Development of an experimental protocol to assess the new kinetic turbine performance

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Context

• The first prototype of an isokinetic turbine for artificial channels with a power of 1 kW has been designed, optimised and manufactured [1].
• Its hydraulic performances have to be measured directly on a pilot site represented by the tailrace canal of the Lavey run-of-river powerplant (Rhône river) [2-3].

Objective:

• Development of an experimental protocol to assess the performance characteristics of the machine on the whole operating range using the available instrumentation.

Electro-mechanical concept

• Sealed bulb housing including the variable speed generator, the encoder, the speed multiplier and the mechanical coupling
• 1kW compact permanent magnet synchronous generator
• Coaxial gear speed multiplier with a factor of 1:16
• Mechanical shaft sealing: resistant to suspended sediment conditions

Performance tests of the generator

Main characteristics:

• Phase TK142-100-041-G-R0-pa synchronous machine
• 12 poles (permanent magnet)
• Water cooled
• Rated power: 2.39 kW
• Rated current: 6 A
• Rated/maximum speed: 1'000/2'000 rpm

Components of the testing bench:

• Testing generator
• Torquemeter & encoder
• Entrainment motor unimotor fm 142U2E300
• Emerson M700 frequency converters

Instrumentation:

• Magtrol TMB 208 torquemeter
• Heidenhein ECN 1325 encoder
• Zimmer LMG 670 precision multimeter

Performance tests of the gear box

Experimental methodology:

• Generator-gear box tested together
• Specific system allowing up to 260 N.m manual breaking torque
• Performance measurements based on synchronized dynamic acquisition of sensors signals

Instrumentation:

• NCTE 3000 torquemeter
• Heidenhein ECN 1325 encoder
• Zimmer LMG670 precision multimeter
• NI cDAQ-7124 signals digitizer

Main result:

• Dependency between the mechanical-to-electrical efficiency of the assembly generator-gear box and the measurements of the generator true-rms values of the current and the speed
• This methodology allows retrieving the hydraulic-to-mechanical efficiency of the turbine runner without torquemeter

Conclusions

• Performances of the electrical generator successfully measured
• Performances of the assembly between the electrical generator and of the gear box successfully retrieved using the dynamic method
• The established experimental protocol enables the performance measurements of the new isokinetic turbine prototype directly in the tailrace canal of the Lavey powerplant

Acknowledgements

References