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LANDFILL LEACHATES PURIFICATION BY NATURAL DRY BIOMASS – COMMON REED (PHRAGMITES AUSTRALIS)

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Sanitary landfills have been the most popular storage facilities for solid municipal waste in recent decades around the world, but recently the waste management policy has mainly focused on minimizing and reusing waste. Energy incineration and recovery play an important role in reducing waste and converting energy. However, sanitary landfills still exist and will continue to be used for the disposal of solid waste and residues in many countries [1]. The processing of landfill leachates generated in the waste storage process and the requirements for their control after the reclamation of landfills is one of the main engineering challenges for compliance with environmental requirements. The main question relates to how to select a method of treatment of landfill leachate, which will be in accordance with the relevant provisions and with a reasonable cost and complexity of the operation. Landfill leachate is characterized by low biodegradability, high concentration of organic pollutants and biogenic elements, and other toxic components resulting from waste decomposition processes in landfills for municipal solid waste are also possible.

Nowadays, there is a wide range of possible technologies that are used to treat this type of waste water. Leachate treatment technologies can be classified into four main groups. Each alternative is accompanied by its advantages and disadvantages [2].

The first group includes the following processes: recirculation, lagoon drainage, simultaneous treatment with domestic wastewater. Combined processing together with domestic wastewater is preferred due to its easy maintenance and relatively low costs. These days it is less and less applicable because the leachate contains poorly biodegradable organic components and heavy metals that would affect the purification efficiency [3-5]. Biodegradation may consist of aerobic or anaerobic treatment depending on the need for oxygen to carry out the biological process. The aerobic treatment must allow the partial removal of the biodegradable components which are mainly converted to CO_2 and solid organic products under atmospheric oxygen. Anaerobic processing of the leachate allows the conversion of high concentrations of organic components mostly to biogas – CO_2 and CH_4. The biological process is characterized by high efficiency in removing organic components and nitrates from immature leachate. The following processes are included in the group of chemical and physical methods: chemical oxidation, adsorption, chemical precipitation, coagulation/flocculation, sedimentation, flotation [6-12].

Adsorption techniques are widely used to remove persistent organic pollutants which are not biodegradable, such as tannins, proteins, pesticides and other substances that cause color and smell of the water [13]. The most industrial adsorbents used are: activated carbon, zeolites, silica gel, activated aluminum. Zeolites differ from the other three types of adsorbents in their crystalline structure, which leads to the formation of correct micropores of the same shape (from where their name "molecular sieves" comes from) [9]. As adsorbents, various types of natural and artificial materials possessing a large specific surface are also used: sawdust, leaf mass, crushed coke, peat, silica gel, allumogels, various active clays and others [14]. Adsorption on natural materials (biosorbents) is considered an effective solution in the management of industrially contaminated water [15]. It is innovative, cost-effective and environmentally friendly [16]. In recent years, researchers from different countries have been able to some extent develop low-cost biosorbents that have been successfully applied in the treatment process of various types of wastewater [17], including landfill infiltrates too [18-23].

As cheap biosorbents are defined those which are widespread in nature or are by-products of industrial waste materials and do not require more special treatment [24]. Due to their low price and high reduction rate of COD, the biosorbents are more preferred than conventional adsorbents. It is important to note that adsorption capacity varies depending on the characteristics of the biosorbent used, its surface change and the initial concentration of the adsorbate.

The aim of this study is to determine the adsorption capacity of natural dry biomass *Phragmites australis* (common reed) and the treatment efficiency of the real landfill leachate.

The landfill leachate used in the experiments was taken from a real-life landfill located in northwestern Bulgaria, and the vegetation used was taken from a comparatively clean area. The biomass is washed repeatedly with distilled water to remove the dust particles from its surface, then dried at room temperature (20 ºC) to constant weight. The dry biomass is cut into small pieces and the resulting fraction having an average particle size of 0.5 x 0.25 cm.

For examination of the process equilibrium (adsorption under static conditions) solutions with a certain initial concentration of COD are prepared. Of the prepared standard solutions of the landfill leachate, samples of 50 cm^3 have been taken and are placed into iodine flasks with a 100 cm^3 volume. In each of the flasks, the same amount of sorbent is added – 0.5000 g. The samples thus prepared are placed on a shaker machine for 48 h at constant temperature (25±1 °C) and pH (7÷7.6). Blank studies (distilled water with adsorbent) have been also carried out to exclude the influence of adsorbent in the analytical determination of the contaminant.

When the equilibrium was achieved, the samples were filtered and the equilibrium COD concentration of each of them was determined. On the basis of the data obtained, equilibrium curves are built. The results were processed using Langmuir, Freundlich and Temkin models.

The maximum adsorption capacity reached is $q_e q_e$ = 7.39 mg g^{-1}. The Langmuir type II isothermal describes best the course of the experimental isotherm, confirming the correlation coefficient R^2 = 0.9946. It can also be concluded that this model is best suited for describing adsorption equilibrium.

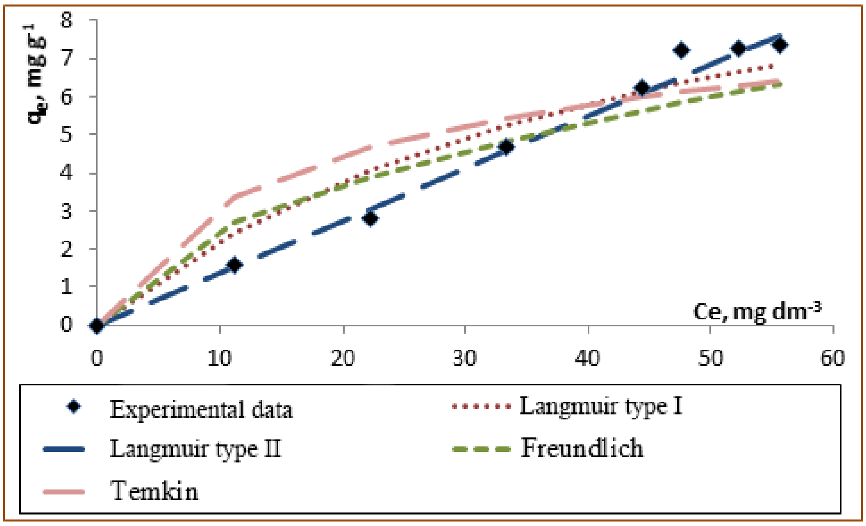

Figure. Experimental and model adsorption isotherms

The correlation between the experimentally measured concentrations and the results obtained with the numerical solution of the model are close, which confirms the correctness of the results obtained from the equilibrium.

The high sorption capacity of the common reed, its widespread distribution in nature and easy pre-treatment, define it as a suitable inexpensive biosorbent for wastewater treatment. *Phragmites australis* can be successfully used as an adsorbent to remove substances which are nonbiodegradable.

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