Efficient and Low-Cost Solution to the Evaporation of Leachate in a Large Landfill

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Abstract: In this study, which aims to preserve our environment, we used a low-cost device to get rid of the leachate existing in the landfill of the city of Khénifra, Morocco. This material, which has a negative impact on the environment, is mainly composed of organic matter. The solution proposed in this paper is the use of a flat solar collector in order to accelerate the evaporation of the leachate occupying three large basins within the landfill. According to the results obtained, this flat solar collector was able to increase the evaporation efficiency up to 300% and thus decrease the evaporation period compared to the conventional method adopted in the landfill. In the case of our experiment, we estimated a gain of 18 days between the natural evaporation technique and evaporation by this solar collector. This simple, efficient, and, above all, low-cost technique shows interesting results.

Keywords: leachate, flat, solar collector, Household waste, Khénifra city.

1. Introduction

Various studies have estimated the risk to human health and the environment from leachate-contaminated groundwater[1–3]. Leachate has a high biochemical oxygen demand (BOD) and high concentrations of organic carbon, nitrogen, chloride, iron, manganese and phenols. Many other chemicals may be present, including pesticides, solvents and heavy metals, personal care and pharmaceutical chemicals and ammonia.

Leachate generation is a major problem for municipal solid waste landfills and poses a significant threat to surface and groundwater

However, the physico-chemical characteristics of pollutants vary greatly from one leachate to another due to the type of waste, the structure of the site, the climatic conditions and their variability. Of course, leachates contain emerging and refractory pollutants, which implies as many difficulties in their treatment requiring combinations of biological and physicochemical processes[4–8]. This is the reason why the implementation of processes capable of depolluting this type of recalcitrant effluent is crucial in order to contain the risks and dangers that the presence of this type of leachate poses to the environment[1].

In this context, several research projects have studied the performance of leachate treatment processes in laboratory, pilot and semi-pilot conditions. Described as innovative and promising, this work was based on robust purification processes, in particular membrane bioreactors and advanced oxidation processes[8–10]. However, a problem arises in this respect, it involves the formation of potentially toxic by-products. These include trihalomethanes, haloacetic acid, chlorates, perchlorates and others.

The physico-chemical characteristics of leachate wary from site to site depending on the waste conditions of the landfill and the factors that condition the fermentation and leaching process, mainly temperature, moisture content and the degree of microbial activity[11,12]. In general, and in order to refine the knowledge of leachates and to draw up their profiles, we can rely on physico-chemical indicators such as COD, BOD5, nitrogen and phosphorus fractions, conductivity, pH, as well as the concentrations of heavy metals and anions[1,1,13–15].

We distinguish between young, mature, and old leachate depending on the conditions and duration of the landfill under consideration, a biodegradable character of refractory character[16].
The leachate may contain high concentrations of metals, refractory organic matter such as pesticides, etc.[8,17] ....
Historically, the removal and treatment of leachate from operating landfills has been limited to expensive options[1,14] and are often very efficient but also too complex: vacuum evaporation, reverse osmosis, ultrafiltration, membrane bioreactor[2,4,6,12,18]. Their operation and monitoring require specific skills and a quasi-continuous presence of personnel.
It is therefore important to carry out research to define whether more "rustic" treatments exist or need to be developed that meet the needs of operators and comply with discharge standards. Indeed, this study comes to this objective for this present study. We have developed a very efficient technique that is less costly and above all does not require any energy for its operation, and it is also ecological.
In this study, we will use a very interesting process of a flat solar collector[19–28]. This principle of flat solar collector is used in various applications and in various fields, namely, solar cookers, solar water heaters, etc..., in our experiment this flat collector is used to accelerate the evaporation and removal of leachate. The experimental study has effectively shown the effectiveness of this technique in the elimination of leachate, or the amount of leachate evaporated by this process is ten times that evaporated naturally, this shows that the speed of evaporation will be multiplied by ten, so the leachate contained in the ponds that requires three months of treatment will be treated quickly and for a period that does not exceed three or four days saving 90% of the time.