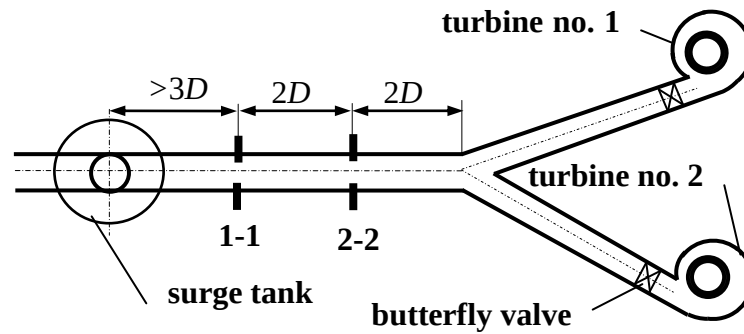


Fig. 2 Layout of the flow system of the tested turbines with marked hydrometric sections used by Gibson method.

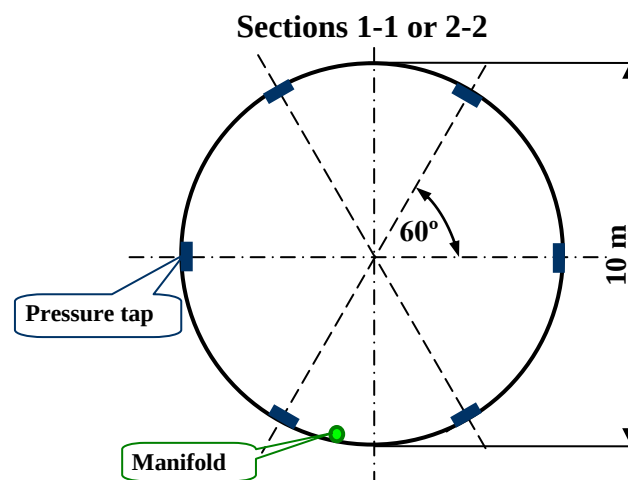


Fig. 3 Distribution of the pressure taps in the penstock hydrometric sections 1-1 and 2-2.

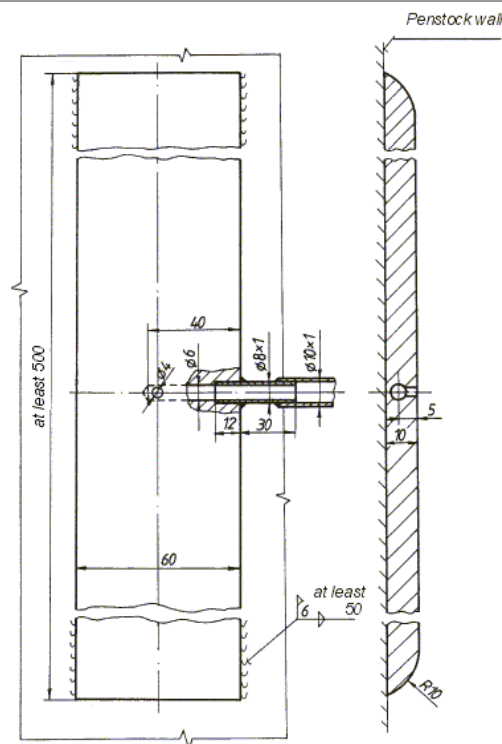


Fig. 4 Layout of the pressure measurement strip mounted to the internal side of the penstock wall, parallel to the water flow direction.

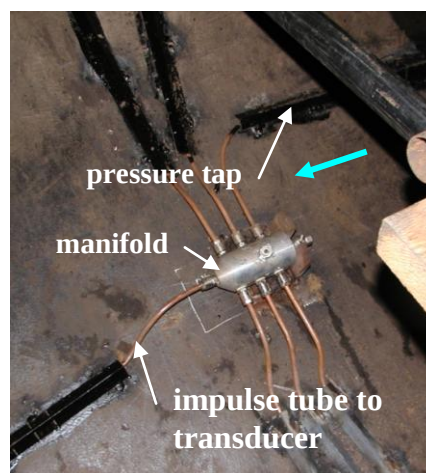


Fig. 5 View of several components of the pressure measurement system in the hydrometric section 1-1: manifold collecting pressure from six taps in section and one of the pressure taps.

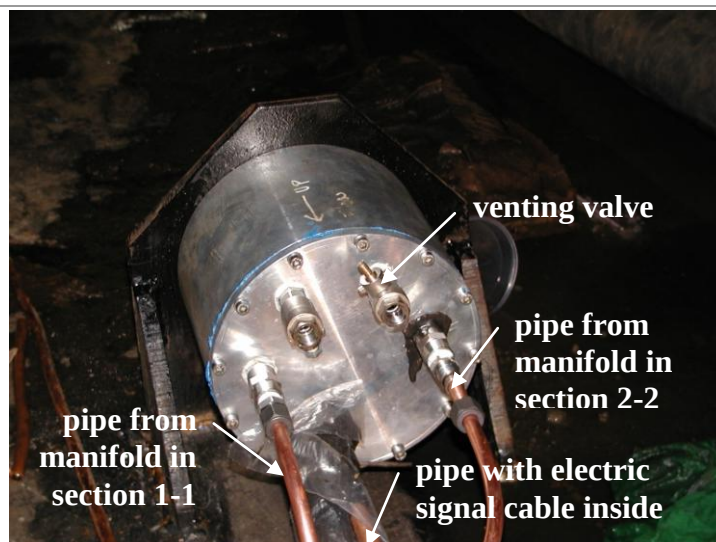


Fig. 6 Hermetic case with the differential pressure transducer installed inside a penstock.

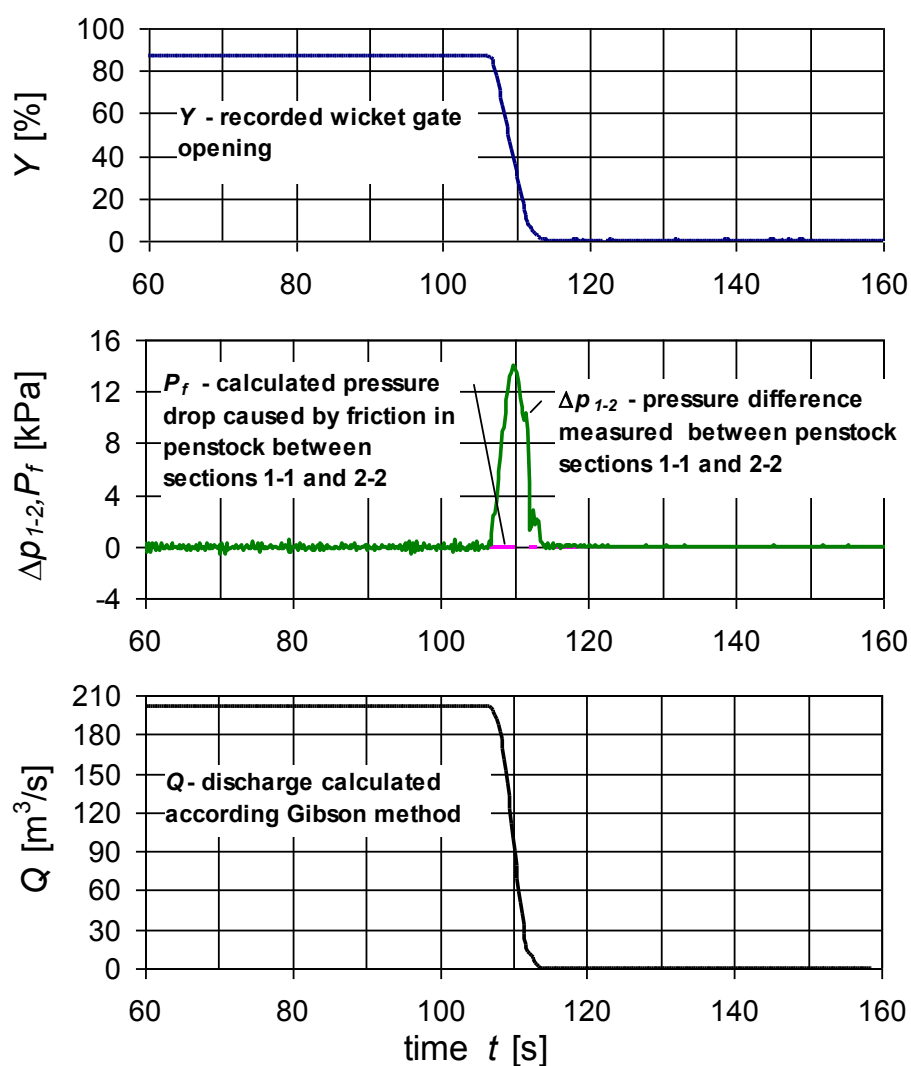


Fig. 7 Time-history of recorded and calculated variations of parameters used for flow rate measurement by means of the Gibson method.

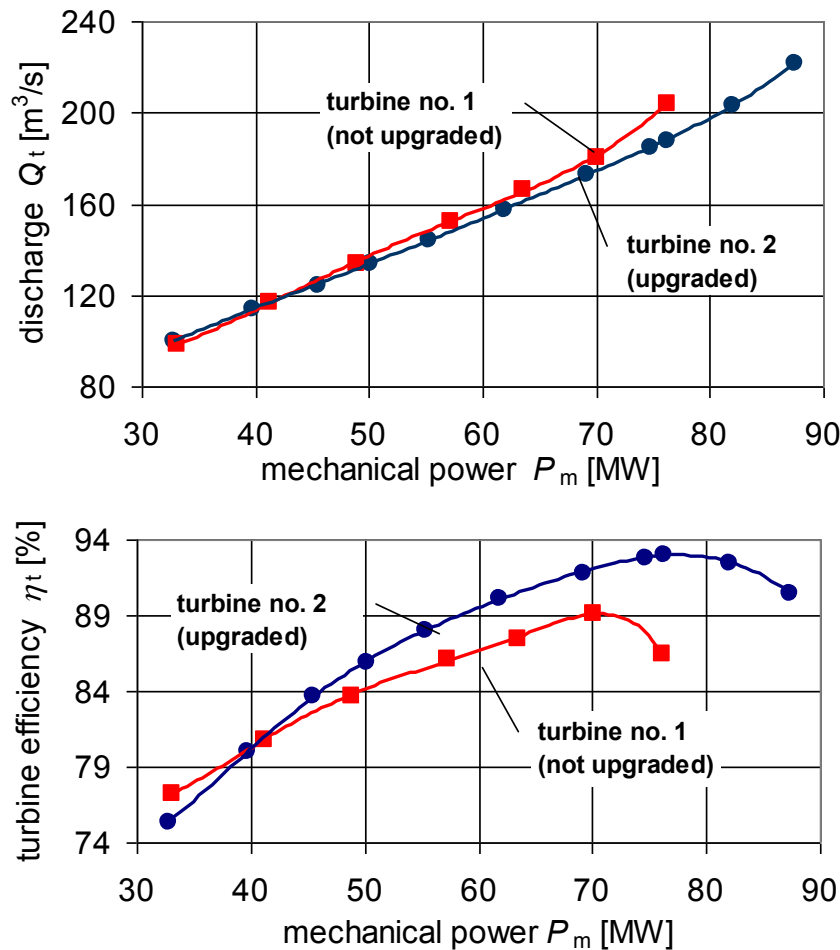


Fig. 8 An example of turbine characteristics, determined for one net head value basing on tests performed using the Gibson method.

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