Research topic:
Energy

DII research group

TES Research Group

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This research activities on energy recovery potentail and leakage reduction are carried out in collaboration with the University of Pretoria (South Africa) and with i@Consulting (Pty) Ltd.

In particular the following people were involved in the project:

Dr. Marco Van Dijk
Department of Civil Engineering

Dr. Gideon Johannes Bonthuys
i@Consulting (Pty) Ltd,

Main research topics:

- Optimal design and management of hydro and pumped-hydro power plants
- Design and optimization of hydraulic and wind turbines (VAWT and HAWT)
- Cavitation, instability and pressure pulsations in turbomachines at design and off-design operation conditions
- Design and management optimization of energy systems by means of multi-criteria methods, Life Cycle Assessment (LCA)
- Gas turbines: development of numerical codes for performance prediction
- Aerodynamic optimization of rotors of helicopters and of high efficiency profiles isolated and detached

Renewable Energy Recovery and Leakage Reduction in Water Distribution Networks

In a water distribution system, the pressure is generally managed and controlled by means of Pressure Reducing Valves (PRVs), dissipating energy in order to control the maximum admissible pressure in the system and to avoid rupture. The hydraulic grade line principle associated with a PRV is similar to that of a turbine. In both cases, a pressure drop across the component allows downstream pressure control. However, instead of dissipating energy, conduit hydropower plants allow for recovering energy and hence may potentially increase the sustainability and resilience of cities. The exploitation of this potential will contribute to the city's sustainability not only in terms of renewable energy recovery but also in terms of leakage reduction, since a reduction in pressure through conduit hydropower will also reduce water losses through leakages due to the direct proportionality of leakage to pressure.

The research carried out by the TES research group focuses on the water distribution networks with the aim of identifying the hidden energy recovery potential. In particular, The City of Polokwane, a local municipality within the Limpopo Province in South Africa, was considered. The municipal surface area covers over 5000 square kilometres and serves around 280 000 customer units, inclusive of residential and non-residential customers. A section of the Polokwane/Seshego regional segment was isolated as a District Metered Area (DMA) and modeled with the EPANET hydraulic modelling software hydraulic model. Standard demand patterns for the applicable levels of service were used for the 24h period simulation of the model. An energy recovery optimization algorithm was applied to the analysed district in order to identify the energy recovery potential. Several constraints were considered in the optimization procedure. Above all, the operating pressure was not allowed to drop under the operating pressure limits, fixed based on leakage control and consumers satisfaction. A decreased average operating pressure was achieved by energy recovery at the 10 locations with the highest conduit hydropower potential (see figure below)., resulting in a combined energy recovery potential of 264 kW. The reduction in operating pressure due to the energy recovery resulted also in a 4.2% reduction in potable water supply losses.