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Recent Trends and Issues of Sustainability in Battery Manufacturing Industries of Bangladesh

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Abstract

In recent times, sustainability is an important phenomenon for manufacturing industries. Sustainable manufacturing and recycling process can be applied in different manufacturing industries especially, battery industries to produce green product as well as process. Most industrial/automobile batteries contains hazardous components such as lead, bitumen, nickel etc. where lead is very harmful to human health and environment. This project is aimed at identifying the method of producing green lead-acid industrial/automobile battery and to study recent trends and advancements of the battery manufacturing industries in Bangladesh regarding sustainability. To accomplish this goal, green test of different parts contained by an industrial/automobile battery, various methods of making pure/green lead, reverse logistics and transportation of industrial battery, recycling of the battery, industrial battery manufacturing companies in Bangladesh and their sustainability has been studied. It is observed that only few battery industries in Bangladesh apply sustainable technologies and there is obvious scope of applying sustainable manufacturing among all the battery industries which will make the environment healthy, green and sound. Finally, this paper suggests various techniques and opportunities of sustainability in manufacturing industries as future recommendations.

Keywords: *Sustainability, Battery Industry, Reverse logistics.*

1. Introduction

Battery technology has already changed our lifestyles. In near future batteries are going to have even bigger effect on earth and human mankind. This research is to study the environmental impact of battery and its manufacturing process on earth, its recent trends if those are sustainable or not and the future possibilities. Our primary objective is also to collect information about manufacturing procedures from different battery industries existing in Bangladesh. How battery technologies can be improved referring to recycling, battery alternatives as well as correct battery handling, use and disposal are also discussed here. In this purpose, we selected lead acid battery to get relative information. In most countries, nowadays lead-acid batteries are used and returned for lead recycling. However, considering a normal battery, which contains sulfuric acid and several kinds of plastics, the recycling process may be a potentially dangerous process if it is not properly controlled. These technical guidelines are, therefore, meant to provide guidance to those manufacturers whom are planning to build their capacity in order to manage the used lead-acid battery wastes. A comprehensive approach is adopted and clear information is provided on these mentioned issues and it is expected that by using these guidelines country will be able to improve its actions in relation to the following aspects:

I. Protection and improvement of its environmental quality;
II. Protection of its population health;
III. Adoption of clean technologies in order to minimize waste generation;
IV. Adoption of reuse and recycle as means to protect non-renewable natural resources and reduce energy consumption;
V. Adoption the environmentally sound management of used lead-acid batteries;
VI. Creation of a sustainable and regulated system of lead utilization;
VII. Adoption of management plans for lead wastes;
VIII. Generation of social, economic and environmental benefits through the environmentally sound management of lead wastes.

2. Literature Review

Sustainability

Sustainability is based on a simple principle: Everything that we need for our survival and greater interests depend either directly or indirectly on natural environment. Sustainability creates and maintains the conditions under which human and nature can exist in productive harmony that permits fulfilling the social, economic and other requirements of present and future generations. Sustainability is important to make sure that we have and will continue to have, the water, materials, and resources to protect human health and our environment. A typical sustainable design cycle is drawn here. Any manufacturing process design should possesses green option or sustainability from raw material extraction to end of its product.

Fig. 1. Typical sustainable design cycle

Recycling

The recycling process is very essential for sustainable development that provides rational uses for scarce, or potentially scarce, natural resources such as lead. Some potential advantages of recycling process are as follows:

I. Extension of natural resources lifetime– although there are undiscovered ore deposits all over the world, they are all ultimately finite and this limit is linked to its usage rate. Therefore, recycling processes extend the lifetime of these deposits;

II. Reduced monetary costs– secondary materials provide means of monetary economy by: (a) being cheaper processes than primary minerals recovery, (b)reducing the dependence on imported materials; (c) reducing the investment cost of equipment; and (d) reducing the waste production, specially the primary extraction waste;

III. Energy conservation– since few metals occur in nature as readily usable forms, the recycling processes allow the production of metals with about 25% or less1 of the energy used in the primary processes. Furthermore, since most of the primary metal processes require energy-expensive procedures which usually depend on fossil fuels, as in furnaces for example, the recycling processes provide means of pollution reduction;

IV. Toxicity toward the environment and human health– it is well known the consequences of lead exposure, being it human or environmental exposure. Thus, it is reasonable to think that a lack of a lead recycling system would increase dramatically the risk of exposure since the lead waste would have to have environmentally unsound destinations;

V. Large recyclability– the fact that lead has a low melting point and it is easily refined from scrap increases its recyclability, i.e. the relatively technical ease or feasibility of lead isolation from scrap and reintroduction into the raw material stream;
VI. Large market– lead enjoys a large market and, depending on the country of course, a reasonably well-organized collection system of up to 96% from one predominant product which has a short and predictable lifetime: the SLI battery.

Lead acid industrial battery

Industrial batteries are very useful for large and medium industry power and energy usage. It directly affects environment and hazardous issues. So sustainable battery manufacturing is recent demand. There are different types of these batteries i.e., lead acid, nickel cadmium battery, solar battery, flooded solar battery, integrated battery, tubular batteryetc. where lead acid is mostly used in industry purpose. In lead acid industrial battery, around 96% lead is used which is highly toxic and produces a range of adverse health effects particularly in young children. Exposure to excessive levels of lead can cause damage to brain and kidney, impair hearing; and lead to numerous other associated problems. Therefore, it is necessary to ensure its proper collection and eco-friendly recycling.
Lead acid industrial batteries have numerous applications that may employ different voltages, sizes and weights, ranging from 2kg no-break batteries to industrial batteries that may weight more than 2.000kg or more.Normally lead acid battery has more than ten parts such as, plates, separator, hard rubber container, lead, bitumen, battery cap, cork, connectors, electrolyte, electrical accumulator, negative plate or anodepositive plate or cathode, sealant and chemical compound: CFCs, carbon tetrachloride, halons, methyl chloroform, lead, Sulphuric acid.

3. Theoretical Analysis

Sustainable battery manufacturing process follows lead acid recycling since 96% of lead is used in general battery manufacturing. Lead is dangerously toxic to environment as well as hazardous for human being that should be removed or controlled for sustainable practices by recycling process. Recycling process for lead acid battery manufacturing is as follows:

Pre recycling process

Before reaching into the recycle stage, used batteries must be collected, transported and stored with proper care, in order to avoid adverse health effects and environmental contamination.

Recycling process

The pre recycling process finishes when the used batteries are again received and properly stored at the storage place in the recycling plant. After this, the used batteries enter into the recycling process that could ideally be divided in three major processes:
I. Battery breaking or breakage;
II. Lead reduction;
III. Lead refining.
Battery breakage process increases the possibility of soft lead production and polypropylene recovery. The battery scrap obtained from the breaking process is a mixture of several substances: metallic lead, lead oxide (PbO), lead sulfate (PbSO4) and other metals such as calcium (Ca), copper (Cu), antimony (Sb), and arsenic (As), tin (Sn) and sometimes silver (Ag). In order to isolate the metallic lead from this mixture, two methods may be applied: pyro-metallurgical processes, also known as fusion-reduction methods, and hydro-metallurgical processes, or electrolytic methods.As indicated earlier, if a smelting plant stops at the stage of the fusion-reduction plant, it will produce what is known as hard or antimonial lead. If the plant is meant to produce soft lead, the crude lead bullion must undergo a refining process. The objective of the refining process is to remove almost all Cu, Sb, As and Sn; since the soft lead standard does not allow more than 10g per ton of these metals.

Environmental control measures

Sustainable technologies require permanent monitoringand control even after implementing the best available technologies. Environmental monitoring correctly identifies the defective steps in the recycling chain as well as provides concrete data in order to improve the process, and increase the degree of environmental and human

health protection. Ultimately, the environmental monitoring ensures the environmental friendly recycling process.Control measures provide a simple set of instructions that, if followed, decrease significantly the risk of environmental contamination.

I. Personal protection equipment (PPE)
II. Green work practices
III. Dust filtering system
IV. Internal transports should be in the form of enclosed conveyers
V. Slag storage
VI. Air filtering system
VII. Coal storages should be protected
VIII. Rainwater must be collected

Health control measures

Lead is, and always has been, naturally present and quite abundant not only in the environment and but also in human body. Natural mobilization of lead occurs by weathering of mineral deposits and gaseous emissions and it has been estimated that together these two mechanisms release about 210.000 tons of lead into the environment each year. So, the lead acid battery recycling processes may be considered as a potential and powerful magnifier of the natural lead sources if the proper controls are not taken. Lead is absorbed by human being through inhalation, ingestion and skin. Basically, the lead absorption depends on individual characteristics such as physiological state and tissue integrity, both related to age and other factors such as nutritional, metabolic and anatomic conditions. The most affected human body systems by lead exposure are:Hematopoietic System, Central Nervous System (CNS), Peripheral Nervous System (PNS), urinary system, gastrointestinal system, cardiovascular system, reproductive system, endocrine system and joints. From health point of view, the proposed prevention measures are activities that should be observed in the occupational environment in order to prevent human exposure to lead from suffering adverse effects of lead contamination.

I. Consider every material containing lead as a possible source of environmental and human contamination;
II. Keep the work environment in compliance with the national regulations for industrial safety;
III. Prohibit eating and smoking inside the working areas;
IV. Prohibit children and pregnant women from working in lead recycling facilities;
V. Undertake the development of educational and informative programs;
VI. Ensure the use of personal protection equipment in working places containing at least:
    (a) Effectively protective cloth;
    (b) Daily clean the used cloths;
    (c) Protective masks which may vary in accordance of the average lead concentration in air;
VII. Control the lead concentrations in the working environment;
VIII. Demand periodical medical control of lead exposed workers.

Reverse logistics

The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. More precisely, reverse logistics is the process of moving goods from their typical final destination for the purpose of capturing value, or proper disposal. Normally, logistics deal with events that bring the product towards the customer. In the case of reverse logistics, the resource goes at least one step back in the supply chain. For instance, goods move from the customer to the distributor or to the manufacturer.Reverse logistics offers the concept of goods return from manufacturing to end consumers in order to reuse or proper disposal. This research concerns to management of used batteries that contains a hazardous material/chemicals and creates a problem of environmental inputs if it is not properly treated in disposal area. In order to gain economic value, this reverse logistics model accommodate an objective not only to minimize the total cost, but also consider the other objective based on the multi criteria analysis. The reverse logistics model developed is goal programming model, which take into account 3 objectives in optimization process namely to minimize the total reverse logistics cost, to minimize the environmental impact and to maximize the number of quantity used batteries collected.

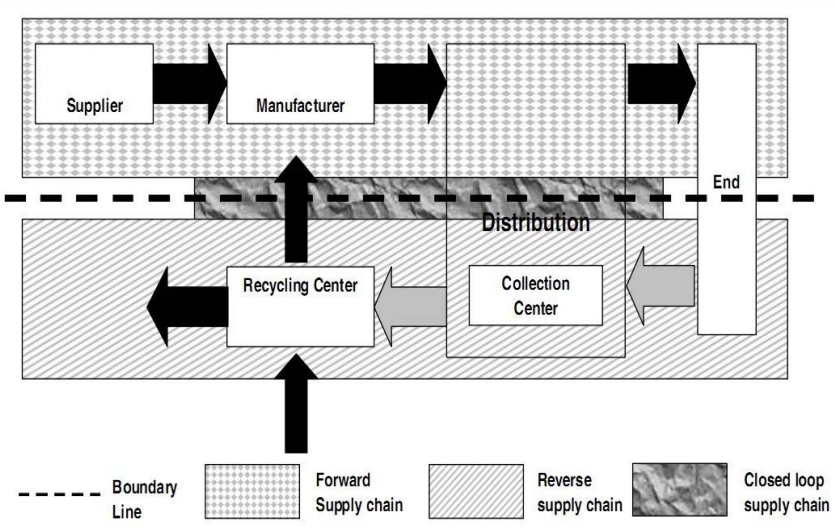

Fig. 2. Reverse logistic model for lead acid battery

4. Result & Discussion

In Bangladesh there are almost 40 industrial battery-manufacturing companies. Among them only 3 or 4 use sustainable manufacturing technologies while 10 to12 use recycling process. The technologies discussed in this paper such as reverse logistics, pure lead manufacturing process, recycling process can be used easily in these industries with minimum establishment cost. Bangladesh is an environmentally polluted country. Pollution due to adopting hazardous technologies and unsustainable practices are causing various harmful effects environment. This paper discusses various sustainable options and possibilities for battery manufacturing companies and ranks the battery manufacturing companies in Bangladeshi with satisfactory sustainable practices.

Table 1. Bangladeshi industrial battery manufacturing companies

Name	Location	Green/Sustainable Practice
AFTAB AUTOMOBILES LTD.	Dhaka	Satisfactory
EASTERN BATTERIES LTD.	Dhaka	Semi- Satisfactory
HAMKO	Dhaka	Satisfactory
HAQUE BROTHERS (CARBIDE) LTD.	Dhaka	Semi- Satisfactory
JEWEL MOTORS	Dhaka	
MULTI POWER LTD.	Dhaka	
OLYMPIC INDUSTRY LTD.	Dhaka	Semi- Satisfactory
P.K. INDUSTRIES LTD	Dhaka	
POWER DISTRIBUTION (TROKEN)	Dhaka	
QUASEM DRYCELL LTD.	Dhaka	
RAHIM AFROOZ BATTERY LTD.	Dhaka	
RELIANCE ELECTRONICS	Dhaka	Satisfactory
TYRE & BATTERY BAZAR	Dhaka	
UTTARA MOTORS LTD.	Dhaka	
VISION BATTERY INDUSTRY LTD	Dhaka	
NEW DUNLOP BATTERY CO.	Dhaka	
PANDA BATTERY CO. LTD.	Dhaka	
R.B.C. BATTERY	Dhaka	

REGNANT TECHNOLOGIES	Chittagong	
S.R. BATTERY	Dhaka	
PANNA BATTERY LTD.	Dhaka	
BELL CORPORATION LTD.	Dhaka	
MOTI BATTERY	Dhaka	
ROLEX BATTERY CO.	Dhaka	Satisfactory
SAFAT MOTORS LTD.	Dhaka	
URMI TYRE & BATTERY CENTRE	Dhaka	
PLATINUM POWER TRADING	Dhaka	
BATTERY PLUS	Dhaka	

- Based on available data

5. Recommendations &Conclusion

Several important issues related to the recycling of used lead acid batteries were considered along with other aspects such as, technical aspects, recycling process overview, monitoring and control measures, health issues, status of green lead acid battery in Bangladesh etc. However, a complete survey on the lead recycling processes would require a much deeper incursion on industrial processes, economic factors, social aspects and other, which is out of the scope of this technical guideline. Other performance indicators, such as Technology Assessments (TA), Life Cycle Analysis (LCA), Risk Assessment (RA), Environmental Auditing (EA) and Environmental Manage System (EMS), should be adopted and used in order to improve the environmental and health protection.Therefore, a specific contextual map should be generated, encompassing local politics, economical aspects, social aspects, local and international market aspects, etc., and the lead recycling plant inserted into this context.

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