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AL-MUTHANNA JOURNAL FOR ENGINEERING SCIENCES
مجلة المثنى للعلوم الهندسية

CHARACTERISTICS AND COMPOSITIONS OF SOLID WASTES FROM ALTUHMAZIYA REGION IN HILLA CITY

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ARTICLE INFO

Received: 17/4/2014

Accepted: 24/8/2014

Keywords
Energy content, Residential solid wastes, Chemical formula, Hilla city .

ABSTRACT

The main objective of the present study is to investigate the residential solid wastes characteristics and energy content in Hilla city in the middle of Iraq. The solid waste characteristics, and energy content of Hilla city were found by selecting one area, which represent different lifestyles. Data of samples were collected from 13 multi-storey buildings in the Tuhmaziya region in Hilla city through 2013. The refuse was classified into ten categories (food wastes, paper, plastics , glass, textiles, rubber, tin cans , wood, cardboard, and garden trimmings, etc). The food category was found to be 46.31% of the total weight, and moisture content of 37.52 % .

The chemical formula of a residential solid waste of Hilla city was found to be $C_{802.3}$ $H_{2630.3}$ $O_{1074.3}$ N_{18} with sulfur and without sulfur as $C_{44.6}$ $H_{146.1}$ $O_{59.7}$ N. The energy content (dry basis) was found to be 12369kJ/kg .

خواص ومركبات النفايات الصلبة لمنطقة الطهمازية في مدينة الحلة

الكلمات المفتاحية
محتوى الطاقة ، النفايات الصلبة المنزلية، الصيغة الكيميائية ، مدينة الحلة.

الخلاصة

الهدف الرئيسي من هذه الدراسة هو دراسة خصائص النفايات الصلبة و محتوى الطاقة في مدينة الحلة في وسط العراق. تم تحديد خصائص النفايات الصلبة ، و محتوى الطاقة لمدينة الحلة من خلال تحديد منطقة واحدة ، والتي تمثل مختلف أنماط الحياة . تم جمع البيانات لعينات من 13 مبنى متعدد الطوابق في منطقة الطهمازية في مدينة الحلة عام 2013 .

تم تصنيف النفايات إلى عشر فئات (النفايات الغذائية والورق و البلاستيك والزجاج و المنسوجات والمطاط وعلب الصفيح والخشب و الورق المقوى، و مخلفات الحدائق ، الخ). بلغت نسبة الفضلات الغذائية (46,31٪) من الوزن الكلي، و محتوى الرطوبي (37,52 ٪).

وقد استخرجت الصيغة الكيميائية للنفايات الصلبة المنزلية في مدينة الحلة مع الكبريت $\mathbf{C_{802.3}\,H_{2630.3}\,O_{1074.3}\,N_{18}}$ وبدون الكبريت $\mathbf{C_{44.6}\,H_{146.1}O_{59.7}\,N}$ وقيمة محتوى الطاقة (على أساس جاف) 12369كيلو جول/كيلو غرام .

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I. Introduction

Solid wastes are all the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted. The term solid wastes is all-inclusive and it encompasses the heterogeneous mass of throwaways from residences and commercial activities as well as the more homogeneous accumulations of a single industrial activity [1].

Problems with the disposal of wastes can be traced from the ancient time, when humans first began to congregate in tribe, villages, and communities and the accumulation of wastes became a consequence of life. Throwing of littering of food and other solid wastes into unpaved streets, roadways, and vacant land – led to breeding of rats, with their attendant fleas carrying the germs of disease, and the outbreak of plague. The lack of any plan for the management of solid wastes led to epidemic of plague, the Black Death, that killed half the Europeans in the fourteenth century and caused many subsequent epidemics and high death tolls.

The relationship between public health and improper management of solid wastes is quite clear. The rats, flies and other disease vectors breed in open dumps, as well as in poorly constructed or poorly maintained housing, in food storage facilities, and in many other places where food and harborage are available for rats and the insects associated with them. The U.S public health service (USPHS) has published the to improper solid waste management [2].

Ecological impacts , such as water and air pollution , also have been attributed to improper management of solid wastes. Solid waste management is one of the major environmental problems facing most of the developed and developing nations of the world. Higher rates of waste generation, a shortage of manpower, limited land resources, and increasing costs of collection and disposal are the major factors to be considered in solid waste management planning [3].

II.Objectives

The objectives of this research are:

1. Study the properties and energy content of residential solid wastes in Hilla city. These items are then compared with those of other part of the country and the world.
2. Study of the existing residential solid wastes trend system and development of a system based on local climate and , physical, social, and economic factors.

III. Existing Solid wastes Management in HILLA City

A. Storage

Even with a given area of the city, there are significant differences in storage. The majority of people do not have containers, which unfortunately do not ensure sanitary storage of refuse. The containers used by household vary in size and shape, and without cover. Refuse scattering are often witnessed alone the streets in high and low income residential areas. The high temperature and the lack of household storage space make frequent collection essential.

B. Collection in Hilla city

In Hilla city refuse collection includes collection and hauling to disposal sites. Collection is so poorly organized and irregular. In most parts of the old districts of the city efficient refuse collection is more complicated because house to-house collection is not possible. This is because houses are not accessible by collection vehicles and are so closely built and arranged in such an order less manner that it is impossible to haul refuse properly from them. These, districts are close to city center. In other districts most streets are unpaved so they obstruct vehicle moves in the rainy season.

Refuse collectors are exposed to some considerable health hazards. Often they work without gloves and without protective clothing, and suffer from skin and intestinal infections. The collection trucks, available are about 15 years old and which are in a poor state repair.

C. Disposal in Hilla city

All solid wastes collected by the municipal of the city are presently disposed by dumping in a areas within the city, or near it, or purchased by farmers to make composts to enhance agricultural production. When open dumping is used, the waste is left uncovered, so the damage to the environment can be clearly noticed. At all stages of the system, from the storage to the final disposal, materials that can be reused are removed scavengers.

III. Properties of Residential Solid Wasted in HILLA City

Information of the properties of solid wastes is important in evaluating alternative equipment needs, system and management programs and plans.

A. Physical Properties

1.Individual Components

Samples were collected from 13 multi-storey buildings in the Tuhmaziya region in Hilla city, each building has three floors and each floor contains four apartments[4].

The analyses of this waste is represented in Table 1.

Table 1. Altuhmaziya region solid waste composition in 2013

Composition of waste	% By mass	Mass.kg	Volume .m^3[4]	Typical density Kg/m^3[3]
Food waste	46.31	2296.8	7.92	290
Paper	21.59	1071	12.6	85
Plastics	3.77	187.2	2.88	65
Glass	4.24	210.6	1.08	195
Wood	3.48	172.8	0.72	240
Textiles	1.88	93.6	1.44	65
Rubber	9.43	468	3.6	130
Tin cans	3.26	162	1.8	90
Cardboard	2.17	108	2.16	50
Garden waste	3.81	189	1.8	105
Total	∑99.94	4959	∑36	

IV.HILLA City Solid Waste Data Gathering and Discussion

A. Time and place

Hilla city is located in the middle of Iraq, most of the population had completed primary education, the income of many families are low. The climate is seasonal, varying from January mean minimum of $0C^0$ to August mean maximum 50 C^0. As with most solid waste systems, in Hilla city the operation involved storage, collection, and disposal. This system is managed by the Hilla finicality directorate.

The city of Hilla is divided into five districts: Alfayha, Alfrdous, Alforat, Alsalam, Alzehara. These five districts are further subdivided into many neighborhoods, and some of district neighborhood named are presented in Table 2.

Table 2. Hillas five districts and its neighborhoods

District	Neighborhood
Alfayha	Tuhmaiza.
Alfrdous	Thayla, Khratda, kalg and Wardya dahal, Housohra, Malab(1), Jhamyia Almohalmen (Bakarla), Sakak(1), Malab (2), Babil, Bakarla, Safe sahad andAlnumhany, Huther, Alraa (2), Alraa(1), Sakak (2), jhzaher.
Alforat	Nader(1), Nader (2), zehara, Shaoay(1), Shaoay (2), Jomhory, Jamhan, Mahdya (1), Akrahd, Tahes , Mahdya (2), Mahdya (3), Abrahmya, Mustafa rakeb, kadyia.
Alsalam	Buohtary, Ahaa, Mahazem(1), Moharben, Mahazem(2), Shuhda in Makrory, Amam, Thoubat in Makrory, Methak and Mahazem, Sader, Abo hasnoyi and wazir, Antefada, Asateda, Amarat alsakanya(1), Amarat alsakanya(2), 17Neshan(1), Bastan, 17Neshan (2), 17 Neshan (3), 17Neshan (4), Jazra and Marina, Saeha, Tayhra, Muohafda aljedyda, Karahma (1), Tadamen, Karahma (2), Hassen, Jhamyia and Asalah, Muokabrat, Sendbad.
Alzehara	Sanha aljedyda (2), Sanha aljedyda (1), Sanha (2), Noor,Mahzen (2), Fazha and maina, Adil, Sanha(1), Afrah, Mohndsen(1), Askri(1), Fayha(1), Mahzen(1), Fayha(3), Akramen(2), Akramen(1), Fayha(2), Nader(3), Sanha aljedyda (3), Askri (2), Askri(3), Amer, Nasegh, Jhamiaa, Tasnek Askri, Iskan(1), Iskan (2), Muortath, Akramen (5), Akramen (3), Akramen (4), Mohndsen (2), Salam, Mohalmen, Hamza aldaly(1), Hamza aldaly (2).

Table 3 shows the equipment, vehicles, and labors used by Hilla municipality in each district for refuse collection and disposal during 2013.

Table3. Population vehicles, labors used by Hilla municipality in each district [Hilla municipality, 2013].

District	Alfayha	Alfrdous	Alforat	Alsalam	Alzehara
Urbanized Area (km^2)	0.94	10.8	4.68	19.44	20.1
Population	10751	62133	70243	147947	148650
No. of Houses	1581	9737	10979	22126	20675
No. of Families	1477	9647	11045	22839	20967
Compactor Trucks	13	10	14	10	8
Tractor	15	12	5	21	15
Dumper Bins	4	2	2	-	-
Dumper placer	1	1	2	1	1
Waste containers	2	1	1	1	1
Workers	186	201	128	107	70
Drivers	23	16	23	16	9

The weight of material in each category was recorded as a percentage, by weight, of the total sample in Altuhmaziya region of Hilla city. The results are shown in Fig. 1.

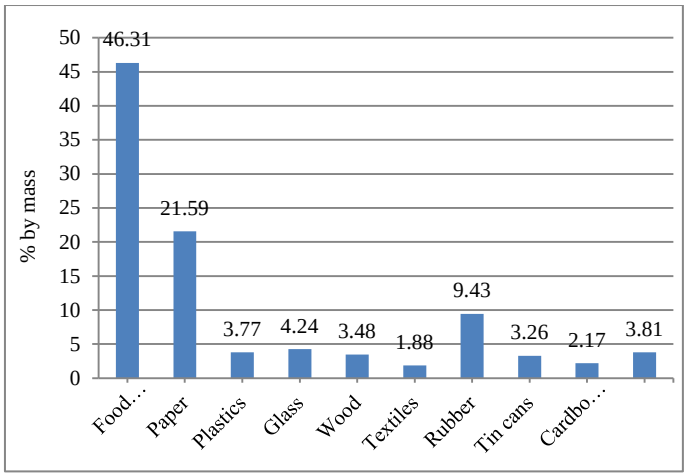

Figure 1.Average percent by mass of individual components in Altuhmaziya region of Hilla city

From Fig 1. found that the organic matter (food wastes) is much higher than the other wastes due to the method of cooking for most families as well as much of material which is used as food especially vegetables and fruits required to remove the rinds which represent a considerable weight.

The individual components of refuse sample of Hilla city which are compared with the other Iraqi governorates presented in Fig 2. Yet it can be noted that the percentage of food in the Hilla waste is the lowest as compared with other governorates in Iraq (Table 4). This does not necessarily mean that the other governorates are throwing away more food; it means that the overall production of solid wastes is much lower than in Hilla city (at the time of survey) and that the food wastes make up the greatest percentage the waste amount generated.

Table4. Comparison of major solid waste components for Hilla city with some other Iraqi governorates.

Composition of waste	Hilla	Baghdad	Mussel	Kirkuk	Fallujah	Najaf
Food waste	46.31	69.6	81.00	67.5	70.60	60.03
Paper	21.59	5.00	3.00	6.33	2.60	3.06
Plastics	3.77	5.30	3.00	6.33	8.10	5.89
Metals	-	2.20	5.40	8.40	1.30	7.09
Glass	4.24	2.20	1.00	2.50	2.20	2.71
Wood	3.48	-	-	-	-	-
Textiles	1.88	3.00	1.50	2.50	4.30	3.59
Rubber	9.43	-	-	-	-	-
Tin cans	3.26	-	-	-	-	-
Cardboard	2.17	-	-	-	-	-
Garden trimming	3.81	5.00	2.90	3.00	1.00	3.06
Inert	-	7.70	-	4.77	10.00	4.04
Leather	-	-	0.20	2.50	-	1.50
Total		100				
References	4	5	6	7	8	9

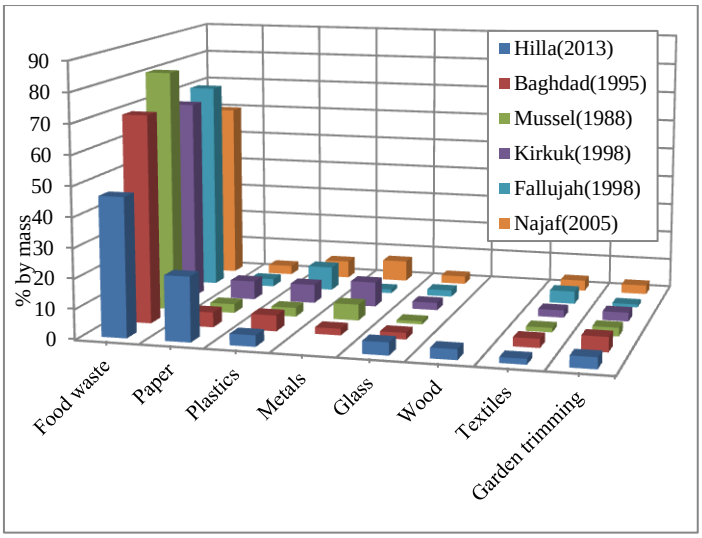

Figure 2.Comparison of major solid waste components for Hilla City with some other governorates.

Fig. 3. shows the major solid waste components for Hilla city with other solid waste management in some Arab countries[10].

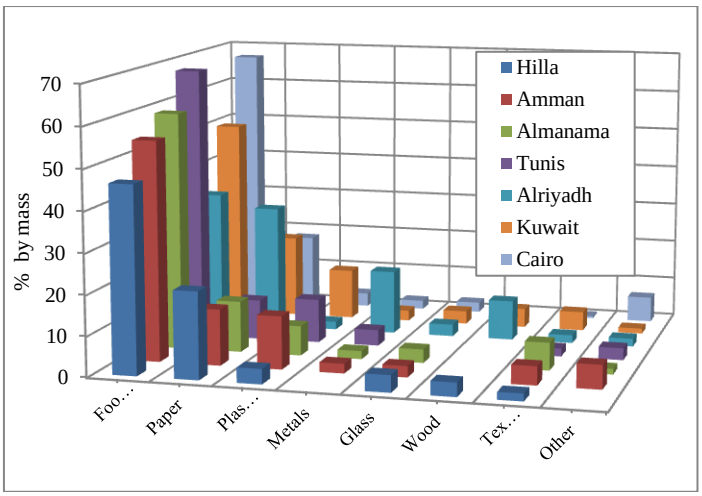

Figure 3. Comparison of major solid waste components for Hilla city with other in some Arab countries.

B. Moisture content

Samples were chosen to determine the moisture content of the components of residential solid wastes, by the oven drying method, in accordance with the American Public Work Association standards. It is usually expressed as the mass of moisture per unit mass of wet or dry material. The wet mass moisture is expressed as [11].

Moisture content (%) = [(a – b)/a]×100
Where a = initial mass of the sample as delivered.
b = mass of the sample after drying.

To obtain the dry mass, the solid–waste material is dried in an oven at 77 C^0(170 F^0) for 24 hr. This temperature and time is used to dehydrate the material completely and to limit the vaporization of volatile materials[12].
Table 5 shows an estimation of the dry mass by using Typical data on the moisture content for the solid waste components [3] depending on the percentages of the components of a refuse sample in Tuhmaziya Buildings site. Dry mass (kg) = % , by mass (1- moisture content).

Moisture content=[(100-62.48)/100]× 100=37.52 %

Table5. Estimating the moisture content of a solid waste sample from Tuhmaziya Buildings site 2013.

Composition of waste	% By mass	% Moisture content[3]	Dry mass. Kg
Food waste	46.31	70	13.89
Paper	21.59	6	20.29
Plastics	3.77	2	3.69
Glass	4.24	2	4.16
Wood	3.48	20	2.78
Textiles	1.88	10	1.69
Rubber	9.43	2	9.24
Tin cans	3.26	3	3.16
Cardboard	2.17	5	2.06
Garden trimming	3.81	60	1.52
Total			62.48

Fig. 4 shows the differences in moisture content for many cities in the world. These differences are due to refuse storage practices and local weather conditions. Moisture content depends on the composition of the wastes, the season of the year, and humidity and weather condition, particularly rain.

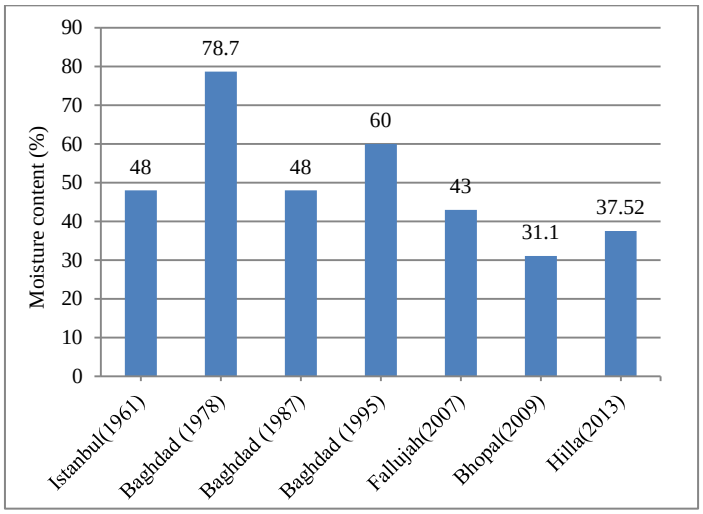

Figure 4. Comparison in moisture content in some cities in the world.

C. Density

Typical densities for various wastes as found in containers are reported by source [3]. Because the densities of solid wastes vary markedly with geographic location,season of the year and length of time storage, and degree of compaction expected from the onsite storage, and handling, great care should be used in selecting typical values. Fig.5 represent the as – discarded density comparison in the world.

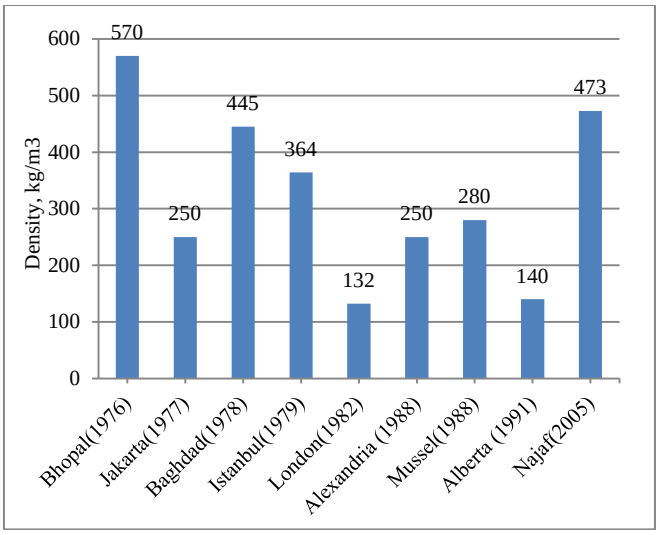

Figure 5.Comparison of density value in some cities in the world.

V. Chemical Properties

A. Energy content

The energy value of Tuhmaziya Buildings site refuse was established by using equation of energy content:
KJ/Kg (dry basis) = KJ/Kg (as discarded)*[100 /100 - % moisture]

A typical energy value and percentage of components in solid waste sample determined in Tuhmaziya Buildings site because of the devices used for measurement are not available. Table 6 shows the estimation of the total as discarded energy content of the solid waste sample in Tuhmaziya Buildings site[13].

Table 6. Estimating of the as-discarded of a solid waste sample Tuhmaziya Buildings site2013.

Composition of waste	% By mass	Type. Energy, KJ/Kg [4]	Total energy, KJ (Based on 100-kg sample)
Food waste	46.31	4650	215342
Paper	21.59	16750	361633
Plastics	3.77	32600	122902
Glass	4.24	150	636
Wood	3.48	18600	64728
Textiles	1.88	17450	32806
Rubber	9.43	23250	219248
Tin cans	3.26	700	2282
Cardboard	2.17	16300	35371
Garden trimming	3.81	6800	25908
Total			1080856

The unit energy content=1080856 KJ /100Kg=10809 KJ/Kg
If the moisture content of the sample is 37.46%, than the energy on a dry basis is :
Energy content kJ/kg (dry basis) =10809 × [100/ (100- 37.52)] =17300

This value of the energy content (10809) kJ/kg of a solid waste in Tuhmaziya Buildings site is low, so it was not economic process to use incineration [14].

B. Chemical content

Chemical composition of the solid waste sample from Tuhmaziya Buildings site is estimated according to the typical analysis of the combustible components and the characteristics of a refuse waste sample, It is determined according the following steps [15].
1.Set up a composition table to determine the overall computation of the waste based on 100 kg sample.

Table7. Chemical composition of waste sample from Tuhmaziya buildings site 2013.

Components	Wet Mass (kg)	Dry Mass (kg)	Composition (Kg)					
			C	H	O	N	S	Ash
Food wastes	46.31	13.89	6.67	0.89	5.22	0.36	0.06	0.69
Paper	21.59	20.29	8.83	1.22	8.93	0.06	0.04	1.22
Plastics	3.77	3.69	2.21	0.27	0.84	-	-	0.37
Glass	4.24	4.16	0.02	0.004	0.02	0.004	-	4.12
Wood	3.48	2.78	1.38	0.17	1.19	0.006	0.003	0.04
Textiles	1.88	1.69	0.94	0.11	0.53	0.08	0.003	0.04
Rubber	9.43	9.24	7.22	0.93	-	0.19	-	0.93
Tin cans	3.26	3.16	-	-	-	-	-	-
Cardboard	2.17	2.06	0.91	0.12	0.92	0.006	0.004	0.10
Garden Trimming	3.81	1.52	0.73	0.09	0.58	0.05	0.004	0.07
Total	99.94	62.48	28.91	3.80	18.23	0.76	0.11	7.58

2. Prepare a summary table of the above data.

Components	Mass (kg)
Moisture	37.52
Carbon	28.91
Hydrogen	3.80
Oxygen	18.23
Nitrogen	0.76
Sulfur	0.11
Ash	7.58

*(99.94 - 62.48)
3. Convert the moisture content reported in step 2 to hydrogen and oxygen .
a. H = [2 / 18] × 37.52 = 4.17 kg
b. O = [16 / 18] × 37.52 = 33.35 kg

4. Using the data from step 3 prepare a summary table.

Components	Mass (kg)	Percent by mass
Carbon	28.91	29.83
Hydrogen	7.97	8.22
Oxygen	51.58	53.23
Nitrogen	0.76	0.78
Sulfur	0.11	0.12
Ash	7.58	7.82
Total	96.91	100

5. Compute molar composition of the elements :

Element	Mass, kg	Kg/mol	Moles
Carbon	28.91	12.01	2.407
Hydrogen	7.97	1.01	7.891
Oxygen	51.58	16.00	3.223
Nitrogen	0.76	14.01	0.054
Sulfur	0.11	32.06	0.003

6. Determine an approximate chemical formula with and without sulfur.

a. Compute normalized mole ratio.

Element	Mole ratio	
	Sulfur = 1	Nitrogen =1
Carbon	802.3	44.6
Hydrogen	2630.3	146.1
Oxygen	1074.3	59.7
Nitrogen	18	1.0
Sulfur	1.0	0

b. Chemical formula with sulfur : $C_{802.3}\,H_{2630.3}\,O_{1074.3}\,N_{18}\,S$

c. Chemical formula without sulfur : $C_{44.6}\,H_{146.1}\,O_{59.7}\,N$

7. Estimate the energy content of the waste using Dolung formula [16] and the data from step 4.

kJ/kg = 337 (29.83) + 1428 (8.22- 53.23/8) + 95 (0.78) = 12369

VI. Conclusions

1. The refuse was classified into ten categories (food wastes, paper , plastics, glass, textiles, rubber, tin cans, wood, cardboard, and garden trimmings, etc.The food category was found to be 46.31% of the total weight, and moisture content of 37.52%.

2. The chemical formula of the residential solid waste from Tuhmaziya Buildings site was found to be $C_{802.3}\,H_{2630.3}\,O_{1074.3}\,N_{18}\,S$ with sulfur and without sulfur as $C_{44.6}\,H_{146.1}\,O_{59.7}\,N$. The energy content (dry basis) was found to be 12369 kJ/kg .

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