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Control Mechanism of Bad Odor Generated from Sanitary Landfill Leachate Using Swiss Pharm BioMist

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Abstract

Among the variables that could influence the citizens' sense of a healthy environment, odor emissions play an important role, as they deeply affect the human life quality and psycho-physical wellness. An odor is a mixture of light and small molecules that are able to stimulate an anatomical response in the human olfactory system. Sensory analyses by odor panels are important in defining odorous nuisances. Biodegradable mist can be applied to liquid or solid waste, as a surface treatment, by incorporation, or dosing during processing.

As the limits of urbanization are extending to far flying areas in Addis Ababa, Sandefa Sanitary Landfill site has been established since December 2015. The new Sandefa Sanitary Landfill site is located about 35 km from Addis Ababa city and 5 km South-West of Lagedadi Dam, at North-Eastern side of Addis Ababa in Oromia Region, Finfine Zuria special zone, Bereh Woreda, in Ele Kebele close to a town called 'Laga Tafo'. However, the new municipal solid waste landfill leachate is causing a great concern to the communities settled around. The main objective of this study is assessing the applicability of BioMist in removing the Odor from landfill leachate at specified environmental conditions. In order to come up with realistic solution, field observation, field measurement and experimental/sample analysis standard method is employed. The result showed that BioMist is effective in removing bad odor and improving water quality at lower concentration.

Keywords: Biodegradable; BioMist; Color; Landfill; Leachate; Odor; Sandefa

Introduction

In the perspective of the improvement of life quality and citizen's wellness, odor pollution is becoming a more and more relevant issue. In fact, among the variables that could influence the citizens' sense of a healthy environment, odor emissions play an important role, as they deeply affect the human life quality and psycho-physical wellness [1]. An odor is a mixture of light and small molecules that are able to stimulate an anatomical response in the human olfactory system. Sensory analyses by odor panels are important in defining odorous nuisances. Detection to Threshold (DT) is a method of determining the total odor of a sample by having panelists evaluates progressively more diluted samples until the sample is below odor threshold [2]. The DT can be used to establish the relative strength of different odorous sites. This method was based on applying of the Flavor Profile Analysis Method, Standard Method 2170, to odorous air sample [3]. This method is known as the Odor Profile Method (OPM). The character of the odor provides a clue as to what is causing the odor as operations at a facility may have distinct odors. Odor wheels can be used to help define the odor character. Odor wheels consist of three segments: the inner circle listing categories such as Sulfide; the outer circle giving specific odors falling into that odor category (e.g., Rotten Eggs, Rotten Cabbage, and Rotten Garlic); and outside the wheel are specific chemicals matching to the odors (e.g., Hydrogen Sulfide, Dimethyl Disulfide and Dimethyl Trisulfide) [4].

One of the major odor problems is the municipal solid waste landfill leachate. Leachate is the liquid residue resulting from the various chemical, physical and biological processes taking place within the landfill. Landfill leachate is generated by excess rainwater percolating through the waste layers in a landfill. Generally, leachate may contain large amounts of organic matter (biodegradable, but also refractory to biodegradation), as well as ammonia-nitrogen, heavy metals, chlorinated organic and inorganic salts, which are a great threat to the surrounding soil, groundwater and even surface water [5,6].

The composition of landfill leachate, the amount generated and the extraction of potential pollutants from the waste depend upon several factors, including solid waste composition, degree of compaction, absorptive capacity of the waste and waste age, seasonal weather variations, levels of precipitation, Landfill temperature, size, hydrogeological conditions in the vicinity of the landfill site, engineering and operational factors of the landfill, pH, landfill chemical and biological activities [7]. A simplified water balancing equation takes all of these factors into account and allows designers to predict an amount of leachate that will be produced by the landfill.

Biodegradable Mist is liquid antibacterial disinfector, this single preservative is broad spectrum and cost effective antimicrobial that is active against gram-positive bacteria, gram-negative bacteria, mildews and microzyme, wound disinfector, air-clear, deodorizer for conditioner, embalmment for plastic. It is widely used as a combination sanitizer-disinfectant for hospital, livestock and personal hygiene sectors/sugar and waste treatment. Biodegradable mist's main focus is to provide odor control solutions with worldwide expertise and best in class products which offers strong detergency and rapid, safe, powerful antimicrobial activity at low concentration.

Biodegradable mist solution minimizes foul odor generation by influencing the microbiology of an organic waste delivering highly specific micronutrient to the indigenous microorganisms of the waste material to promote growth and reproduction of bacteria that break down waste, while reducing the growth of odor causing bacteria by selective inhabitation. Biodegradable mist can be applied to liquid or solid waste, as a surface treatment, by incorporation, or dosing during processing. Biodegradable mist is completely soluble in water and added conveniently with special fit to more water prescription. This product is non-toxicity and not irritating to skin. Biodegradable Mist is widely used in the formulation of cleaner-sanitizers additional to odor removing and water treatment. BioMist offers proven power sanitizing products that are safe for people and safe for the environment. Our patented technology and proprietary formula help kill pathogens in environments where viruses and bacteria are negatively impacting businesses and brands while creating a tremendous financial burden on our healthcare system and in many cases, costing human lives.

Among the several existing types of industrial plants that generally cause Odor nuisance, municipal solid waste landfills represent one of the major sources of odor emissions and complaints. The need for better control of municipal solid waste landfill odors is of critical importance for removing nuisances and assuring health to surrounding communities [8]. As the limits of urbanization are extending to far flying areas in Addis Ababa, the problem of odor from municipal solid waste landfill leachate is causing a great concern to the communities settled around landfill sites. However, the Addis Ababa City Government could not found the solution for such problems. The complaint of the community due to the commencement of the landfill operation increases as time passes and tried to stop the waste transportation trucks by means of collecting stones on the road and harming the truck drivers. The responsible bodies from the Addis Ababa City Government, HoA-RECandN, Addis Ababa University (AAU) as well as the representative from a region of Oromia had communicated with the Oromia special zone, Cheffe Woregunu Wereda leader's officials to discuss on the grievance of the community due to the bad odor generated from the landfill. As the result of the discussion the city administration of Addis Ababa together with HoA-RECandN agreed to find a solution for the bad odor generated from the landfill leachate. Limited experiences, necessary equipments and lack of odor emission standard in Ethiopia indicated that BioMist was used for bad odor control. Therefore, HoA-RECandN, AAU and Addis Ababa Municipal Solid Waste Management suggested to Swiss Pharm to conduct a research on the BioMist effectiveness for bad odor control and environmental impacts by third body.

Materials and Methods

Study site

The study site is located about 35 km from Addis Ababa and 5 km South-West of Lagedadi Dam, Oromia Region, Finfine Zuria special zone, Bereh Woreda, in Ele Kebele close to a town called 'Laga Tafo. The materials used during the study include pH meter, DO meter, Sampling bottle, Ice box and laboratory equipments.

Data collection methods

In order to determine the quality of leachate, samples were collected (April 15 to May 7, 2016) from inlet of anaerobic pond at landfill location using three approaches: Field Observation, Measurement on site and Laboratory Analysis. Leachate was frequently sampled directly from prepared sampling containers once every week for four respective weeks. The samples were collected in well-labeled clean bottles that were rinsed out thrice prior to sample collection as shown in Figure 1.

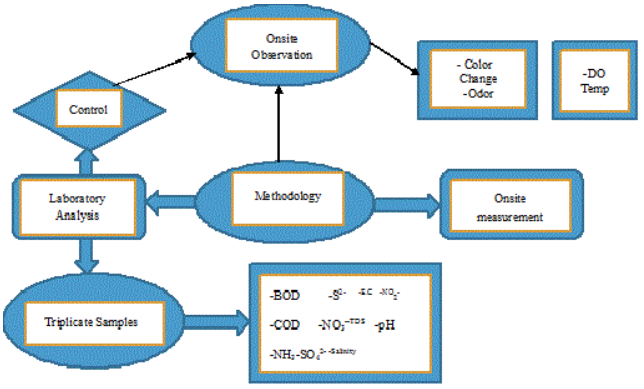

Figure 1: Conceptual design for the Research.

Sampling procedure

The inlet of the leachate was first closed before mixing with at anaerobic pond using sand. After two days, the leachate filled in the sanitary tube. Once leachate entered a storage facility, it was subjected to physical, chemical and biological reactions that can change the composition of the leachate. Therefore, the best representative sample was collected as close to the leachate generation point as possible, as the leachate leaves the waste. The leachate collection location was selected with this objective in mind. Typically, leachate was collected using grab samples, i.e., single samples taken at specific times. As a result, the samples were taken at the sampling point located at the inlet of the anaerobic pond.

Analytical work

Analytical methods were according to "Standard methods for examination of water and wastewater" specified by American Public Health Association [9]. The pH was measured by electronic pH meter (4500-H+B of Standard Methods). Total Solids (TS) was determined by properly shaken unfiltered sample and estimated by gravimetric method (2540.B of Standard Methods). Total Dissolved Solids (TDS) was determined by filtered sample through Whatman filter paper-44 and estimated by gravimetry (2540C: Standard Methods).

Chemical Oxygen Demand (COD) was determined by refluxion of sample followed by titration with Ferrous Ammonium Sulphate (FAS) was adopted (5220C: Standard Methods). Biological Oxygen Demand (BOD)-Winkler's method was used for estimating initial and final DO in the sample and BOD was determined (5210-B of Standard methods).

Nitrate was analyzed by HACH Portable Spectrophotometer (DR 2800) by Cadmium Reduction Method (8039) adapted from Standard Methods at a wavelength of 450 nm [10]. Sulphate was analyzed by HACH Portable Spectrophotometer (DR 2800) by Sulfa Ver 4 Method (8051) adapted from Standard Methods at a wavelength of 520 nm [10].

Results and Discussion

Field observation and measurement

A total of ten sample including control sample were taken to the AAU Centre for Environmental Science Laboratory. For leachate characteristics, shown in Table 1.

Parameters	Leachate
Odor	Bad odor
Color	Dark black
Dissolved oxygen	0

Table 1: Result of field observation and measurement at first phase.

As shown in Table above, before adding the BioMist, the leachate has bad odor with dark color and there was no dissolved oxygen which indicates having high BOD and COD. Dissolved Oxygen and temperature were measured on site in different intervals; the color and odor change were observed with Swiss Pharm BioMist.

Figure 2 and Table 2 below show the results of field observation of odor, color and field measurement of DO as well as temperature. This result indicates that for the first to third (Control A-Control C) field measurement, the concentration of dissolved oxygen is highly increased in all samples except control, but the concentration of DO in the control sample remains zero until fourth measurement. The temperatures remain the same in all conditions. The color and odor of the leachate indicate highly improvement in all concentration of Swiss Pharm BioMist.

Concentration	DO	Temperature	Color	Odor
Control A	0	19	Dark	Bad odor
A1:500	1.56	18.3	brown	odorless
A1:1000	1.66	18.6	brown	odorless
A1:2000	1.88	18.7	brown	odorless
Control B	0	19	Dark	Bad odor
B1:500	2.66	19.3	brown	odorless
B1:1000	2.87	19.6	brown	odorless
B1:2000	3.08	19.7	brown	odorless
Control C	0	18.81	Dark	Bad odor
C1:500	2.96	19.3	light brown	odorless
C1:1000	3.07	19.6	light brown	odorless
C1:2000	3.28	19.7	light brown	odorless
Control D	1.4	19	Dark	Bad odor
D1:500	1.8	19	light brown	odorless
D1:1000	2	19	light brown	odorless
D1:2000	2.1	19	light brown	odorless

Table 2: Result of Field observation and measurement at different phases.

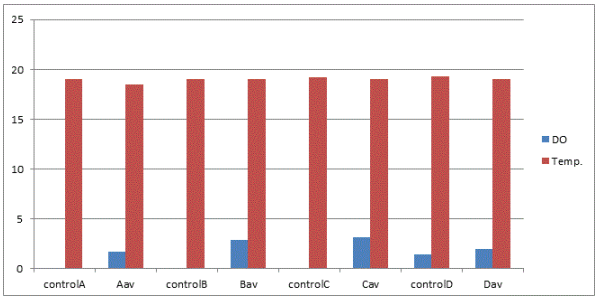

Figure 2: BioMist concentration Vs DO and Temperature.

Figure 3 shows that the Sandefa landfill leachate has high concentration of NH_3-N, COD; BOD and S^{2-}. As a result, the high concentrations of these parameters indicate that the leachate is highly polluted and emit odorant gases to the surrounding environment. The leachate odorous smell may be due mainly to the presence of organic acids, which come from the high concentration of organic matter (OM) when decomposed [11].

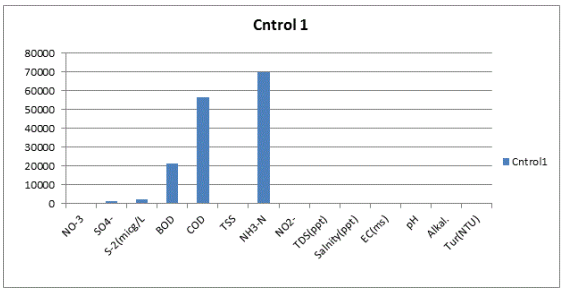

Figure 3: Physico-chemical characteristics of Leachate.

After addition of BioMist, the Physico-chemical characteristics of leachate decrease in all concentration of BioMist. These major causes of water pollutants, such as COD, NH_3-N, BOD and sulfide (S^{-2}) decreased in comparison with the control and leachate background [12]. Besides laboratory result, field observation and field measurement the color of the leachate was changed from black to light brown. The bad odor of leachate was completely disappeared. Consequently, the dissolved oxygen of the leachate increased as shown in Figure 4.

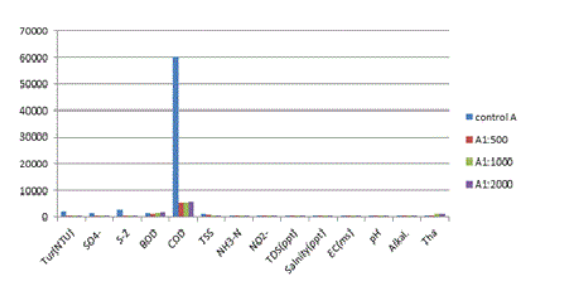

Figure 4: Physico-chemical characteristics of treated Leachate (first phase).

As shown in Figures 5 and 6 show that the concentrations of NH_3-N, BOD, S^{-2} and COD are highly decreased. As a result, the water quality indicators, such as color, odor and dissolved oxygen have been improved.

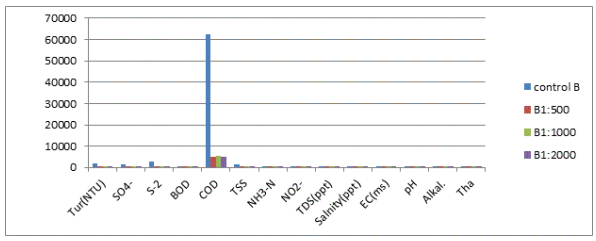

Figure 5: Physico-chemical characteristics of treated Leachate (Second Phase).

Figure 6: Physico-chemical characteristics of treated Leachate.

The leachate sample taken after 21 days of experimental result showed that almost all of odor causing parameters has been decreased with same previous trends [12]. The conditions that cause H_2S formation in municipal solid waste landfills, such as SO_4^{2-} source, carbon source, anaerobic conditions, moisture, and appropriate pH and temperature are appreciably decreased; then the leachate quality increased [13] as shown in Figures 7 and 8.

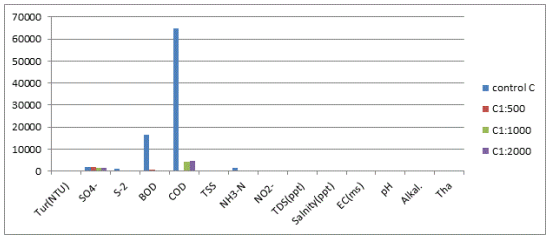

Figure 7: Physico-chemical characteristics of treated Leachate (third phase).

Figure 8: Comparison of Physico-chemical characteristics of treated Leachate.

The leachate sample taken after 45 days of experimental result showed that almost all of odor causing parameters has been under recommended limit of the waste water discharge with the same previous trends [12] shown in Figure 9.

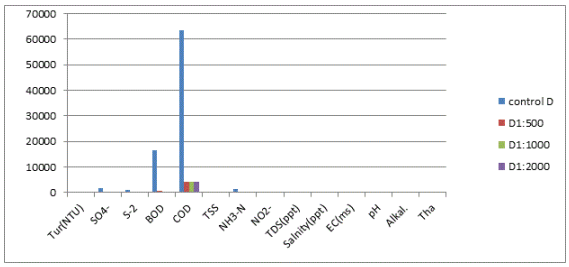

Figure 9: Physico-chemical characteristics of treated Leachate (fourth phase).

Acknowledgments

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Conclusion

This experiment showed that BioMist can eliminate the entire bad odor from landfill leachate acting as quick removal of odor. This can be explained by the fast reaction of BioMist, due to its chemical characteristics that can neutralize odor producing gases such as NH_3 and H_2S. Therefore, as fast reduction or removal is vital in landfill leachate treatments plants, BioMist is technically qualified. As the experimental results show that temperature of the leachate has no effect on the treatment. The concentration of odor causing parameters was reduced throughout experiment and this indicates that the quality of the landfill leachate is improved.

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