THOMSON REUTERS ENDNOTE

[Badi, 5(2): February, 2016] ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

FEASIBILITY STUDY OF WASTE INCINERATION PLANT IN THE CITY OF MISURATA- LIBYA

Ibrahim Badi*, Mohamed Sawalem, Ali Shetwan

*Mechanical Engineering Department, Faculty of Engineering, Misurata University, Libya
Industrial Engineering Department, College of Industrial Technology, Misurata, Libya
Industrial Engineering Department, College of Industrial Technology, Misurata, Libya

ABSTRACT

Waste management and utilization strategies are major concerns in many countries. Incineration is a common technique for treating waste, as it can reduce waste mass by 70% and volume by up to 90%, as well as providing recovery of energy from waste to generate electricity. The waste generated from municiple solid waste incinerations (MSWI) usually ends up in two ways; disposed as landfill or for reuse as secondary raw materials. In most developed countries where land is scarce and the environmental controls are strict, environmental policies tend to reduce landfill disposals as much as possible. This article is a feasibility study of energy production from waste through incineration in Libya. The research has focused on the management of food waste. Many barriers persist in the development of the incineration plants. The major obstacles are the logistic management, the classification of the waste and the Electricity Price. Becouse of the subsidization of the electricity, the break-even point is high and the net profit isnegative for the first five years.

KEYWORDS: solid waste, incineration, feasibility study, Libya.

INTRODUCTION

Libya is a North African country located along the southern coast of the Mediterranean Basin. Its total land area is about 1.8 million km^2, most of which (95%) is a desert, while the rest is either rangeland (4%), or agricultural land (0.5%), and less than 0.5% is a scattered forested area.

Rapid expansion of industry, urbanization and increasing population, especially in large cities like Misurata, has dramatically increased the amount of solid waste generated in Libya. However, issues related to sound municipal solid waste management – including waste reduction and disposal – have not been addressed adequately and the collection and the separation treatment of solid waste are still neglected.

In the last few years, the Environmental General Authority in Libya has worked to create regulations and instructions for waste management, but up to now they are still under development. This belongs to the fact that there is only little information available regarding generation (quantities and compositions), handling and disposal of waste. Therefore an appraisal of the current situation regarding solid waste management in Libya is required [4].

Waste incineration is a common practice of solid waste management in European countries, for it renders useful energy and reduces mass, volume and chemical reactivity of waste components. On the contrary, solid waste in Libya is still dumped.

Municipal solid waste contains valuable materials that could be recycled and a considerable amount of energy that could be recovered as heat and electricity. Solid waste management and the associated pollution problems have attracted significant attention and great deal of research has been conducted on these topics in countries such as India [5], Ethiopia [6], Jamaica [7] and Bangladesh [8]. Rare studies on solid waste have been conducted in Libya indicating that no proper management is existing yet [1,9].

Figure (1) depicts the schematic diagram of MSW incineratoion plant. The wastes are delivered as feed stock to the pre-combustion (grate) and during post combustion, gas and slug or ashes are produced. In the next phases flue gas is cleaned by water absorber or different filtering methods. Finally, the clean gas is emitted through the chimney to the air.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

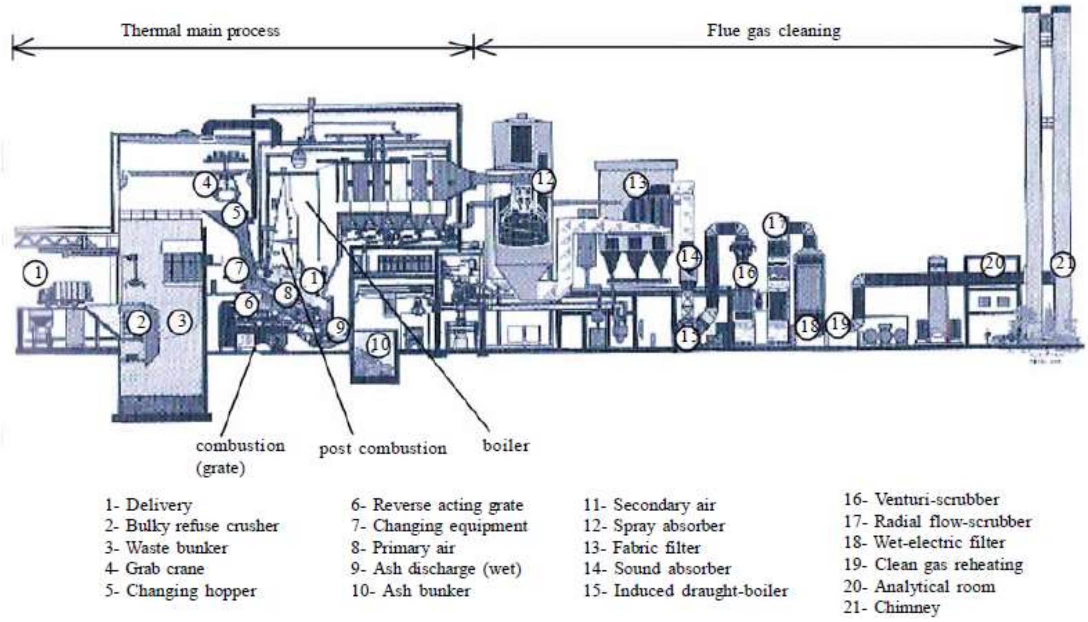


Figure (1): ***A schematic MSW incineration plant[11]***

CURRENT SITUATION

General information

The study was conducted in the city of Misurata, which situated in the western north part of Libya as a case study. This city is the third largest city in Libya. It serves a community of about 350,000 people. The city is divided to ten zones. Figure (2) shows the population of each zone.

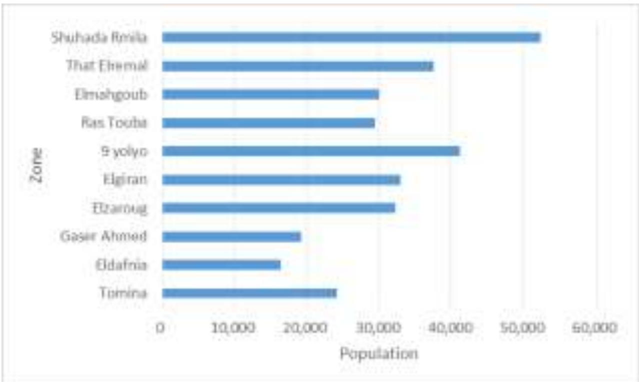


Figure (2): Population in the city of Misurata 2014 [9]

The qualitative analysis of solid waste (Fig 3) identifies organics as the major component (56%), followed by plastics (26.5%) [1]. This high plastic rate is due to the widespread use of disposables rather than the reusable for different purposes (e.g. bottles, packing materials and bags used for food). Whereas paper had the third highest percentage (8%).

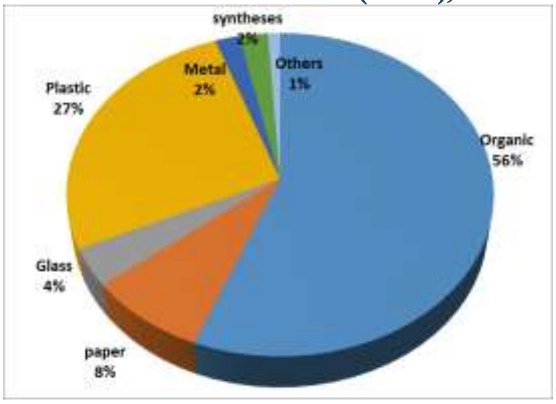


Figure (3): The qualitative analysis of solid waste in Misurata [1]

Waste collection, transportation and final disposal

Solid wastes generated at all zones are collected by municipal companies, and then transported to the final dumping site. There are three trans-shipment points in the city. The municipality has the responsibility for off-site transportation of the waste to the final disposal site. From daily to three times a week[1], the municipality workers collect the solid wastes from the on-site storage containers and transport them along with general domestic waste to open dumping sites outside the city. Generally, simple trucks and in some cases uncovered tractors are used for waste transportation[1]. These open tractors are passing within residential areas which increase the potential risk to the public and the environment. All domestic waste dispose, in an open dumping sites outside of the city[1]. In these open dumping sites the waste is buried and sometimes combusted.

The calorific value is a very important parameter in establishing a conversion technology to power generation. Some studies reported that calorific value for incinerated waste should not fall lower than 6500 kJ/kg [12]. The heating values (calorific values) of the solid waste generated from the study areas are greater than the standard values. Figure (4) shows Current material flow of municipal solid waste in Misurata. Transshipment points 1 and 2 are currently closed. The organic fertilizer plant has a capacity of 60 ton/ day.

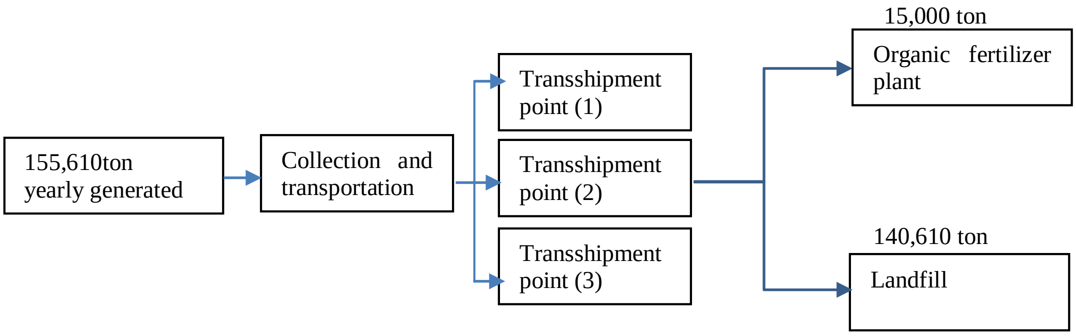
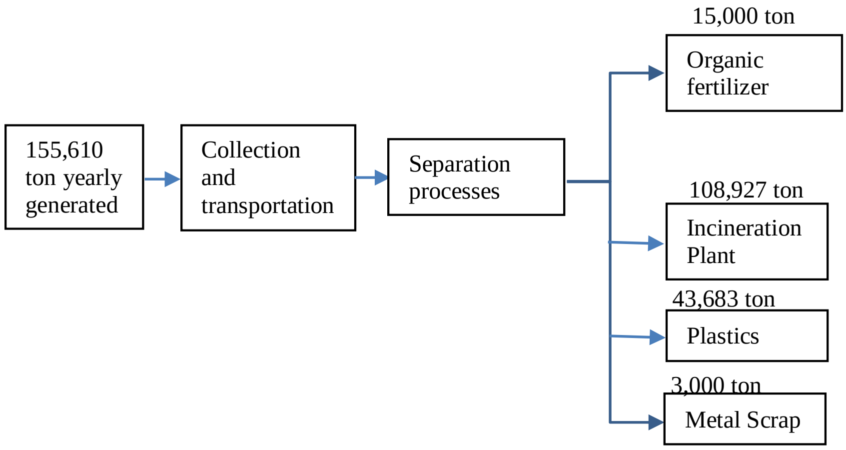


Figure (4): Current material flow of municipal solid waste in Misurata

Figure (5) depicts the suggested system.



(b)

Figure (5): suggested system

FEASIBILITY STUDY

This feasibility study is concerned with the study of incineration plant. The assumed plant capacity is 450 ton per day. It consists of two lines with the same capacity. It is assumed that the lifetime of the proposed incinerator is 20 years.

Assumptions

- Waste input to incinerator = 70% of the total waste.
- Incinerator equipment's cost= 130,000,000 L.D.
- Construction and installation costs= 30,000,000 L.D.
- Logistics costs = 0.0764 L.D/ kg of waste.
- Depreciation rate = 5%.
  - Electricity fee: Table (1) shows the electricity fee categories in Libya.

Table (1): Electricity fee categories

Description	Fee (Cent)	Percent	average
Housing	2	25%	0.5
Heavy Industry	31	10%	3.1
Light Industry	42	20%	8.4
Agriculture (1)	32	10%	3.2
Agriculture (2)	30	10%	3
Utilities	68	25%	17
Total Percentage		**100%**	**35.2**

- Charging fee: Every customer (Household, restaurant, Hotel,… etc) will be charged by 0.050 L.D per ton of waste.
- The yearly operational cost of the incineration plant includes utility costs (water, electricity, gas), human resource costs, cost of chemical materials needed for air pollution control, cost of auxiliary fuel when needed, cost of materials for amenity and office maintenance, and other administrative costs, excluding equipment maintenance cost equal to 30 L.D. 330 kwh of electricity transmission to the power grid per ton of waste incinerated for the baseline calculation of total electricity transmitted by an incineration plant.
- The average population growth (for the last 30 years) equal to 2% [10].

Calculations

The indices calculated are the yearly profit, net present value, and break-even point. Also, sensitivity analysis has been conducted. Tables (2) and (3) explain the calculations for the first year. Table (2) illustrates the total quantity of waste collected each year. It also shows the quantity incinerated each year.

Table (2): Waste generated and incinerated

Possible supply from customers		
Population	343,502	person
Average waste per person	1.25	Kg/ day
Total waste	155,610	ton/ year
Waste incinerated (70% of the total waste)	108,927	ton/ year
Incineration facility		
Total lines	2	Line
Capacity (per line)	450	ton/day
Energy generated	330	kWh/ton

Table (3) shows the first year total revenue. The total revenue equals to the summation of electricity fee, charging fee, metal and plastics selling revenue. The average price for metal scrap equal to 150 L.D/ ton, where the plastics waste price equals to 250 L.D/ ton.

Table (3): total revenue

Description	**Quantity**
Total waste quantity	155,610 ton
Revenue	
Electricity (average price =35.2)	12,652,960 L.D
Charging fee (0.050/ kg)	7,780,500 L.D
Aluminum & steel revenue	1,610,564 L.D
Plastics Revenue	3,034,395 L.D
Total Revenue	**25,078,419 L.D**
Variable Costs	
Logistics	11,894,000 L.D
Maintenance	3,900,000 L.D
Operational Costs	3,267,810 L.D
Total Variable costs	19,061,810 L.D
Fixed Costs	
Depreciation	8,000,000 L.D
Total Fixed costs	8,000,000 L.D
Total costs	**27,061,810 L.D**
Net Profit	**-1,983,392 L.D**

Figure (6) depicts the yearly profit of the plant. It is clear that the project loses during the first 10 years under the given conditions.

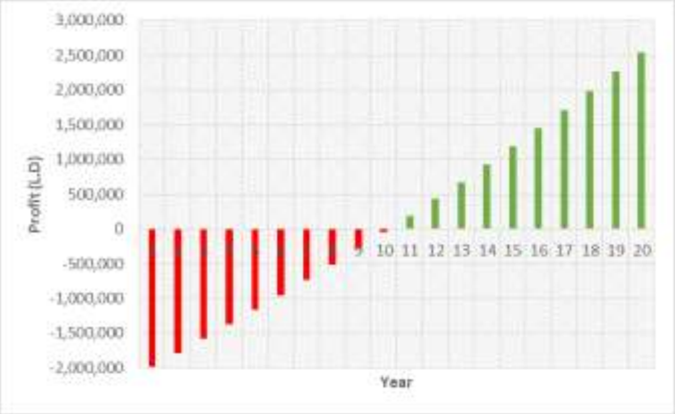


Figure (6): yearly profit

Net present value can be calculated from the following equation:
NPV = $\Sigma R_t(1+i)$^-t - $\Sigma C_t(1+i)$^-t
Where: i= interest rate, R_t: revenue at year t, C_t: cost at year t.
Where break-even point can be calculated from equation 2:
Break even point= Fixed cost/contribution
Whereas: Contribution= unit price- unit variable cost.
NPV= -6,544,608 L.D
Break even point= 144,835 ton.
One of the main reasons that the project has low indices is the subsidization of electricity price. However, to analyze the effect of the electricity prices on the net present value, sensitivity analysis has been carried out. Table (4) shows the effect of changing the electricity price and the fuel price (which affects the logistics costs). The plant will start gaining profit when the electricity price arises above 0.5 L.D.

Table (4): sensitivity analysis

(a): Changing the average electricity fee

Price	NPV
	-1,983,391
0.20	-7,447,169
0.40	-257,987
0.60	6,931,195
0.80	14,120,377
1.00	21,309,559
1.20	28,498,741

(b) Changing the fuel price

Price	NPV
	-1,983,391
0.10	-1,866,724
0.20	-2,100,057
0.30	-2,333,391
0.50	-2,800,057
0.70	-3,266,724
0.90	-3,733,390

[Badi, 5(2): February, 2016]
ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

CONCLUSION

Waste in Libya is still being dumped. Environmental measures or recycling programs are not available yet. There is a great need for establishing and implementing a proper waste management.

The result of the cost analysis indicates potential economic savings for the waste management system in Misrata. It is therefore worthwhile for policy makers to consider adding waste incineration to their agenda of improving the city's waste management system for environmental protection and for economic efficiency.

REFERENCES

1- Mohamed Sawalem, Ibrahim Badi, Suleman Aljamel, Evaluation of Solid Wastes for Utilisation in Biogas Plant in Libya – a Case Study, IJESRT, November, 2015.
2- S. Alexopoulos, Biogas Systems: Basics, Biogas Multifunction, Principle of Fermentation and Hybrid Application with a Solar Tower for the Treatment of Waste Animal Manure, Journal of Engineering Science and Technology Review, Vol 5, No4, 48 -55, 2012.
3- A. Omran, A.Gebril, A. Pakir, Municipal Solid Waste Management in BENGHAZI (LIBYA): Current Practices and Challenges, Environmental Engineering and Management Journal, Vol.9, No. 9, 1289-1296, 2010.
4- Amitava Bandyopadhyay, A regulatory Approach for E-waste Management: a Cross-national Review of Current Practice and Policy with an Assessment and Policy Recommendation for the Indian Perspective, Int. J. of Environment and Waste Management, Vol.2, No.1/2 pp. 139 - 186, 2008.
5- H.R. Sharma, Temesgen Abebe, Mengesha Admassu, Tadele Teshaye, Tadiwos Aseffa, Mustofa Emana, Municipal Solid Waste Management and Community Awareness and Involvement in Management Practices: an Overview and a Case Study from Gondar Town of Ethiopia, Int. J. of Environment and Waste Management , Vol. 7, No.3/4 pp. 294 - 304, 2011.
6- Jennifer L. Post, James R. MihelcicWaste Reduction Strategies for Improved Management of Household Solid Waste in Jamaica, Int. J. of Environment and Waste Management, Vol. 6, No.1/2 pp. 4 - 24,2010.
7- Rafia Afroz, Sustainable Household Waste Management Improvement in Dhaka City, Bangladesh, Int. J. of Environment and Sustainable Development, Vol. 10, No.4 pp. 433 - 448, 2011.
8- Fares. B, Elkrew. Z, Solid Waste Manegament in Libya, The third Arabic Conference of Enivronment Management, Sharm Elshaikh, Egypt, 2004 .
9- Population in The city of Misurata 2014, Municipility of Misurata Report, 2014.
10- http://www.tradingeconomics.com/libya/population-growth-annual-percent-wb-data.html
11- Ludwing, C.; Hellweg, S.; Stucki., S., (2002). Municipal Solid Waste Management; Strategies and Technologies for Sustainable Solutions, Springer.