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Solid Waste Landfills as a Source of Green Energy: Case Study of Al Akeeder Landfill

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Landfills are remaining and will remain a common method for landfill disposal. Unless properly managed, landfills will pose serious environmental and health risks. Several gases are generated by decomposition process of organic materials in a solid waste landfill. The composition, quantity, and generation rates of the gases depend on several factors such as refuse quantity, density and composition, placement characteristics, landfill depth, refuse moisture content, temperature and amount of oxygen present. Three processes form landfill gas, these are: bacterial decomposition, volatilization and chemical reactions.

The purpose of this research is to estimate the amount of methane emitted from Al Akeeder landfill which is the second largest landfill in Jordan. To achieve that Gas-Sim model was used in predicting the amount of methane emissions. It was found that the methane emission will reach its peak value of 12 Million M^3/year by the year 2021, one year after the landfill closure. Furthermore, the power that can be obtained from the landfill in case of methane recovery was estimated to be 5.6 MW in 2021. Utilizing the biogas will not only generate a green energy, but also will create a source of revenue through selling the CERs regulated by Clean Development Mechanism of Kyoto protocol.

Landfills are source of greenhouse emissions. If biogas recovered from the landfill, adverse environmental impacts will be minimized. In addition, clean energy will be produced that will offset the polluting fossil fuel. In addition, the amount of greenhouse gas emission reduction will be about 80 thousand tones of CO_2 eq in the that year. It is recommended to carry out a field study by conducting a pump test, so as to verify the results of methane modeling process.

Keywords: Landfills; AL Akeeder; Green Energy; Power; Greenhouse Gases

Geophysical tools for environmental studies in sanitary landfills

Nataly Aranda

Nowadays the sanitary landfill is the main method used worldwide to deposit Municipal Solid Waste (MSW). In Brazil, the use of MSW landfill is growing up, and so there is a necessity to know techniques to prevent environmental damages caused by waste mismanagement such as groundwater contamination by leachate infiltration or possible landslide due to stability problems. Geophysical methods are a very useful tool used in environmental studies including waste management due to the easiness of application and the high coverage achieved with them without being invasive. In the case of MSW landfills, geophysical methods are used to determine the depth and geometry of landfill's boundaries, to image leachate plumes and to track them along the time to prevent groundwater contamination or even to identify contaminated areas. Seismic analysis can also be useful to prevent landslides.

The high conductivity of the leachate allows geoelectrical methods (such as electrical resistivity and induced polarization imaging) to identify possible contamination plumes and to map them along the time. Therefore, it makes it possible to identify the extension of the contaminated area in case of existence, and aid in the prevention of contaminated groundwater. Geoelectrical methods are also used to detect damage to the landfill cover in the case of hazardous waste that require the use of impermeable cover to prevent water infiltration and to prevent accumulation of leachate at the landfill.

Determination of mechanical properties of the MSW landfills is necessary for the analysis of slope stability, waste settlement, safely design and to enlarge old landfills. Seismic methods such as seismic refraction, multi-channel analysis of surface waves and cross hole, are useful tools to characterize the MSW mechanical properties like velocity of the compression wave (Vp) and shear wave (Vs) as well as the elastic properties of the ground: Young's modulus (E), Poisson's ratio (v), shear modulus (G) and bulk modulus (K). These properties are essential to analyze the seismic response in areas with high seismicity or areas subject to dynamic loads like vibrating machines which can cause landslides.

The values of the elastic parameters of MSW are still poorly known in landfills located in subtropical climate areas. These parameters vary according to the composition of MSW and also to the climate. Most studies of elastic parameters have been developed in areas of dry weather where the velocities tend to be high. My PhD project aims to use seismic and geoelectrical methods to evaluate the elastic parameters, the geometry and the leachate concentration of MSW in an experimental cell within a landfill located in Campinas, Sao Paulo – Brazil (a subtropical climate area). The velocities of the waves (Vp and Vs) in the different layers are obtained using seismic methods, such as shallow seismic refraction, MASW and cross-hole. By means of the velocities, the related elastic parameters are obtained. With geoelectrical methods such as resistivity and induced polarization, the geoelectric response of the constituent materials of the cell is calculated to map the leachate plumes that are characterized by low resistivity values. This is done along the time after periods of drought and rain to track the leachate plumes. The relationship between humidity and resistivity of MSW is also evaluated.

Current results show low values of P wave velocity, obtained using shallow seismic refraction. The obtained Vp=195 m/s could be attributed to the high concentration of organic waste and to the subtropical climate area characterized by high humidity. Low

velocities for P waves are not commonly reported but there are some studies of subtropical climate areas showing the same range of velocities as those obtained here.

Leachate and water quality assessment at Sari landfillsite using HELP model

One of the conventional methods of municipal waste disposal is using places as burial centers. These places can be important sources of several potential problems. Leachate produced from unsuitable landfill sites may cause environmental concerns such as contamination of groundwater, soil, and air pollution and potential health risks. One ton of waste can produce about 500 liters leachate and each liter leachate can contaminate 4,000 liters of water. The quantity and composition of leachate produced from landfill is affected mainly by meteorological and topographical parameters. Rainfall as main external entry water is effective parameter. The leachate produced in rainy areas is higher than that of dry areas, because a significant portion of precipitation seeps into landfill sites. Another factor is the topography that impacts the water balance in the layers beneath the landfill and its entry into a burial place.To develop models to predict the amount of leachate in the landfill, several studies have been conducted. Maximum and average flow of leachate is measured using Water Balance Method (WBM) orHydrologic Evaluation of Landfill Performance (HELP) model. HELP is the most practical method and its final version prepared by Schroeder and colleagues in 1983 for the US Environmental Protection Agency (EPA).Its ability to do long-term prediction of the leachate amount at landfills in different countries has been established.It is also used for estimating landfill leachate percolation potential into underground layers. The HELP model requires daily meteorological data, soil characteristics, and design specifications to perform the analysis. Daily data may be input by the user, generated stochastically, or taken from the model's historical database. Since the landfill substrate texture is considered the key point for leachate infiltration and drainage to the underlying soil layers, it is essential to examine relative percentages of soil particles including clay, silt and sand. The study area is the Sari city landfill site located in 110 km distance from Sari, center of Mazandaran Province in north of Iran.Landfill located within 10 kilometers of Kiasar national park and Charnou wildlife protected area. Main landuse type in the region is pasture in hilly land. According to laboratory measurements, soil texture in the landfill site is clay. The landfill site has width of 200 meters and length of 1,000 meters dedicated to garbage depot which everyday 25 garbage trucks convey the waste to this site. Day by day this site is expanded and it is expected that the region will experience loss of vegetation, nature destruction and conversion of the region to an infected abandoned desert.Since the region around the landfill site is source of surface water and fresh water springs, it is potentially vulnerable and seriously threatened by the landfill leachate.

“Analysis of solid waste management master plan in the city of Ouagadougou: opportunities, challenges and solutions for optimization”

Sustainable solid waste management is one of the most important concerns for the preservation of environment quality and especially for the health of populations. In 2005, to address this problem, the municipal authorities, with the support of the World Bank, implemented a master plan for waste management in the city of Ouagadougou, whose main purpose is to improve the system of solid waste management.

The aims of this study is to analyze the implementation of this plan in order to point out the opportunities and challenges, and to propose optimization solutions. This analysis shows firstly that the plan allowed the establishment of new waste collection systems, transport and recovery, and a partial privatization of the sector. This new system presents huge opportunities for job creation and income for the population, throughout waste collection and sorting. It also allows the recovery of plastic waste in the manufacturing of art objects, granules and devices used as paving stone, as long as the production of compost using biodegradable household waste.

Secondly, the pre-collection and evacuation mechanism of waste aren’t still operational. The main challenges of this management system are the lack of human, material and financial resources, and a lack of collaboration between the population and the workers in charge of waste management system. In addition there is a lack of civic virtue of populations.

Optimizing the waste management system requires sensitizations of populations for better collaboration, especially regarding waste collection and sorting, and the reinforcement of waste valorization actors’ capacities. The establishment of an environmental police and an effective implementation of pollution taxes would improve citizen participation for the success of this plan. Moreover, energetic valorization of biogas produced by wastes in the technical landfill will be a financial support. All these measures will ensure a sustainable management of solid waste in Burkina Faso.

Keywords: Solid wastes, management, Ouagadougou

Environmental Impact of Waste Disposal

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ABSTRACT

The disposal of municipal solid waste on landfills is in a global context still increasing. According to estimations made by the World Bank in 2010 about 3.5 million tonnes of MSW were generated per day and this mass will increase to about 6 million tonnes per day in 2025. Depending on the economical situation of the individual states about 70 – 95 % of the generated waste are currently deposited on dumps or landfills. While in the world´s richest regions the percentage of waste deposited on landfills is decreasing because of the implementation of recycling/reuse measures, in middle or low income countries the percentage of deposited waste is still increasing, although also in these countries recycling is getting more and more important. Also closely related to the socio-economical situation are the construction and operation of the disposal sites. Landfilling usually progresses from open-dumping with no control of the deposited waste and emissions, via controlled dumping and controlled landfilling, to sanitary landfilling with high technical and management standards. The need of certain standards is widely recognized as the risks resulting from inadequate waste disposal are manifold as for instance groundwater pollution by uncontrolled leachate emissions, GHG emissions, health risks for people living or working on or nearby dumps, risk of slope failure.

In the presentation for the main risks occurring from landfilling the causes, the relevance, the long-term importance are discussed as well as possibilities to minimize or even to avoid these risks before or during landfilling.

Also the idea of landfill mining, which means the complete removal of the already deposited waste, is presented

Keywords: landfills, GHG emissions, leachate, mechanical stability, longterm behavior

Progress of solid waste management system and green economy: a case study of Xiamen, China

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In a country with rapid economic growth such as China, environmental problems are rightfully among the top concerns of the country. However, since the directly effect of air and water pollution to human health, much attention was paid to them while neglect the issues caused by solid waste, especially municipal solid waste (MSW). The impact of social, economic, and environment to current MSW growing stream is significant. And the annual growth of MSW generated in China is estimated at about 8-10% and it is expected to increase to 323 million tons by 2020. The increasing volume and complexity of wastes associated with economic growth are posing serious risks to ecosystem and human health due to the problem in the inability of traditional waste management system. While municipal solid waste management (MSWM) is an essential part of city service, especially in a coastal tourism city like Xiamen, thus a feasible set of alternative is highest the top priorities on the agenda of Xiamen.

After reviewing the progress of solid waste management since the release of reform and opening policy in China, greening waste sector puts forward a solid waste management hierarchy promoting waste reduction, prevention, reuse and recycling followed by “three Rs” before final disposal like landfilling. With the properly implementation of this hierarchy will contribute to the enhancement of cooperation between government and private company, the increase of green jobs position opportunity, and resources saving.

This article puts insight into the current status, history and opportunity of MSWM, figures out the future direction on MSWM and encourages decision makers to make plans for the transition to green economy in waste sector. This study will not only contribute to the establishment of an integrated MSWM system in Xiamen but also in nationwide by updating the generation and quantities of MSW and providing possible recommendation.

Keywords: Municipal solid waste; green economy; waste hierarchy; developing country; Special Administrative Region (SAR)

Biodiesel Production Potential of Fleshing Solid Waste Generated from Cattle hides Processing Tanning Industry

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Abstract

Tannery generates huge amount of solid wastes containing 50-60 fleshing; 35-40% chrome shaving and chrome splits and buffing dust; 5-7% skin trimming and 2-5% hair. In Ethiopia, tanning industries generate about 70,104 metric tonnes of solid waste per annum and dispose to an open dump systems. This creates a serious effect on the environment ranging from soil and water pollution to greenhouse gas emission. Hence, solid waste generated from tanning including fleshing wastes should be managed properly. The treatment of waste with recovering resources like biogas and bio-fuel are getting wider attention. The objective of this study was to evaluate the biodiesel production potential of fleshing wastes generated from tanning industry. The fleshing waste was collected, washed with water and dried in open air. The oil was extracted with n-hexane solvent from the grinded air dried flesh waste using soxhlet apparatus. The quality of the oil was characterized using the convention physico-chemical parameters. The results obtained in the laboratory analysis indicated that the extracted oil had saponification value and iodine value of 170.59 and 43.71gI/100g, respectively. The acidic value was found to be 5.642 mg KOH/g of oil and total free fatty acid content was 2.821% which was half of the acidic value. The density of the oil was 0.8861 g/mL at 15^0 C and the kinematic viscosity was found to be 20.3495mm^2/s at 40^0C. All these analysis values confirmed that oil extracted from flashing waste is suitable for biodiesel production. The biodiesel was produced from the extracted oil using two step processes of acid catalyzed esterification and base catalyzed transesterificaton. The quality of the biodiesel produced was evaluated using the American standard for testing material (ASTMD 6751) and Europian standard (EN). The biodiesel yield from the extracted oil after washing and drying was 67.05%. The produced biodiesel had a density of

0.8609g/mL at 15^0C which falls within the EN standard (0.86–0.90 g/mL). The acidic value was 0.1792 mg KOH/g which is below the maximum allowable value of both ASTM (0.85mg KOH/g) and EN (0.5mg KOH/g). The Kinematic viscosity at 40^0C was 5.4705 mm^2 /s. This value of Kinematic viscosity was within the ASTM standard limit (1.9-6.0 mm^2/s) and slightly higher than EN 14214 limits (3.5–5.0 mm^2/s). The flash point was found to be 153°C. This also complies with the ASTM and EN standards. The distillation value of the biodiesel sample at 90% volume recovery was 345.5°C which was within the range of ASTM D 6751, 2002 standard. The volume of water and sediment in the produced biodiesel was very small (0.02%v/v) and met the ASTM standard requirement of the water content (0.05% maximum). The carbon residue and the ash content in the biodiesel were 0.066505 and 0.02417 % by mass, respectively and they were within standard limits of EN 14214 and ASTM, respectively. The cetane number (54) was found to be within both ASTM D 976 and EN 14214 minimum standards limit 47 and 51, respectively. The calorific value was 43.07MJ/Kg which was slightly higher than the HHVs of standard limit for biodiesels (39 -41MJ/kg). The results of this study showed that cattle fleshing waste generated form tanning is quite suitable for biodiesel production. Hence, fleshing waste generated from tanning industries can be managed efficiently while recovering useful resources such as biodiesel.

Key words*:* *Biodiesel, Cattle flesh waste oil, Estrification, Transesterification*

Solid waste: The significant problem of Thailand

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Abstract

Solid waste is defined as discarded or abandoned materials. It can be in a form of solid, liquid, semi-solid or containerized gaseous material. Solid waste is one of the most pernicious local pollutants. Uncollected solid waste is usually the leading contributor to local flooding and air and water pollution. Solid waste is inextricably linked to urbanization and economic development. Many countries have increased their urbanized economic wealth and it leads to improving the standard of living according to increasing in incomes and consumption of goods and services, which results in a corresponding in escalating the amount of solid waste produced.

The rapidly rising of solid wastes due to the trends of increasing the number of the population leads to a serious problem of solid waste management. Nowadays the daily waste generation rate in South Asia, East Asia, and the Pacific combined together approximately 1 million tons per day (WorldBank, 2012). Also in Thailand showed the amount of solid waste has increased as same as any other countries in the world. In 2013, the amount of solid waste in Thailand rises to 26.77 million tons. At the same time, the transport and storage of the solid waste are only limited to 7.2 million tons. In fact, approximately 6.9 million tons of solid waste that have been transporting and stored inappropriately. It was also found that 7.6 million tons of solid waste had not been collected in many areas. Only 5.1 million tons has been recycling (Pollution Control Department, 2013). In Thailand, the solid waste is handling by the local government's agency. Therefore, a city does not have any authority to manage solid waste effectively such as providing more services such as service regarding

of health hazards issue, educational program, new transportation, and proper disposable places.

Today in Thailand we still do not have a clear alternative to solve the solid waste problems which related to the waste collection method, recycling process, garbage reduction procedure, waste reusable, transportation and the final disposal areas. In general, people perception of the solid waste problems shows a lacking awareness of the seriousness problem so they make a minimal effort to work on the reduction of the solid wastes. Generally, the amount of the solid waste depends on many factors such as the economy development, the level of industrializing in the city, the behavior of people in that city, and the urban environment. As a result, social and economic development can cause to increase of solid waste in the city as well.

In the past, Thailand has been trying to use the principal solution to solve the solid waste problems accordance to the zero waste management; 1) to promote waste minimization and waste separation at sources 2) to provide regular waste collection service in order to make the community clean 3) to develop the system of collection and disposal for hazardous and infectious waste 4) to establish a network center on waste management 5) to increase the efficiency of waste disposal by adapting technologies and encouraging private sectors participation on waste management 6) to increase separation of waste, the efficiency of recycling and treatment that would go to more environment-friendly treatment 7) to make solid waste collection and disposal service more financially self-sufficient and 8) to use the new technology to change solid waste to an energy, become a landfill gas recovery, and anaerobic digester biogas in order to reduce fossil fuel consumption and greenhouse gas emission. In addition, the solid waste management will be accomplished by cooperation from everyone in Thailand.

Assessment of the viability of co-digestion of sludge with food waste and its potentials for methane gas generation, in Central Jordan

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Abstract:

Jordan economy is suffering from the heavy load of energy prices, beside severe water shortage. Recent studies reveal that Jordan is suffering bad climate change impacts in terms of rainfall decreasing; drought, and desertification. Aiming in investigating suitable solution for the problem of sludge, Jordan is cooperating with GIZ in a pilot project of decentralized management of sludge. The project aims to reduce carbon foot print of sludge by using it as a source of energy and /or soil conditioner or fertilizer. Co-digestion of sludge by processing it with organic waste is considered an attractive option to improve the process and to increase the yield of gas noting that large amounts of municipal food waste can be utilized.

A bench-type experiment of anaerobic co-digestion between sludge and food waste to generate biogas was conducted at PFC-DSEER labs. Different sludge - food waste mixtures were used in feeding process. The aim was to find the best ratio of sludge: food waste that would give higher biogas production. Five different mixtures of sludge and food waste were prepared, they were (sludge: food waste; 100:0; 80:20; 50:50; 20:80 and 0:100). The co-digestion took place under anaerobic conditions at 35ºC. A total solid content of 150g in each mixture, the mass of each feed were calculated on the basis of its solid content (TS %).This weight chosen to ensure sufficient gas production. Additionally, 100 ml of inoculum solution was added to each mixture as source for anaerobic bacteria. The pH in anaerobic reactors was monitored, it was very low pH (3.4 - 4) in reactors contains more than 20% food waste, due to high organic load. As optimum pH for anaerobic digestion is (7-7.5), therefore, attempt was made to raise pH by adding $CaCO_3$. Despite that the pH never exceeds 5.5 in bottles of high food waste ratios, indicating extremely acidic conditions. In the contrary, bottles with low food waste, the pH was 6-6.5, and gradually became 7 without adding $CaCO_3$.

The higher biogas production were obtained from reactors having low food waste content, whereas the higher food waste ratios yields small biogas quantities and terminated quickly. The best ratio was 20% of food waste, it gave the highest methane production (i.e. methane production increased about 29%). Beside it decreases the time required to reach the maximum yield, thus decreasing the cost. Thus indicate the importance of co-digested food waste with sludge. The heavy load of food waste as one dosage was the main reason for the failure of higher ratios of high food waste. It would cause extremely toxic acidic conditions that killed the anaerobic bacteria. Therefore; pH should be controlled and monitored and never be below 6. In addition, food waste feeding should not be added as one dosage but in small and step-batch supply to avoid the toxicity shock.

Treated organic matter (TOM) characterization showed that it has much lower trace elements and Total Fecal Coliform (TFCC) contents than the permissible limit according to the Jordanian standard for treated sludge (JS 1145, 2006). Beside; it is enriched with N and P, that approved it as suitable and safe soil amendment.

Fundamental tools for a sustainable waste management in Brazil

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The National Policy for Solid Waste, published in 2010 in Brazil, moved the theme solid residue to another level, extrapolating discussions focused exclusively on forms of final disposal in landfills. The new legal framework incorporates the consciousness of wealth and potential possibilities in waste management, it also reveals the errors and omissions that have been accumulated over the past 30 years.

During the Law implementation it was highlighted the need to enter into debates that spanned from the technologies in the form of fermentation, composting, recycling, and energy recovery up to the provision of information, advice on the introduction of a sustainable waste management and, still, the engineering and scientific content, as well as the relevant aspects for the implementation of the projects, such as trends and challenges of management, among other aspects of the market. The diversified themes aimed to open a multidisciplinary discussion integrating several market segments, in order to allow the design of tools for the implementation of a sustainable management of municipal solid waste.

After 6 years publication we can observe a slowly movement, slowly doesn't mean small when we consider the giant waste market that Brazil represents, expecting for 2016 around 15 billion euros turn over in waste management where 80 % is done by private sector. Although the good news, Brazil still have 42 % of waste final disposal being done at wild landfill and their remediation represents also an interesting market. To change traditional practices we need to open a multidisciplinary discussion integrating multiple market segments to enable the design of tools for the implementation of sustainable management of municipal solid waste.

Observing the past years we can identify certain obstacles in Brazil, to stablished efficiently the terms of the new Waste Policy, hinder the process of building a new stage of waste valorization, as such: lack of knowledge to choose technologies, to build tenders, to stablish an environmental license and financial lines, among other difficulties that are direct or indirectly related to a modern waste management.

To overcome the challenges is also necessary to establish of technical cooperation between institutions will enhanced the best practices in the management of municipal solid waste transcending preliminary aims by provision of technical staff and infrastructure, and creating opportunities to democratize the information for promoting purposes of a holistic view as differentiated waste management. These efforts will cause a cultural change that will protect our natural resources and climate, ensuring a better future for next generations.

In general, the majority of these obstacles is based on market immaturity, meaning that is necessary to identity the weakness and to set a discussion about the arrangements to minimize risks, providing ***fundamental tools for a sustainable waste management***, consequently the market will react in order to recognize that a sustainable waste management not only contribute to the better environment but can also represent a new market opportunity.