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Management of Hazardous Medical Waste Treatment in Egypt

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Abstract: Significant steps have been taken to properly manage medical hazardous waste through on-site small scale incinerators. Coping with potential local demand necessitates merging of two types of incineration services namely on-site incineration and central incineration service regime. The financial cost of both types of services have been developed and compared. The capital cost, total annual cost and unit cost are $143,000, $35145 and $0.234/kg for an on-site incineration facility of capacity 500 kg/day. The corresponding costs of a central incineration facility of 5 ton/day capacity are $ 858,000 $3296850/year and and $0.198/kg. The future service program should include both types of incineration facilities to cope with the requirements of hundreds of small remote coastal or desert areas and rural communities who merit service by on-site incineration.

Key words: Environment · Hazardous medical waste · Incineration · Management

INTRODUCTION

Hazardous medical waste management is becoming a serious concern for environmental and health safety authorities. Medical wastes (MW) generated from medical facilities are dangerous, if handled, treated or disposed of incorrectly. In Egypt, the issue of hazardous medical wastes management has acquired an increasing interest in the last two decades, as the awareness of their serious health effects has increased on both public and governmental levels [1-3]. Medical hazardous wastes include but not limited to; infectious waste, pathological tissue or body fluids, chemicals, pharmaceutical wastes, genotoxic wastes, radioactive wastes, etc. [4-6]. According to WHO, the average amount of waste per bed per day is estimated to range from 0.7-1.7 kg/bed in Egypt [7]. Data obtained from Ministry of health in Egypt, shows that the total quantities of medical waste generated from the health care units annual is about 371776 kg/day and the proportion of hazardous waste is in the range of 25-30%, approximately [8,9]. Reported amounts of wastes generated by different sources in Egypt including laboratories, blood banks, intensive care units, inpatient service are 0.06 kg/sample, 0.8 kg/unit of blood, 0.05 kg/patient /day and 0.5 kg/bed/day, respectively [7].

In Egypt, the technologies applied for MW treatment are incineration, steam sterilization (with or without shredding) and chemical sterilization with shredding. Incineration represents the most common method applied in Egypt [9-11]. The number of current incinerators spread all over Egypt is 151 incinerator [8] treating about 77% of the total treated MW. The incinerator consists of, but not limited to, two combustion chambers, heat exchanger, pollution abatement unit and discharge system for gaseous emissions and solid residues. The ash residue should not exceed 5 % by weight of the charge [12-18]. Small batch incinerators could be installed inside an existing hospital or medical center, or in a separate room in an appropriate location. Central incinerator could be located in a separate location appropriately selected to alleviate environmental hazard of airborne emissions generated from relativity larger incinerator. The central incinerators should have continuous MW feeding and ash discharged systems [17, 18]. Incinerators have many environmental and health related issues that should be considered to ensure environmental and public health safety. Many reports have been published in this concern [19]. The most important issues are as follow:

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- Safe collection and handling are essential; radioactive waste and bottled gaseous vessels must be excluded.
- Gaseous emissions should comply with native regulations for environment protection. NO_x, SO_x, CO and HCl are among major pollutions to be controlled. Highly toxic pollutants could be mitigated to large extend by proper operation practices. Further, ashes resulting from incinerator should be properly collected, handled and disposed of using environmentally safe practices. Liquid wastes generated should be treated and disposed of in accordance to environmental regulations [19, 20].
- Workplace safety is essential, to avoid infection and injuries of workers. Proper operation, training and regular health check-up of workers are mandatory.
- In high density areas, large incinerators could present a potential hazard to environmental and public health. Proper site selection of large incinerator is a prerequisite to avoid severe environmental and health impact due to unexpected accidental events [19]. In this paper, the technical and financial indicators for the suggested medical hazardous waste treatment in Egypt via incineration as addressed.

Approach and Methodology: In view of the complexity of the addressed issue and taking into consideration the rapid development of the health care institutions for both governmental and private sectors, the present work capitalizes on reported national and local indicators, contacts with consultants and experts to come up with appropriate answers pertinent to the actual and anticipated waste loads, implementation scenarios, uncertainties and elements of financial analysis [8, 21, 22]. Thus, the methodology incorporated the following:

- Load identification within appropriate planning period (2015-2030), based on up-dating of a base-year (2010) data and population growth during the planning period.
- Identification of service/demand escalation to cope with assumed service coverage objectives.
- Financial analysis of on-site and central incineration scenarios. Cost estimates are based on up-dated cost data and available recent cost of incinerators locally available and operating costs items.
- Identification of implementation implications of the suggest scenarios, based on techno economic and environmental considerations.

RESULTS AND DISCUSSION

Table 1 presents medical hazardous wastes treatment need and actual treatment capacity according to base year population, treatment capacity needs and % coverage for the base year 2010 and the estimated values for planning years of 2015-2030.

The medical hazardous wastes treatment capacity estimates during the planning period according to 60, 70, 80, 90 and 100% treatment coverage are depicted in Fig. 1. The 100% coverage represents the actual needs for treatment to cover the amount of medical wastes generated. The dotted line represents a progressive development (PCD) scenario for the medical hazardous wastes treatment of 70, 80, 90 and 100% at years 2015, 2020, 2025 and 2030, respectively. According to this scenario, the hazardous waste treatment capacity is developed from about 82ton/day at 2015 to about 151 ton/day at 2030.

Alternative Scenarios for MW Treatment Future Coverage

Scenario 1: Small Scale Incinerators: In this scenario, a 500 kg/day unit is installed to serve large hospitals; medium hospital and small health care units near incinerator site. The incinerators should be provided with the necessary pollution abatement units and with be operated using natural gas or diesel fuel for burning and electricity for electro-mechanical components. The plant availability is proposed to be 300 day/year. Table 2 depicts the capital cost estimates for the unit.

Table 1: Medical hazardous waste management forecasts for predicted population in the period 2010-2030

Year	Population (Million)	Treatment Capacity Needs (ton/day)	% Treatment coverage	Treatment capacity (ton/day)
2010	78.1	109.5	59.4	65
2015	84.9	119.1	70	83.4
2020	92.3	129.5	80	103.6
2025	99.5	139.6	90	125.6
2030	107.3	150.5	100	150.5

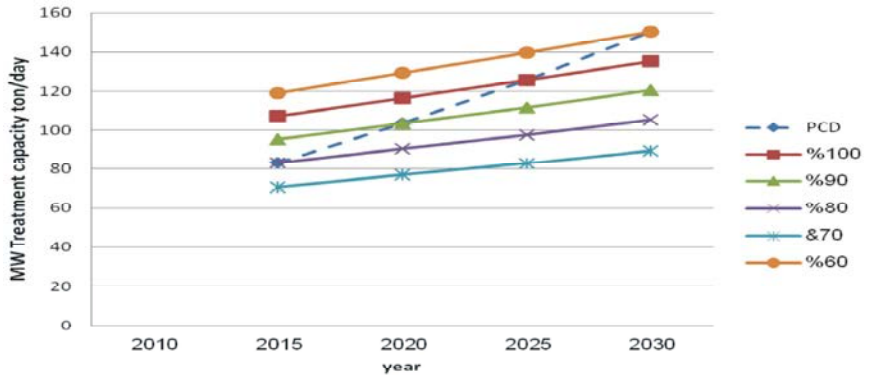

Fig. 1: Medical hazard wastes treatment capacity change with different % coverage during planning period (2015-2030).

Table 2: Capital cost for small scale incinerator (500 kg/day)

Item	Cost ($1000)
Equipment purchased (PE)	100
Installation (15 % of PE cost)	15
Civil work (15 % of PE cost)	15
Sub-total	130
Engineering and contingencies 10 % of sub-total	13
Total	143

Table 3: Annual cost for small scale incinerator (500 kg /day).

Item	Cost basis	Cost ($/year)
Annul operating cost		
Fuel	20 l/ batch, 5 batches /d x $1.4/l	6000
Electricity	4 KWh/ batch x $0.05 / KWh	300
Water	1 m 3/ batch x $0.15 / batch	225
Chemicals	Caustic soda / lime, $0.15 / batch	225
Maintenance	5% of equipment cost	5000
Labor	2 technicians *$300/month	7200
Sub-total		18950
Other costs	10 % of sub total	1895
Total		20845
Annual deprecation cost	10 % of capital cost	14300
Total annual cost		35145
Unit Cost($/kg)		0.234

Table 4: Capital cost for central MW incinerator (5 ton/day)

Item	Cost ($ 1000)
Equipment purchased (PE)	600
Installation (15 % of PE cost)	90
Civil work (15 % of PE cost)	90
Sub total	780
Engineering and contingencies (10 % of subtotal)	78
Total	858

Table 5: Annual operating cost for central MW incinerator (5 ton/day).

Item	Cost basis	Cost ($/year)
Operating cost		
Fuel	50 l/ hr, x $0.2/l	6000
Electricity	(10 KWH/ hr) x $0.05 KWH	300
Water	1 m3/ hr) x $0.15 / KM	900
Chemicals	lime $0.15/ hr	600
Maintenance	5% of equipment cost	30000
Labor	2 engineer, 4 technicians, 4 laborers and with total monthly salaries of $400, 300, 250 respectively.	36000
Sub-total		130500
Other costs	10 % of sub total	19050
MW transportation cost	$ 45 /t	67500
Total		211050
Annual deprecation cost	bases 10 % of capital cost	85800
Total annual cost		296850
Unit Cost($/kg)		$0.198/kg

The total capital cost is estimated to be $143,000. Table 3 presents annual cost, including operating cost and annual depreciation cost which are estimated to be $20845 and $14300, respectively. The annual cost is estimated to be $ 3514. The cost per unit kg is estimated to be $0.234/kg

Scenario 2: Central Incinerator: In this scenario incinerator with 5ton/day capacity is installed to serve hospital and health care units within an area of 50 km^2. The unit shall operate on continuous basic. The unit is equipped with mechanical feeding and ash discharge mechanisms as well as pollution abatement equipment. Transportation to incinerator site of packaged MW should be conducted in an environmentally safe way. Further, location selection should be conducted based on environmental impact assessment to mitigate potential impact on environment and public health. Table 4 summarizes capital cost estimates, while. Table 5 represent the operating cost, depreciation and cost per unit. The capital cost, annual operating cost, annual depreciation cost and cost/ kg are $858,000, $296850, $85,800 and $0.198/kg, respectively.

Implications of the Proposed Hazardous Medical Waste Management Scenarios: Two scenarios have been proposed for management of hazardous medical wastes via locally produced incinerators. The first scenario is an extension of service coverage using small on-site incinerator after modernization of the current incinerator. The total capital costs, annual operating costs and cost per unit are $ 143000, $20845 and $0.234 /kg, respectively. The cost of fuel represents about 29 % of the annual operating costs. This scenario manifests dedication of a special department in the hospital or health care facility for operation and maintenance. Moreover, it eliminates the need for bulky transfer of wastes associated with potential transport risk. However, strict control of emissions is required to protect the hospital environment and surrounding residential areas.

The second scenario copes with increasing hazardous wastes load and the requirements of modern central incineration. Hazardous wastes will be hauled to a central incinerator via dedicated trucks. The site will be thoroughly monitored according to the most stringent standards. It is of course, easier to hire specialized management company for operation and maintenance of the incineration facility. Failure of any part of the system will be easily rectified without any significant adverse environmental impact. Also the economics of incineration are encouraging. The capital, operation and maintenance and cost per unit are $858,000, $ 211,050 and $ 0.198/kg, respectively. The real scenario for future implementation of an appropriate service extension program involves both scenarios. Hundreds of small scale scattered health care units in remote governorates and rural areas may be best served by the first scenario. Planning studies are needed to define the extent of application of each of the proposed scenarios.

CONCLUSION

The current status of medical hazardous wastes management calls for immediate intervention through on-site or centralized incineration facilities. In this paper, the

capital, annual operation and maintenance as well as unit cost of the on-site incinerator are estimated to be $ 143,000, $ 20, 845 and $ 0.234/kg, respectively. The corresponding estimated costs of a central incineration unit are $858,000, $ 201,105 and $ 0.198/kg, respectively. It is further concluded that the pattern of potential services is in fact a composite of both on-site and central incinerators. Targeted planning studies are urgently needed to develop an optimized service program for management of medical hazardous wastes in Egypt.

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