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Research Article

Advance in Environmental Waste Management & Recycling

Development of a Mathematical Model for Calculating Accumulated Solid Waste: An Experimental and Statistical Sampling

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Abstract

In recent innovation, refining of waste into biofuel, transformation of waste into useful materials and as well of waste recycling has been accomplished. Waste management has being an important factor in community development. The transformation of waste into useful materials has received much work and the most abundant and useful waste are solid waste.

In order to minimize the rate of which solid waste is being wasted and to know amount of solid waste reserved in an area. A database must be developed to know the amount of waste accumulated or generated over a given period of time. Taken into consideration the burning and recycle reduction factor, incremental factor and degradable waste ratio.

This paper look for a mathematical formula that can be used to generate data for amount of solid waste accumulated over time for geographical location in respect of mass.

Keywords: Waste Management, Solid Waste Collection, Data Collation, Mathematical Model

Introduction

Estimation has been given of waste generated in a geographical location per day [1]. The formula works with the estimated figures of waste generated per day geographical location using statistical models of sampling [2].

The importance of data in this present age cannot be overemphasized. It is important because it provide useful information for institutions, organizations and researchers of past record.

The aim of this research is to develop a formula that will help companies, institutions and researcher of biofuel, bioenergy system and other waste transformation related fields determine the amount of solid waste available to them in a geographical location based on the data derived from the formula and waste chart.

Methods

To determine the estimated accumulated waste of a geographical location for a given time interval. Three factors were considered and these factors varies from different geographical locations. Therefore, geographical locations should be experimental samples. The factors are:

- Waste incremental ratio (i)
- Degradable waste ratio (c)
- Burning and recycle reduction factors

These factors tend reduce or increase the accumulated waste from expected waste generated. The availability of waste-to-waste companies can be examined using these factors. To determine these factors, statistical model and experimental sample methods will be employed.

Statistical Model of Waste Incremental Ratio (i)

$$i = \frac{1}{t}\sum_{k=1}^{\infty}\left(\frac{N_k - N_{k-1}}{N_{k-1}}\right)$$

where, N is amount of waste generated per day and k is the number of days

t is number of days used which is k_{max}

Experimental Method Procedure

- Create an open boundary space samples of dumpsite A,B,C,D,E,…….∞
- Determine the mass of solid waste of each samples
- Check the increment in mass of each samples per day for given period of days

Sample	Day1	Day2	Day3……. Day k
A	N_1a	N_2a	N_3a……N_ka
B	N_1b	N_2b	N_3b ……...N_kb
C	N_1c	N_2c	N_3c ……...N_kc
D	N_1d	N_2d	N_3d ……N_kd
E	N_1e	N_2e	N_3e ……N_ke
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
∞	$N_1\infty$	$N_2\infty$	$N_3\infty$ ……$N_k\infty$

Waste incremental ratio for each samples

$$i_A = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{ka}-N_{(k-1)a}}{N_{ka}}$$

$$i_B = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{kb}-N_{(k-1)b}}{N_{kb}}$$

$$i_C = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{kc}-N_{(k-1)c}}{N_{kc}}$$

$$i_D = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{kd}-N_{(k-1)d}}{N_{kd}}$$

$$i_E = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{ke}-N_{(k-1)e}}{N_{ke}}$$

.

.

$$i_\infty = \frac{1}{t}\sum_{k=\infty}^{\infty}\frac{N_{k\infty}-N_{(k-1)\infty}}{N_{k\infty}}$$

Average waste incremental ratio

$$i = \frac{\sum_{k=A}^{\infty} i_k}{number\ of\ samples}$$

In order to avoid or minimize mathematical and computational error, a small number of samples and minimum duration of days is advice.

Statistical Model of Degradable Waste Ratio (c)

$$c = \frac{1}{t}\sum_{k=1}^{\infty}\left(\frac{N_k - N_{k+1}}{(k+1)-k}\right)$$

where, N is amount of waste generated per day and k is the number of days
t is the number of month of experiment

Experimental Method Procedure

- Create space samples of dumpsite A,B,C,D,E,…….∞ in a closed and isolated system
- Determine the mass of solid waste of each samples
- Check the decrement in mass of each samples per day for given period of days

Sample	Month 1	Month 2	Month ……Month 3 ……k
A	N_1a	N_2a	N_3a……N_ka
B	N_1b	N_2b	N_3b ……...N_kb
C	N_1c	N_2c	N_3c ……...N_kc
D	N_1d	N_2d	N_3d
E	N_1e	N_2e	……N_kd
.	.	.	N_3e ……N_ke
.	.	.	.
.	.	.	.
.	.	.	.
∞	$N_1\infty$	$N_2\infty$	. $N_3\infty$ ……$N_k\infty$

Waste incremental ratio for each samples

$$c_A = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{ka}-N_{(k+1)a}}{((k+1)-k)a}$$

$$c_B = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{kb}-N_{(k+1)b}}{((k+1)-k)b}$$

$$c_C = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{kc}-N_{(k+1)c}}{((k+1)-k)c}$$

$$c_D = \sum_{k=1}^{\infty}\frac{N_{kd}-N_{(k+1)d}}{((k+1)-k)d}$$

$$c_E = \frac{1}{t}\sum_{k=1}^{\infty}\frac{N_{ke}-N_{(k+1)e}}{((k+1)-k)e}$$

.

.

$$c_\infty = \frac{1}{t}\sum_{k=\infty}^{\infty}\frac{N_{k\infty}-N_{(k+1)\infty}}{((k+1)-k)\infty}$$

Note ((k + 1) - k) = 30 *days k should be in days*

Average Waste Degradable Ratio

$$c = \frac{\sum_{k=A}^{\infty} c_k}{number\ of\ samples}$$

Burning and Recycle Factor

The assumed burning factor is in the range of 0.005 to 0.006 depending on the burning and recycling activities of the geographical area considered.

Result

A reduction constant k is developed from the mathematical combination of all the factors ensuring that reduction is at a reasonable range. $k = i^{bc}$

The amount of solid waste accumulated over a given period in term of the mass is given as

$M = kTN + N$

$T = T_0\text{-}1$

Where

M is accumulated waste over a period of time

K is reduction constant

T_0 is period of time taken in days

Conclusion

This paper has shown a method of calculating the amount of accumulated solid waste in mass. The factors consider varies from one geographical area to another. We employ researchers to further the research with the aim of obtaining the factors for different geographical locations in the world. Develop a chart that will contain the data of all i, c and k for all experimented geographical areas [3].

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