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Could Landfill Leachate be a Resource for a Proper Environmental Management of Closed Landfills?

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The disposal of urban waste into landfill has been used for long time because of its relatively low cost. One of most important drawbacks associated to such a practice is related to managing the leachate that is generated when water passes through the waste. Leachate is, in fact, the aqueous effluent generated by rainwater percolation through wastes, biochemical processes in waste cells and the inherent water content of the waste itself [1-4]. The chemical composition of landfill leachate is influenced by a number of factors including seasonal precipitation,waste composition, and, mainly, the age of the landfill [5]. Consequently, the age of the landfill site is one of the main variables that affects the leachate characteristics [4,6]. Usually, young landfill leachates contain large amounts of biodegradable organic matter (i.e., volatile fatty acids) that decrease with increasing landfill age as a result of the anaerobic decomposition that takes place in the landfill site. As the content of volatile fatty acids decreases, organic matter in the leachates becomes dominated by refractory compounds, such as humic- and fulvic acid-like ones with consequent reduction of the BOD/COD ratio [7]. In addition, ammonia concentration increases at higher landfill age as a result of the fermentation of organic matter containing proteins, being concentration higher than 2 g/L typical in old landfill leachates. Therefore, stabilized landfill leachates are more difficult to treat with respect to young ones. Although leachate composition may widely vary within the successive aerobic, acetogenic, methanogenic and stabilization stages of waste evolution, three types of leachates are commonly defined according to landfill age (recent, intermediate and old).

According to local employed regulations, landfill leachate must be properly treated before the final disposal to receiving water bodies. The most common practice is to discharge leachate into conventional wastewater treatment plants [8]. However, this is likely to negatively affect the biological treatment step due to the presence of recalcitrant compounds and high concentration of ammonia. Therefore, new technologies and new treatment combinations are required [9]. Treatment selections must also be cost-effective, allowing compliance with local discharge standards at the lowest cost [10].

Another method of leachate management that was more common in uncontained sites was leachate re-circulation in which leachate was collected and re-injected into the waste mass. This process greatly accelerated decomposition and therefore gas production but had the impact of converting some leachate volume into landfill gas and reducing the overall volume of leachate for disposal. However it also made to substantially increase the concentration of contaminant materials making it a more difficult waste to treat [11]. Biological treatments of landfill leachate are more attractive and they are, probably, the most efficient and cheapest processes to reduce the chemical oxygen demand (COD) and nitrogen from leachate. These biological treatment processes are quite effective for leachate generated in the early stage with a high BOD_5/COD but they generally fail to treat leachate with a rather low BOD_5/COD ratio [12-16]. Moreover, due to main problems of sludge bulking or inadequate separability in conventional aerobic systems, a number of innovative aerobic processes, called attached-growth biomass systems, using biofilm, have been recently developed. These systems present the advantage of not suffer from loss of active biomass. Also nitrification is less affected by low temperatures than in suspended-growth systems, and by inhibition due to high nitrogen content [17,18].

Furthermore, some breakthroughs in the membrane filtration industry have now made it possible for the treatment of some previously difficult separation applications. Now, with more open high turbulence membrane modules that are resistant to fouling and plugging, membranes are becoming one of the most used options for treating landfill leachate. However, the possibility of reusing leachate substances for agronomical purposes might be of interest, especially in arid areas when used in addition to the leachate water content. Specifically, leachate can be reused as a fertirrigant for many crops which are not for human consumption [19].There have been several studies on the possibility of using leachate for irrigation purposes. There are investigations focused on soil properties related to leachate irrigation [20-23], on using pretreated leachate [19] and on fertirrigation of plants for energy purpose [24].

However, for landfill where solid waste already reached the maximum available load and therefore no waste can be longer disposed of (i.e.landfill reached the end of its life cycle) a new opportunity appears. In such a situation, in fact, it is necessary to ensure that the landfill is maintained in a safe condition after its closure and that it can also be adaptable for future use. Governments have started converting closed landfills into recreational facilities such as playgrounds, sports facility's, parks, after suitable restoration [25]. One of the main issues about management of closed landfills is the disposal of leachate which still continues to be produced for a long time after the closure of the landfill. Such a leachate could be thought of as irrigation for the vegetation cover of closed landfills. The use of leachate as a fertirrigant could therefore bring an added-value which otherwise would be lost, contributing to a substantial reduction of disposal operating costs. The employment of leachate as a fertirrigant for the re-vegetation of the walls of closed landfills could be an attractive option. In order to make the re-vegetation as effective as possible, the choice of plant species is fundamental. The selection of the plants should be made by taking into account the plants ability to engraft themselves and grow on the landfill final coverage layer. The hostile environment of the walls of the closed landfills caused by water stress, methane exhalation and relatively high soil temperatures should also be taken into consideration.

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Assessing the opportunity for re-vegetation of the walls of closed landfills employing the leachate as a fertirrigantmust include the choice of specific plants in order to overcome the above described problems. The leachate management procedure should consist of three phases, namely (i) early stages toxicity assessment (apical roots length and germination tests), (ii) adult phase plants resistance assessment (irrigation trials) and (iii) soil degradation assessment.The proposed procedure includes a set of experimental tests aimed at assessing leachate toxicity, plant sensitivity and soil degradation. These tests provide information about the real possibility of using a particular leachate with respect to the resistance capability of the chosen set of plant species, and finally the impact of the leachate on the soil matrix. The rationale of the proposed approach is first to identify the potential degree of toxicity in landfill leachate for fertirrigation purposes. Secondly, through specific tests, rank the chosen plants in terms of their resistance to the aqueous solution that contains leachate. Finally, after a long-term irrigation programme, any possible worsening of soil properties can be investigated.

In the near future, scientific research could prove that a speedy, economical methodology for the possible re-vegetation of the walls of closed landfills, employing the leachate as a fertirrigant, is potentially available. This method should be of importance to decision makers seeking to switch from standard landfill management mode to a more environmentally sustainable one. Further study would be needed in order to understand whether, and to what extent, very long-term use for irrigation of such a saline water matrix could affect the electrical conductivity of the soil and thus adversely affect and cause deterioration of its fertility. In this way it would be closed, with simple and low cost procedures, the cycle of one of the most difficult to treat wastewater.

References

1. Tchobanoglous G, Kreith F (2002) Handbook of Solid Waste Management. McGraw-Hill, United States.
2. El-FadelfM, Findikakis AN, Leckie JO (1997) Environmental Impacts of Solid Waste Landfilling. Journal of Environmental Management 50: 1-25.
3. Robinson AH (2005) Landfill leachate treatment. Membrane Technology 12: 6-12.
4. Renou S, Givaudan JG, Poulain S, Dirassouyan F, Moulin P (2008) Landfill leachate treatment: Review and opportunity. J Hazard Mater 150: 468-493.
5. Foo KY, Hameed BH (2009) An overview of landfill leachate treatment via activated carbon adsorption process. J Hazard Mater 171: 54-60.
6. Bashir MJ, Isa MH, Kutty SR, Awang ZB, Aziz HA, et al. (2009) Landfill leachate treatment by electrochemical oxidation. Waste Manag 29: 2534-2541.
7. Harmsen J (1983) Identification of organic compounds in leachate from a waste tip. Water Research 17: 699-705.
8. Wiszniowski J, Robert D, Surmacz-Gorska J, Miksch K, Weber JV (2006) Landfill leachate treatment methods: A review. Environmental Chemistry Letters 4: 51-61.
9. Di Iaconi C, De Sanctis M, Rossetti S, Mancini A (2011) Bio-chemical treatment of medium-age sanitary landfill leachates in a high synergy system. Process Biochemistry 46: 2322-2329.
10. Kurniawan TA, Lo WH, Chan GY (2006) Degradation of recalcitrant compounds from stabilized landfill leachate using a combination of ozone-GAC adsorption treatment. J Hazard Mater 137: 443-455.
11. Christensen TH, Cossu R, Stegmann R (1992) Landfilling of Waste: Leachate, Taylor & Francis, London and New York.
12. Oller I, Malato S, Sánchez-Pérez JA (2011) Combination of Advanced Oxidation Processes and biological treatments for wastewater decontamination--a review. Sci Total Environ 409: 4141-4166.
13. Jiang Z, Yang H, Sun L, Shi S (2002) Integrated assessment for aerobic biodegradability of organic substances. Chemosphere 48: 133-138.
14. Deng Y, Englehardt JD (2007) Electrochemical oxidation for landfill leachate treatment. Waste Manag 27: 380-388.
15. Amokrane A, Comel C, Veron J (1997) Landfill leachates pretreatment by coagulation-flocculation. Water Research 31: 2775-2782.
16. Gupta SK, Singh G (2007) Assessment of the efficiency and economic viability of various methods of treatment of sanitary landfill leachate. Environ Monit Assess 135: 107-117.
17. Knox K (1985) Leachate treatment with nitrification of ammonia. Water Research 19: 895-904.
18. Dollerer J, Wilderer PA (1996) Biological treatment of leachates from hazardous waste landfills using SBBR technology. Water Science and Technology 34: 437-444.
19. Zupančic JM, Zupančic M, Griessler B, Zrimec T, Šelih A, et al. (2009) Combined purification and reuse of landfill leachate by constructed wetland and irrigation of grass and willows. Desalination 246: 157-168.
20. Cheng CY, Chu LM (2007) Phytotoxicity data safeguard the performance of the recipient plants in leachate irrigation. Environ Pollut 145: 195-202.
21. Gros R, Poulenard J, JocteurMonrozier L, Faivre P (2006) Soil physico-chemical changes following application of municipal solid waste leachates to grasslands. Water, Air, and Soil Pollution 169: 81-100.
22. Smesrud JK, Duvendack GD, Obereiner JM, Jordahl JL, Madison MF (2012) Practical salinity management for leachate irrigation to poplar trees. Int J Phytoremediation 14 Suppl 1: 26-46.
23. Coyle DR, Zalesny JA, Zalesny RS Jr, Wiese AH (2011) Irrigating poplar energy crops with landfill leachate negatively affects soil micro- and meso-fauna. Int J Phytoremediation 13: 845-858.
24. Dimitriou I, Aronsson P, Weih M (2006) Stress tolerance of five willow clones after irrigation with different amounts of landfill leachate. Bioresour Technol 97: 150-157.
25. Ruotsinoja S (2009) Closed Landfill Program. Minnesota Pollution Control Agency.