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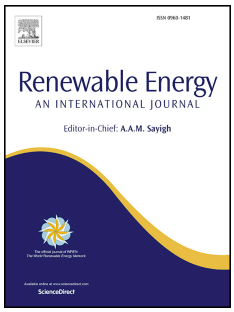

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Pressure Management and Energy Recovery in Water Distribution Networks: Development of Design and Selection Methodologies using Three Pump-As-Turbine Case Studies.

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Abstract

Energy consumption in water distribution networks is a widely publicised problem. Similarly the control of leakage through pressure management in water networks has also received significant attention in the literature. This paper outlines progress on the development of micro-hydropower systems for energy recovery and pressure management in water distribution networks.

Design and selection methodologies are outlined for pump-as-turbines (PAT) to recover energy and control pressure at 3 case study pressure reducing valves (PRV) in the water distribution network (WDN) of Dublin, Ireland. This investigation comprised the use of experimental characterisation of a laboratory scale prototype PAT, extrapolation of these results to larger scales using Suter and Affinity laws, and the assessment of their performance against real-world flow and pressure data. An assessment of existing PAT selection methodologies was also conducted and compared against the experimental data.

The results of this investigation highlight that up to 40% of the gross power potential of an existing PRV could be converted to electrical energy using a PAT while also controlling pressure. Existing PAT selection methodologies did not concur well with the experimental results. The use of 2 PATs in parallel to increase the efficiency of the overall system achieved marginal improvements in performance.

Key words: Micro-hydropower; PAT; pressure control; energy recovery; water distribution; sustainability

1. Introduction

The distribution of water has been widely highlighted in the literature as an energy intensive process responsible for considerable CO_2 emissions worldwide (Nogueira Vilanova & Perrella Balestieri, 2015). Investigations have focused on numerous approaches to improve the energy efficiency and sustainability of water distribution networks (WDNs) using: optimization techniques to manage pressure and energy demands (Corcoran et al., 2015); improved pump machinery including variable speed or variable frequency drives (Wu et al., 2012); and energy conversion and recovery using micro-hydropower (MHP) turbines in place of pressure reducing valves (PRVs) (Carravetta et al., 2013; Fecarotta et al., 2015; McNabola et al., 2014). The use of pumps-as-turbines (PATs) in place of traditional MHP turbines for both energy recovery and pressure management has be shown to be a cost effective device at PRV sites with small power output capacities (Fecarotta et al., 2015; Lydon et al., 2017). The use of PATs in water distribution networks has also been investigated across various forms of network such as public drinking water and irrigation sectors (Perez-Sanchez et al., 2016).