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Department	School of Engineering and the Built Environment
Supervisors	Dr Viviani Onishi, Dr Nazmi Sellami
Funding Status	Funded PhD Project (Worldwide)
Application Deadline	14/04/2022
Project Title	Optimising Renewable Energy-Driven Zero-Liquid Discharge Desalination Systems

PROJECT DESCRIPTION

Zero-liquid discharge (ZLD) desalination systems have recently emerged as a promising solution for dealing with water scarcity worldwide. ZLD desalination systems are high-recovery processes that allow the production of valuable freshwater and salt with (near-)zero-waste generation. Thus, ZLD desalination reduces the environmental pollution related to brine disposals in ocean or surface water bodies. Although widely recognised as a sustainable process for improving water supply sources, the implementation of ZLD desalination systems is still limited by their intensive energy consumption and high associated processing costs.

Still, since both thermal and electric power used in desalination systems are usually produced from fossil fuel energy sources, the elevated energy consumption related to ZLD systems is also responsible for significant pollutant emissions to the atmosphere. Carbon footprint and other air pollutant releases directly (e.g., thermal sources as steam) or indirectly (e.g., energy from electricity grids) associated with ZLD schemes can be mitigated by developing higher energy efficiency technologies, and incorporating renewable (e.g., solar, wind, and geothermal energy) and low-grade energy sources.

Within this framework, this project is aimed at developing new systematic modelling approaches for the optimisation of renewable-based ZLD desalination systems. The optimisation models will be mainly based on mathematical programming techniques, including deterministic and/or stochastic optimisation. The main objectives include developing useful tools to support the decision-making process towards the implementation of more cost-effective and environment-friendly ZLD desalination systems.

Academic qualifications

A first degree (at least a 2.1) ideally in Mechanical Engineering or Chemical Engineering with a good fundamental knowledge of Thermodynamics and Applied Mathematics.

English language requirement

IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental research analysis skills
- Competent in mathematical modelling in MATLAB
- Knowledge of fundamental energy transfer processes
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:

- Knowledge of mathematical programming in GAMS software

- Experience in using Engineering softweare tools and process simulators (Aspen Hysys, TRNSYS, etc.)	
Indicative Bibliography	**Onishi, V.C.,** Khoshgoftar Manesh, M.H., Salcedo-Díaz, R., Ruiz-Femenia, R., Labarta, J.A., Caballero, J.A., 2021. Thermo-economic and environmental optimization of a solar-driven zero-liquid discharge system for shale gas wastewater desalination. Desalination 511, 115098. DOI: 10.1016/j.desal.2021.115098. **Onishi, V.C.**, Fraga, E.S., Reyes-Labarta, J.A., Caballero, J.A., 2018. Desalination of Shale Gas Wastewater: Thermal and Membrane Applications for Zero-Liquid Discharge. In: Veera Gnaneswar Gude (Ed.) Emerging Technologies for Sustainable Desalination Handbook, Elsevier, pp. 399–431, 1st Edition. DOI: 10.1016/B978-0-12-815818-0.00012-6. **Onishi, V.C.**, Reyes-Labarta, J.A., Caballero, J.A., 2018. Zero-Liquid Discharge Desalination of Hypersaline Shale Gas Wastewater: Challenges and Future Directions. In: Amjad Kallel, Mohamed Ksibi, Hamed Ben Dhia and Nabil Khélifi (Eds.) Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions. Advances in Science, Technology & Innovation (IEREK Interdisciplinary Series for Sustainable Development). Springer International, pp. 65–67. DOI: 10.1007/978-3-319-70548-4_24. **Onishi, V.C.**, Ruiz-Femenia, R., Salcedo-Díaz, R., Carrero-Parreño, A., Reyes-Labarta, J.A., Fraga, E.S., Caballero, J.A., 2017. Process Optimization for Zero-Liquid Discharge Desalination of Shale Gas Flowback Water under Uncertainty. Journal of Cleaner Production 164, 1219-1238. DOI: 10.1016/j.jclepro.2017.06.243. [IF: 7.246 – Scopus citations: 13] **Onishi, V.C.**, Carrero-Parreño, A., Reyes-Labarta, J.A., Ruiz-Femenia, R., Salcedo-Díaz, R., Fraga, E.S., Caballero, J.A., 2017. Shale Gas Flowback Water Desalination: Single vs Multiple-Effect Evaporation with Vapor Recompression Cycle and Thermal Integration. Desalination 404 (C), 230–248. DOI: 10.1016/j.desal.2016.11.003. **Onishi, V.C.**, Carrero-Parreño, A., Reyes-Labarta, J.A., Fraga, E.S., Caballero, J.A. 2017. Desalination of Shale Gas Produced Water: A Rigorous Design Approach for Zero-Liquid Discharge Evaporation Systems. Journal of Cleaner Production 140, 1399–1414. DOI: 10.1016/j.jclepro.2016.10.012.
Funding notes	This project may be funded by a scholarship of the School of Engineering and Built and Environment. Please see [School-funded PhD scholarships - RESEARCH AND INNOVATION (napier.ac.uk)] for information on the scholarships and how to apply for them.
Enquiries	For informal enquiries about this PhD project, please contact Dr Viviani Onishi, V.Onishi@napier.ac.uk

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