Innovative low-cost technology for leachate treatment and valorisation

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Water is a scarce and very necessary resource. The absence may have unintended consequences. Regenerated water is one more tool to cope with the scarcity of this resource. This type of water can arise from the leachates produced by municipal solid waste (MSW).

An average municipal landfill site can produce up to 150 m^3/d of leachate, which equates to the amount of fresh water that an average household consumes in a year. Therefore, management and treatment of landfill leachates is one of the most extended and important environmental issue related to waste management. The conventional treatments of landfill leachates are based on biological processes and chemical and physical methods. Although they are usually suitable for young to intermediate leachates, with the continuous hardening and the ageing of landfill sites, they are not sufficient anymore to reach the level of purification needed in the old landfill leachates due to their low BOD_5/COD relation.

Other technologies, such as advanced oxidation processes (AOP), are starting to be implemented to treat low biodegradable leachates. The main drawback of these processes is their high energy and reagents consumption which also results in a high environmental impact in categories such as climate change. With a view to meeting the requirements of the WFD, it is essential to develop and demonstrate innovative technologies and procedures, to prevent or reduce negative effects on the environment as far as possible. The Landfill Waste Directive (LWD, 1999/31/EC) also states that the total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater.

The LIFE LEACHLESS is a reference technology for the integral treatment of leachate and the valorisation of the liquid (water) and solid fraction (by-product) on a first full-scale application. The LIFE LEACHLESS technology is able to recover the water that the leachates contain based on an evaporation/condensation and forward osmosis (FO) process clean with the environment.

Experimental procedure

The treatment system is composed of two main processes: a novel solar panel, which evaporates and condenses the leachate in the first step and FO step to obtain effluent complying with the reuse standards.

The first treatment step, evaporation/condensation, is composed of a solar thermal collector (panel) and a water deposit located behind these collectors. The panel is a set of several tempered glass sheets to concentrate the solar radiation and keep the heat stored in the water deposit. With this structure, the system can reach to temperatures up to 140 °C, even in the presence of weak solar radiations. The water is boiled with these high temperatures and the vapour ascends to an outlet that conducts the vapour to a condenser. Meanwhile, the solids removed fall by gravity into the solids deposit located at the bottom. In case that there is not enough solar radiation, solar technology is supported by energy from biomass.

After the evaporation step, the condensed effluent will enter to FO membranes, which are permeable membranes where the contaminant are removed by creating an osmotic pressure difference between two sides of the membrane. This pressure difference is created by a solution, named as “draw solution”, which has greater osmotic pressure than the feed solution (NaCl will be used in this project due to its high solubility and no risk of scaling), therefore, the water in the feed flows through the membranes with a tendency to dilute the draw solution leaving the contaminants on the feed side.

The prototype plant is composed by three 40 ft length maritime containers. The denomination of the 40 ft length containers is: transportation, FO containers and Input container. The container disposition can be seen in Figure 1.

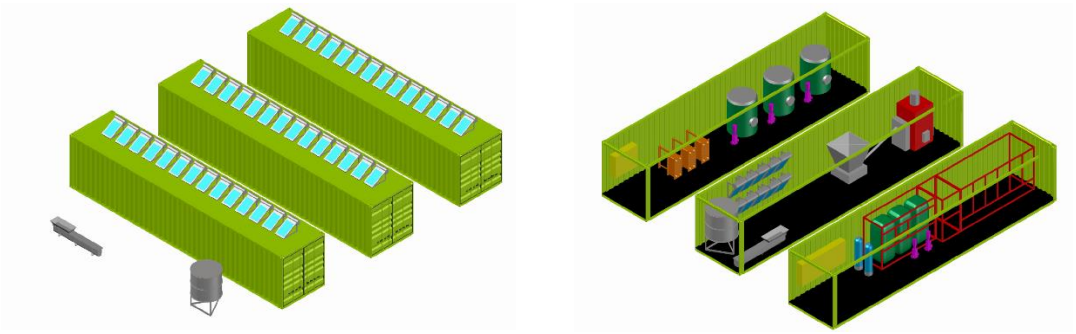

Figure 1. LIFE LEACHLESS technology

Regarding the disposition of the equipment inside of the containers, one of the containers will serve as a storage container to transport: the evap./cond. panels and their individual supporting structure, the piping system that will feed in and fill out the panels.

The second 40 ft length container will contain all the FO equipment including: the FO hollow fiber rack. Three deposits that will contain the 1st stage condensate, the initial draw solution and the diluted draw solution. The electric installation and equipment used to drive the pumping system and finally all the valves and instrumentation. To facilitate the transportation of the FO module a frame has been designed in order to serves as a support of all the FO equipment described above. Two sand filters will be placed in the FO container in order to pre-filtering the 1st stage condensate before getting in the FO module.

Finally, the last 40 ft length container, will contain the equipment related with the input leachate treatment and filling equipment of the solar panels with the initial leachate.

The capacity of the plant is 8-9 m^3/d of leachate treated.

Results

In general, comparing the results of the leachate and the final effluent, all concentrations of the parameters have been reduced considerably. For example, the COD concentration has been reduced by approximately 99% and very low concentrations of metals have been obtained. It is worth highlighting the reduction of sodium concentration (98%). The sludge obtained as a by-product has an optimum composition for valorization as ceramic product.

Conclusions

LIFE LEACHLESS technology is a sustainable solution to treat leachates from landfills or waste treatment centres.

- Recovery of up to 70-60% of the leachate (the rest of the original leachate content is recovered as components of ceramic materials or reused in the draw solution of the FO stage).
- Quality of the final effluent according to the limits set by the legislation. The final effluent can be used for cleaning or irrigation.
- Sludge obtained as a by-product with an interesting metal composition to be used in the formulation of ceramic components.

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