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Operational Decision-Making on Desalination Plants:

From Process Modelling and Simulation to Monitoring and Automated Control With Machine Learning

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ABSTRACT

This paper describes some of the work carried out within the Horizon 2020 project MIDES (MIcrobial DESalination for low energy drinking water), which is developing the world's largest demonstration of a low-energy sys-tem to produce safe drinking water. The work in focus concerns the support for operational decisions on desalination plants, specifically applied to a mi-crobial-powered approach for water treatment and desalination, starting from the stages of process modelling, process simulation, optimization and lab-validation, through the stages of plant monitoring and automated control. The work is based on the application of the environment IPSEpro for the stage of process modelling and simulation; and on the system DataBridge for auto-mated control, which employs techniques of Machine Learning.

KEYWORDS

Climate Change Adaptation, Drinking Water, Horizon2020 Project, IPSEpro, Low-energy Process, Machine Learning, MDC, Microbial Desalination Cell, MIDES, Plant Monitoring, Treated Wastewater

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1. INTRODUCTION

According to (Thu et al., 2013) and (Knowledge & Tools, 2009), the water demand situation, with increasing population and economic growth is estimated to reach 6,900 billion m^3 by 2030. Figure 1 illustrates the estimation of water demand for 2030, considering the needs for agriculture, industry, domestic sectors - taking into account the demand for potable water increases annually by 2% (Thu et al., 2013). This study shows that if business-as-usual practices are continued, it will result in a global water demand that is 40% higher than the available water supply.

Such estimation establishes well the importance of studying solutions based on desalination technologies, which composes the scope of the Horizon 2020 project MIDES (MIcrobial DESalination for low energy drinking water) (2016), upon which the presented developments of the current paper are based.

The MIDES project (running from 2016 to 2020) aims to revolutionize energy-intensive Reverse Osmosis (RO) desalination systems by demonstrating sustainable production of fresh water at three pilot locations in and outside Europe. MIDES is developing the world's largest demonstration of a low-energy system to produce safe drinking water via the use of Microbial Desalination Cells (MDC), which remove ions from saltwater in an innovative process powered by electroactive bacteria. In a general basis, the project supports: (i) Climate change mitigation by lowering greenhouse gases from current desalination systems; as well as (ii) Climate change adaptation through innovation in providing freshwater resources.

This paper describes the part of the work carried out within the MIDES project, concerning the support for operational decisions on desalination plants, specifically applied to a microbial-powered approach for water treatment and desalination (further outlined in section 2). The supported operational decisions and actions on the implementation of the desalination technology follow a roadmap that starts from the stages of process modelling, process simulation, optimization and lab-validation; through the stages of plant monitoring and automat-ed control. For the stage of process modelling and simulation, the developed work is based on the use of the environment IPSEpro (Perz et al., 1995; SimTech Simulation Technology, n.d.a; SimTech Simulation Technology, n.d.b; SimTech Simulation Technology, n.d.c), while for the stage of automated control, the system DataBridge is applied, employing techniques of Machine Learning (MIDES Consortium, 2018c).

Figure 1. Global Water Demand Gap between 2010 and 2030 (Thu et al., 2013)