Life Cycle Assessment of Corrugated Box

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Abstract

The Corrugated box intonated a life-cycle assessment evaluating the environments impact of corrugated box products. This research helps to describe the environmental impacts of corrugated box various life cycle stages in to environmental performance relationship. Beside the procedure of a one unit manufacturing section or package particularization, the research calculates the environmental performance of a semi skill industry of corrugated box throughout its whole life cycle by using its all manufacturing process. In this research present the environmental impacts obtained from the LCA of a corrugated box. All material and energy use, resource use, and exhalation to environment of every process in the life cycle were classify and analyzed. In impacts assessment is a contribution to 4 environmental impacts potentials were describe ex. Acidification, Global Warming Potential, Human Toxicity Cancer, Ozone Depletion and main source of having a impact category. The primary research main objective is using the input and output it will be achieve from International reference Life Cycle Database (ILCD) "Gate to Gate" in Indian scenario using GaBi 8.7. In the result of GaBi analysis week point is responsible for environmental impacts and the source of impact in environment discuses.

Keywords:-Corrugated box, Life Cycle Assessment (LCA), GaBi 8.7, Sustainability, Impact Study

1. Introduction

Life Cycle Assessments (LCAs) are conducted according to LCA standards 14040 and 14044 published by the International Organization for Standardization. The framework of LCA has four phases (Fig. 1): 1) Goal and Scope Definition, 2) Inventory Analysis, 3) Impact Assessment and 4) Interpretation.(ISO. International standard 14040.This research based on above four phases of the corrugated industry, in this Life cycle assessment (LCA) is one effective approach for evaluating the environmental impacts of a product by quantifying the impacts of all inputs and outputs associated with the investigated system (ISO, International Organization for Standardization, 14040, 2006). Such a method has been extensively applied for evaluating environmental burdens generated from fertilizer industry. (Wei chen et al 2018).LCA is extensively applied for evaluating the environmental impacts generated from the industry.(Hong et al,2012). The environmental impact was evaluated by LCA software Ganzheitlichen Bilanzierung International reference Life Cycle Database (GaBi ILCD). The findings can help determine the most important environmental impacts and provide guidance of the full utilization of corrugated product the future. (Zuodong Qina et al 2018). The most paper waste is currently disposed with other municipal waste management require a large amount of space, and has been identified as one of the major source of NH3 emission contributing to climate change (Sunil kumar et al 2014). Incineration reduces the need for land disposal and can recover energy from combustion of waste. (Ping et al. 2018)

Corrugated box and paperboard plays an important role in packing industry. This product has cheap price, and strength flexible properties. Increasing trend of paperboard consumption in India and environmental awareness, many people or organization have close look of the environmental properties. The main purpose of this research is finding the environmental impacts analysis by throughout the life cycle assessment of the corrugated box producing, used, disposal in India and further we are trying to improvement options to reducing the environmental impacts by using life cycle assessment (LCA).

The cardboard was invented by Chinese in 1600. The first commercial cardboard invention and created in 1817. American Robert Gair produced the first really efficient cardboard box in 1879s.Cardboard die-cut and scored box could be stored flat and then easily folded for the use. Refinements followed for it is, enabling cardboard cartons to substitute for labor-intensive, space consuming, and weighty wooden boxes and crates. Since then, cardboard boxes have been widely appreciated for being strong, light, inexpensive, and recyclable.

In the literature review reading the many paper based on LCA study of a product of corrugated box. From the paper the many research, methodology and software are using. In this paper adopting some keywords and methodology for the analysis of corrugated box based on LCA.

1.1. Methodology

The Life Cycle Assessment method's is used for this research. This Methodology is used to classify the environmental impact of the one unit product throughout its life cycle "gate to gate". In LCA approach the first aim is to find the corrugated box system boundary. And the second aim is to classify input and outputs of each and all process of the life cycle (Resources use, Raw Material use, Energy use, Waste generation, Water and Air Emission etc).The goal of this study is to performance on environment. The biggest important data relevant to corrugated box manufacturing was possessed from semi skilled medium size factory with individual process. Other data obtain from, Box production, Transportation, Electricity generation, recycling, and land filling was obtained from other experts such as literature. The GaBi 8.7 was used to optimization and data process to calculate and compile all process use and analyze emission to the environmental impact 1 piece corrugated box. Gate-to-gate is one value-added process in the whole manufacturing process; Gate-to-gate section may be linked in their appropriate manufacturing to form a entire cradle-to-gate assessment. (Xiaopeng Li 2014)

Figure 1 Methodology followed in this study.

1.2 System Boundary this system is design "Gate to Gate" LCA in other words the paper includes the production of corrugated box transportation, processing in covers these steps. In the system boundary the given flow is to express the adhering is the joining process of two paper for making a flutes, and the pasting of flutes layer by layer and the cutting operation of jointed flutes then slot cutting is the cut the different function to add in the corrugated box for bending then in end process is nailing operation is joint and the use it. (Qianjin et al 2010)

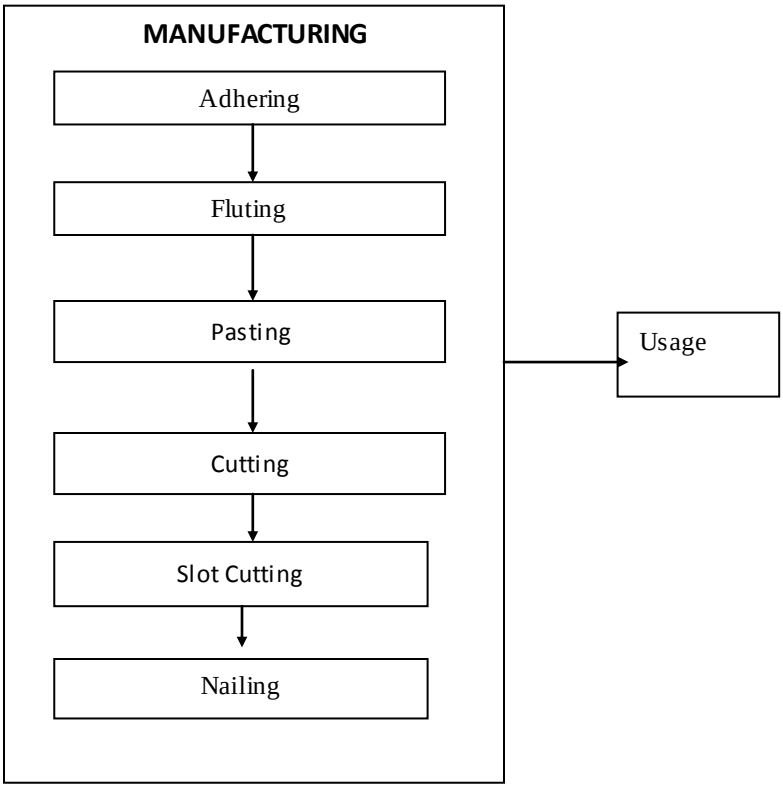

Figure 2 Flow Chart of Corrugate Box Manufacturing

1.3 Goals

The primary Goals of this study is to evaluate the life cycle environmental impact by using the different corrugated each manufacturing and identify the hotspots in reducing the environmental impacts different end of life treatments under the various collections using the GaBi 8.7. Then improving sustainability in semi skilled corrugated packaging industry. The corrugated box is very cheap product in packaging industry so it will be reliable. Every food product, paper, product milk product industry such a use of corrugated box

2. Inventory

The inventory of resource uses and emissions to environment in the "gate to gate" of one corrugated box, the data were obtain from the industry and specializes database. For the obtain the data visually note down the all process data input and output quantity. It consists in the calculation/collection of all the flows of materials/energy and processes needed for the functional unit. The materials and processes to be considered depend on the goals and system boundaries defined in below.

The life cycle impact assessment aims to understand and evaluating environment's emissions impact based on the inventory analysis, in the framework of the goal and scope of this study. In this phase the inventory results are determined to different impact categories, based on the premistics types of impacts on the environment. Impact assessment in LCA generally consists of the following terms: characterization, classification, normalization and valuation. Characterization is the assessment of the magn tude of potential impact of each inventory flow into the corresponding environmental impact (e.g., modeling the potential impact of co_2 and CH_3on global warming).In the classification, process of assignment and initial aggregation of LCI data into the common impact groups. And the Normalization expresses potential impacts in ways that can be compared. In the Valuation , the assessment of the

importance of environmental burdens identified in the classification, characterization, and normalization stages by assigning them weighting which allows them to be compared or aggregated.(Poritosh Roy et al 2009)

The inventory analysis shown in Table 1.

Table1. Inventory data and resources are used for emission to environment per 1 corrugated box (938 g)

Substance	Amount	Unit
Resources use		
Paper reel	**750**	**g**
Adhesive	**70**	**g**
Lubricating oil	**10.22**	**ml**
Ink	**1**	**g**
Electricity	**6.14**	**kwh**
Land use	**352**	**g**
Steel wire	**10**	**g**

The electricity for one piece corrugated box is 22.13mj

3. Impacts Assessment

In this research, presents to four environment's impacts is analyzed; Acidification potential, Global warming potential Human toxicity potential, Ozone Depletion. These four results were obtain form used as reference below the histogram charts show the total emission generation in whole process of corrugated box.

The results of life cycle assessment were performing using the ILCD recommendation in the GaBi 8.7. this approach are consist eleven impact categories these are; global warming ,acidification human toxicity cancer, human toxicity non cancer smog formation, ozone layer depletion, etc. This the research performing the main source of environments impact and its categories . the ILCD method generally used for to described the impact product manufacturing process.(Zuodong Qin 2018)

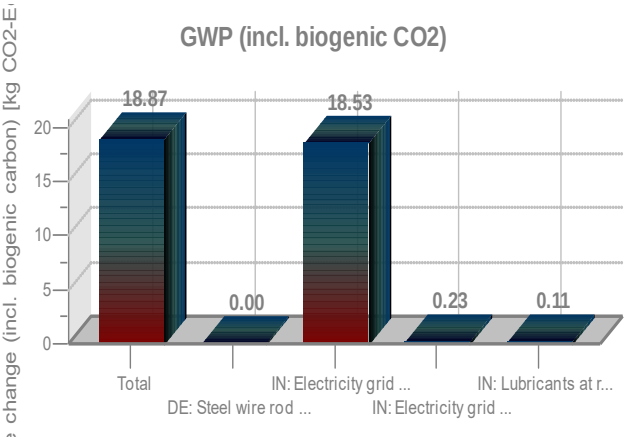

Figure 3 Global Warming Potential

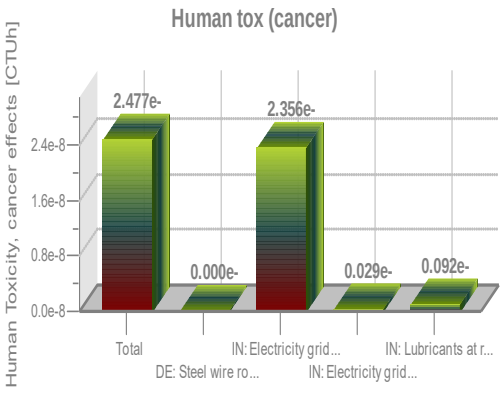

Figure 4 Human Toxicity potential

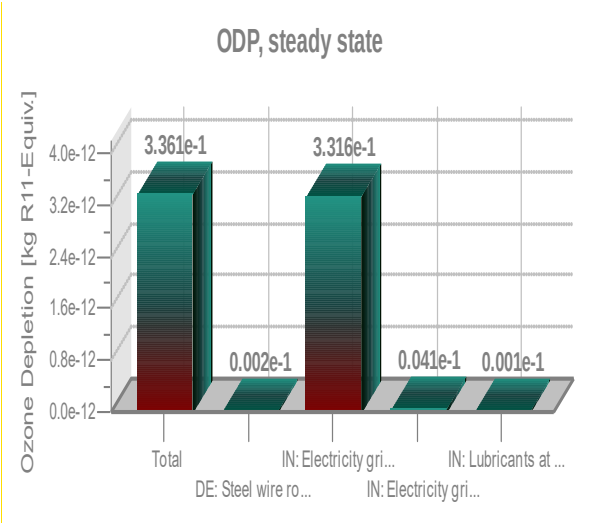

Figure 5 Ozone Depletion

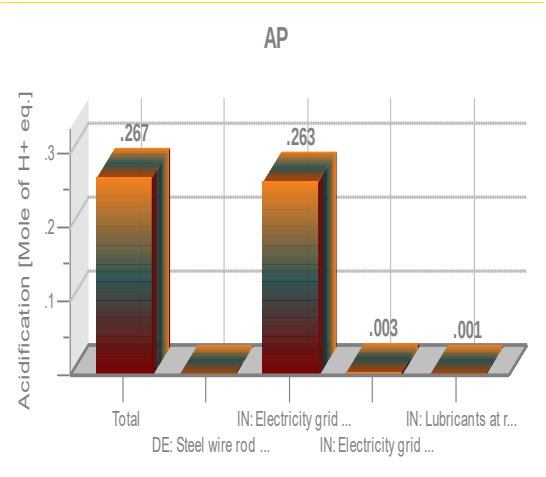

Figure 6 Acidification

The resources of the environmental impact/emission and energy used with reference to one piece corrugated box

Table 2. Categories for environmental impact and electricity use per 1 piece corrugated box

Types	Total Expanse	Entity
Global Warming (GP)	**18.87**	**kg Co2-eq**
Acidification (AP)	**0.267**	**mole H+eq**
Human Toxicity	**2.47e-8**	**CTUh**
Ozone Depletion	**3.361e**	**kg CFC**
Energy use	**22.13**	**kwh**

The above result is total expanse of environmental impact potentials and electricity use in the life cycle of 1 corrugated piece (0.938 kg).

These results are display that the critical process with associating to environment's impacts is land filling of the corrugated product. Land filling is liable for around 1/3rd part to acidification and global warming around 1/4th of the liable to smog creation. From the research four important impacts as a result of the cause of make Ammonia and Methane gas all the while land Filling of the box. (Arunee Ongmonkolkul 2019)

- The major origin of global warming potential methane emissions from the landfill, it content a total amount **18.87 kg Co2-eq**. CH4 is contribution to global warming potential is 50 time of CO2's contribution. The remains contributions are primarily to CO2 emission from steam and electricity production occupying on fossil fuel (natural gas, coal, and oil).

- The major origin of acidification is Ammonia emission to the land fill, it content **0.267 mole H+eq**. It is spread into land and water due to NH3 to be converted into nitric acids in the atmosphere. 1kg of ammonia equals to 1.8 kg Sulfur dioxide gas equivalent. Other origins are SO2 and NOx emissions due to from electricity and steam creation.

- The Human Toxicity Potential (HTP) it content **2.47e-8** CTUh is a measurable toxic equality potential that has been express the potential harm of an entity of chemical released into the environment. Human toxicity potential is responsible for both generic resource and genetics toxicity for widely emissions.

- Depletion of the ozone layer has consequences on humans, animals and plants. It is content a **3.361e** kg CFC is content carbon. The CFC are react with O_3 it is responsible for ozone layer depletion. Due to this reaction the sun rays are enter in the earth and impact on human body.

- The large amounts of steam are generated by energy consumption processes consume; it is the major origin of energy consumption. The 10 percent of total responsible for pre consumption and post consumption of paper.

4. Result

The result from GaBi 8.7 show the environmental impact of each stages of corrugated box were climate change acidification, Ozone depletion, Human toxicity ILCD in GaBi 8.7 .The credit impact obtain from input and output process.
(Mass kg)

Flow/Emisions	Life Cycle of Corruga (Absolute Value)
Resources	9.41E
Others	0
Deposited goods	68.8
Air Emissions	394
Fresh water Emissions	4.6E
Sea water Emissions	27
Agricultural soil Emissions	-2.47495838123609E-7
Industrial soil Emissions	2.8E-6

In this result show the week point analysis in the tools used week point in this the emission generation from deposition of goods, Radioactive waste, stockpile goods (hazards waste ,over burden, slag, waste, slag), Emission to fresh water (heavy metals ,organic in organic emission).

5. Conclusions

The LCA technology is important to appraise environmental impacts and defense of the production phase. In this research the life cycle of corrugated box having of many processes. The major source of environmental impacts is land filling, and electricity consuming of the corrugated box manufacturing. If the degree of land filling is more than 60%, it is most responsible for environmental impacts. And it is also responsible for main contributions to global warming and acidification, if the recycling phase is used for whole product that it is safe for environment.

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