Life cycle assessment of brine effluent. A case study of a large scale demonstration plant in the Energy Port and petrochemical cluster of Rotterdam Port, involving local large industries

According to United Nations, water is the primary medium through which we will feel the effects of climate change. Water availability is becoming less predictable in many places, and increased incidences of flooding threaten to destroy water points and sanitation facilities and contaminate water sources. In some regions, droughts are exacerbating water scarcity and thereby negatively impacting people's health and productivity. Ensuring that everyone has access to sustainable water and sanitation services is a critical climate change mitigation strategy for the years ahead.

The chemical industry comprises the most water-intensive industry accounting, in many countries, for more than 30% of industrial water consumption. According to Global Water Intelligence, other major industrial water users are the mining sector, pulp& paper, power and food & beverage. The water consumed by these industries is transformed into the brine effluent that is the focus of this project. Brine discharges are recognized as one of the major threats to the aquatic environment, according to the United Nations Environment Programme. The concept of the ZERO BRINE project is to close the loop of these particularly problematic effluents and thus: (a) ensure compliance of industry with existing and upcoming regulations; (b) protect the environment; and (c) recover the materials that are currently leaking from our economies. This MSc thesis project will concern the environmental performance of such a brine effluent system based on the Life Cycle Assessment methodology.

Sustainable development is the international community's most urgent priority, and the core aim of the post-2015 development agenda of United Nations. Sustainable development consists of three pillars, economic, social and environmental. Among the three pillars, the Life Cycle Assessment (LCA) is a methodology and tool for modelling the environmental performance of products, systems and services. In addition, LCA identifies hot-spots and bottlenecks for possible improvements. The methodology is standardized by the ISO and it has become very popular the last decade because its results can be presented and understood from decision-makers people with a moderate technical background.

TU Delft under the Horizon 2020 funding platform has formed a consortium with universities, public authorities and companies in order to demonstrate new, economically sound and industrially relevant solutions for materials recovery from process industry brines. A demo plant will be built which will be able to treat part of the brine effluents generated by the industry water supplier (EVIDES), while waste heat will be sourced. In addition, three large-scale pilot plants will be developed in other process industries, providing the potential for immediate replication and uptake of the project results by neighbouring factories for industrial symbiosis. The consortium includes salt producers (such as EUROPIREN), construction management and O&M companies (WITTEVEEN+BOS, TYPSA, FACSA), SME Technology suppliers (SEALEAU, LENNTECH, ARVIA), universities (TU DELFT, NTUA, UNIPA, POLSL, ABDN), applied research institutes (CTM, ECPI, IVL, DLR), public authorities (ROTTERDAM PORT), European Technology Platforms (WssTP, ISPT) and SMEs for dissemination (REVOLVE MEDIA).

In this MSc graduation project the aim is to investigate the environmental performances of the brine conversion. The environmental impacts under focus are the climate change, acidification eutrophication, biodiversity and land use. Main research questions are:

- Does the Zero Brine applications offer greater environmental benefits than virgin salt and minerals systems for the analyzed environmental impacts?
- What are the environmental benefits when the chemical plant uses only renewable electricity?
- Wat are the environmental benefits of the applied industrial symbiosis?
- Which is the aggregated environmental performance of Zero Brine applications?
- Which are the hot-spots of such LCA systems that can be improved and influence the results significantly?
- Are there any bottlenecks in the supply chains?

The MSc. Graduation topic will include modelling via the LCA software SimaPro. The LCA system boundaries will be determined including upstream manufacturing of necessary chemicals and the supply of necessary energy carriers, and downstream, the final disposal or use of brine and other process residues. The final deliverable will be a report that and the student will have to present his/her work in the group.

Further reading:

- Xevgenos D., Moustakas K., Malamis D. and Loizidou M. (2016). An overview on desalination & sustainability: renewable energy-driven desalination and brine management. Desalination and Water Treatment 57: 5. https://doi.org/10.1080/19443994.2014.984927
- Xevgenos D., Michailidis P., Dimopoulos K., Krokida M. and Loizidou M. (2015). Design of an innovative vacuum evaporator system for brine concentration assisted by software tool simulation. Desalination and Water Treatment 53: 12. https://doi.org/10.1080/19443994.2014.948660
- Xevgenos D., Vidalis A., Moustakas K., Malamis D. and Loizidou M. (2015), Sustainable management of brine effluent from desalination plants: the SOL-BRINE system. Desalination and Water Treatment 53: 12. https://doi.org/10.1080/19443994.2014.933621
- Zero Brine Project, European Commission, CORDIS Projects and Results
- Tsalidis, G.A., Discha, F.E., Korevaar, G. et al. Int J Energy Environ Eng (2017) 8: 175. https://doi.org/10.1007/s40095-017-0242-8

Start date	Continuous
Location	Internal
Theme	Circular economy, closing the material loop, Zero Brine project, zero waste, Life cycle assessment
TPM Contact	g.a.tsalidis@tudelft.nl; g.korevaar@tudelft.nl
Expiration date	10/01/2019