Development Of A Mathematical Model For Calculating Accumulated Solid Waste: An Experimental And Statistical Sampling

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Abstract

In newest development, waste is being refined into a biofuel or being recycled. This is to say lots of works has done to turn or transform waste into useful materials. Waste management has being an important factor in community development. Therefore, data base must be developed to know the amount of waste accumulated or generated over a given period of time. Taken into consideration the incremental factor, degradable waste ratio and burning and recycle reduction factor.

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

1.1 Introduction

Estimation has been given of waste generated in a geographical location per day (kehinde Alare, 2020). The formula works with the estimated figures of waste generated per day geographical location using statistical models of sampling (Castle, 1993).

The importance of data in this present age cannot be overemphasis, 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 base on the data derive from the formula and waste chart.

1.2 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 the 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)

$i = \frac{1}{t}\sum_{k=1}^{\infty}(\frac{N_k - N_{k-1}}{N_{k-1}})$ (Dass, 2008)

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	Day 1	Day 2	Day3……. Day k
A	N_1a	N_2a	N_3a ……
B	N_1b	N_2b	N_ka
C	N_1c	N_2c	N_3b ……...
D	N_1d	N_2d	N_kb
E	N_1e	N_2e	N_3c ……...
.	.	.	N_kc
.	.	.	N_3d ……
.	.	.	N_kd
∞	$N_1\infty$	$N_2\infty$	N_3e ……
			N_ke
			.
			.
			.
			.
			$N_3\infty$ ……
			$N_k\infty$

Waste incremental ratio for each samples

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

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

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

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

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

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

Average waste incremental ratio

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

In order to avoid and 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

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

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

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

Burning and Recycle Factor

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

1.3 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

$$M = kTN + N$$

$T = T_0 - 1$

Where

M is accumulated waste over a period of time

K is reduction constant

T_0 is period of time taken in days

1.4 Conclusion

This is paper has shown a method of calculating the amount of accumulate solid waste in mass. The factors consider will vary a geographical area to another. We employ researchers to further the researchers with the aim of getting the factors for different geographical locations in the world. We aim to develop a chart that will contain the data of all i, c and k for all experimented geographical area.

(Dass, 2008)

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