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INVESTIGATION OF SUB-ASSEMBLIES OF 'TWO-WHEELER' FOR ENVIRONMENTAL IMPACT EVALUATION

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Subassembly.

Abstract: *Every human activity has an impact on the environment in the form of emissions. The environment has some capacity to absorb these emissions so emitted to a certain level without lasting the damage. The investigation of environmental impact of products and processes has become a key issue that has lead companies to investigate ways to minimize their effects on the environment. All products have an impact on the environment during their life-cycle spanning all phases from cradle to grave. The manufacturing process of a product produces emissions detrimental to air, water and soil during its entire life from raw material extraction to the final disposal. Major part of the environmental impact of a product is determined at the design stage.*

Environmental Impact Assessment (EIA) is used to identify the detrimental effect or environmental impacts of a product prior to its start. Life cycle analysis (LCA) is one of the tools that can help designer to understand the environmental impacts associated with their products, processes, and activities.

Now a day, using the two-wheeler becomes the necessity of day to day life and a major part of our society is using it in large quantity. This work deals with the investigation of some parts of Engine of 'two-wheeler' for environmental impact assessment using scientific approach of Life Cycle Assessment (LCA).

LCA analyzes total impact of product on environment from extraction of raw materials that go into product through manufacture. LCA method considered for this work is Environmental Design of Industrial Products (EDIP). The environmental impact has evaluated for the parts of sub-assembly 'material-wise'. This will helps the product designer for further development of the product, which would be more eco-friendly for the society.

Keyword: *Environmental impact assessment, Life cycle assessment, Evaluation, Investigation, EDIP, Environmental Design,*

I. INTRODUCTION

All products have an impact on the environment during their life-cycle spanning all phases from cradle to grave. Major part of the environmental impact of a product is determined at the design stage. A standard technique internationally known as 'Environmental Impact Assessment (EIA)' is used to identify the detrimental effect by evaluating the various product parameters. It is used to study the life cycle of a product. Life cycle analysis (LCA) is one of the tools to understand the environmental impacts associated with the products and its processes. The outcomes of impact assessment using this technique can help the designer for improving the design of the product. Therefore, it is essential to study the individual environmental impact of a particular product right from raw material acquisition.

LCA analyzes total impact of product on environment from extraction of raw materials that go into product through manufacture. LCA method considered for this work is Environmental Design of Industrial Products (EDIP).

II. LITERATURE REVIEW

Environmental impact assessment (EIA) studies require a significant amount of primary and secondary environmental data. The primary data needs to be collected in the field to define the status of environment (like air quality data, water quality data etc.). The secondary data is the data which have been collected over the years and can be used to understand the existing environmental scenario of the study area. There is no single organization in India which tracks the data available amongst

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these agencies and makes it available in one place, in a form and manner required by practitioners in the field of environmental impact assessment in India[1-5]

Environmental impact assessment (EIA) is a tool that helps to ensure sustainable development through the evaluation of those impacts arising from a major activity. It is a planning tool which is generally regarded as an integral component of sound decision-making. [6].

The present day trend is to develop an engineering product as 'green product' as a strategy for enhancing the environmental performance for overall socio-economic development. This approach is popularly known as 'Life Cycle Assessment' and briefly termed as LCA. The life cycle stages of a product can be illustrated with the help of figure-1, considered in LCA with typical inputs/ outputs measured as a functional system boundary defined. The emissions of the system in the defined boundaries can be evaluated using the inputs of raw materials and energy so give output such as atmospheric emissions. Hence, in engineering, LCA has become a powerful tool to evaluate environmental impact assessment of a product.[7]

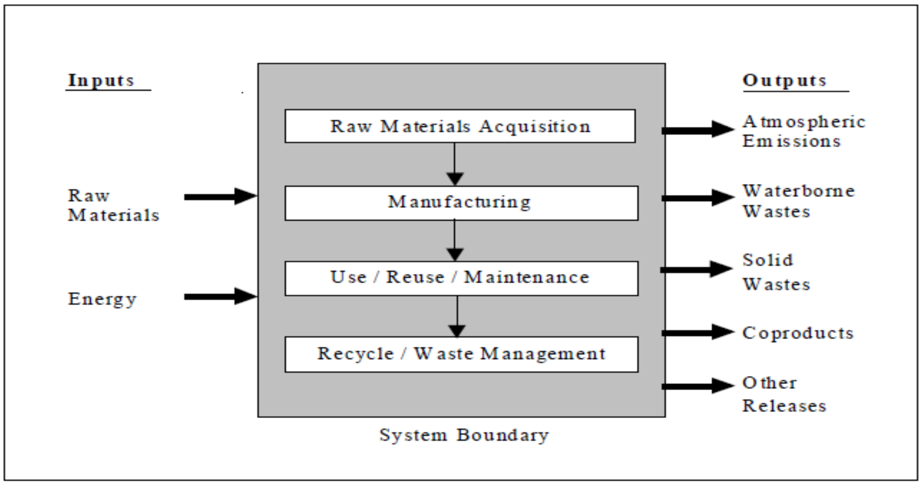

Figure-1: Life Cycle Stages (Source EPA, 1993)

Production and consumption of goods and services are primary factors causing harmful effects on the environment. Life cycle assessment is a method for assessing the environmental considerations of a product or service throughout its entire life cycle. Life cycle assessment is documented in the form of ISO standards 14040-14043, giving instructions for LCA practitioners to conduct LCA applications according to "good practice". A life cycle impact assessment (LCIA) provides a systematic procedure for classifying and characterizing these types of environmental effects. [8]. The environmental impacts as per LCIA are, typically focuses on the potential impacts to three main categories: human health, ecological health, and resource depletion. [9]

III. METHODOLOGY

In this work, the methodology adopted for the environmental impact assessment of the selected products is according to the standard practice of LCA. Normally the investigation of any product for life cycle assessment (LCA), is a systematic, phased approach, broadly suggested four components, as illustrated by figure-2. All these steps suggested are sequential and become iterative, if a change in one stage occurs, It will automatically affect other steps. The work has been carried out using LCA method 'Environmental Design of Industrial Products (EDIP-03)'.

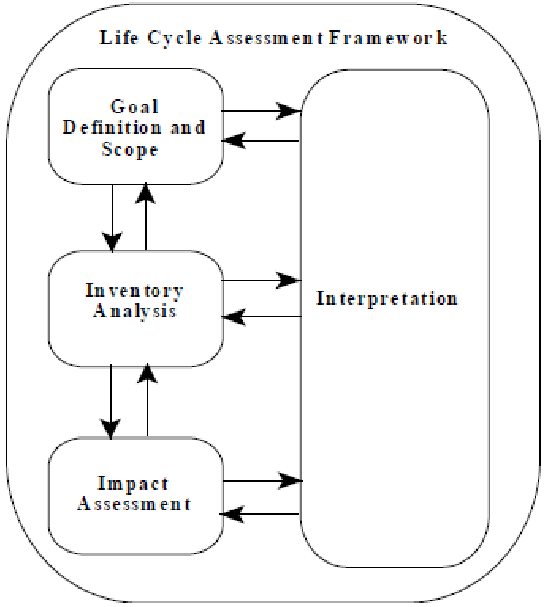

Figure-2: Phases of Life Cycle Assessment (LCA) (ISO, 2006)

IV. THE INVESTIGATION OF PRODUCT FOR IMPACT ASSESSMENT

The multi-entity product which is used in large quantities in day to day life by the consumers has been selected for the investigation. A multi-entity product is the assembly of number of components. Now a day, using the two-wheeler, becomes the necessity of day to day life and a major part of our society is using it in large quantity. This work deals with the investigation of some parts of product 'two-wheeler' for environmental impact assessment using scientific approach of Life Cycle Assessment (LCA).

In the present work, the two subassemblies of 'Engine Assembly Group' of 'two-wheeler' has been selected for evaluating the environmental impact, which will help the designer for further eco-development of the product.

4.1 About the Product

The two-wheeler scooter has been distributed in six assembly groups. Among these, two subassemblies of Engine Assembly Group have been selected for this work. Which are Right Crank Case (RCC) subassembly and Left Crank Case (LCC) subassembly. These two subassemblies having parts of four kinds of materials, i.e. Plastic (P) , Steel (S) , Rubber (R) and Aluminium (Al). The evaluation of environmental impact has been carried out for the parts of these four kinds of materials separately. The weightage of parts of these four different materials for Right Crank Case (RCC) subassembly is as shown in the figure-3 and Left Crank Case (LCC) subassembly is as shown in the figure-4.

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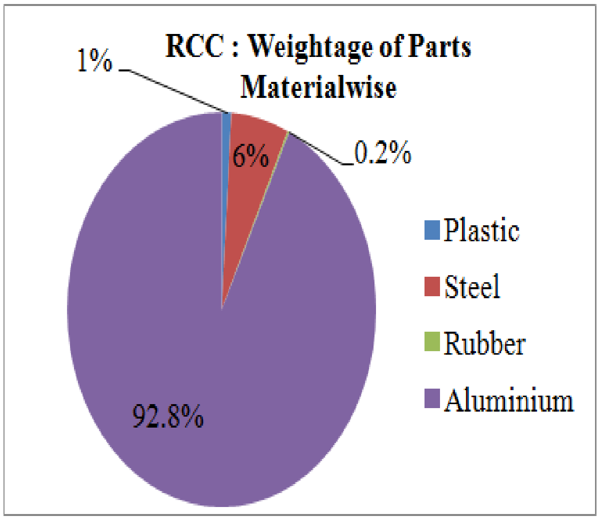

Figure-3: Weightage of Parts (material-wise) of Right Crank Case subassembly (RCC)

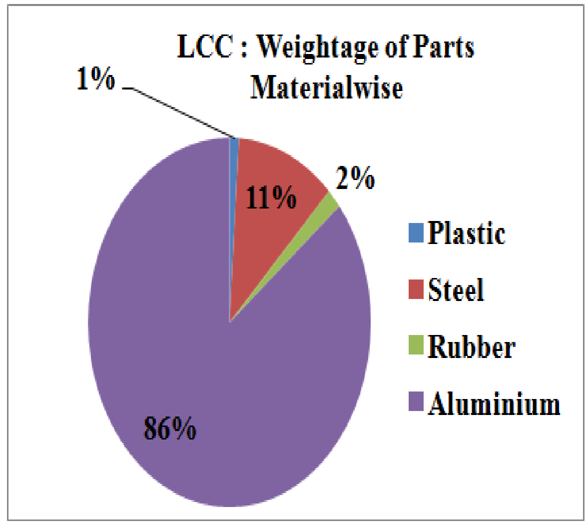

Figure-4: Weightage of Parts (material-wise) of Left Crank Case subassembly (LCC)

This environmental impact is carried out for the life cycle stages covered under 'cradle-to-gate'. It includes the stages raw material acquisition, material manufacturing and part manufacturing.

4.2 Evaluation of Environmental Impact

According to the selected LCA method, i.e. EDIP-03, the impact categories evaluated for environmental impact assessment are ecotoxicity water acute (EWA); ecotoxicity water chronic (EWC); ecotoxicity soil chronic (ESC); human toxicity air (HTA); human toxicity water (HTW); human toxicity soil (HTS); global warming (GW); acidification (AC); terrestrial eutrophication (TET); aquatic eutrophication EP(N) (AETN); aquatic eutrophication EP(P) (AETP); ozone depletion (OD); ozone formation vegetation (OFV); ozone formation human (OFH).

The new developed software 'SSLCASoft' has been used in this work for the quantitative evaluation of impact indicator of these impact categories and the presentation of results of the environmental impact in graphical form.

V. RESULT AND DISCUSSION

The graphical presentation of environmental impact on various impact categories of EDIP-03, of parts of Right Crank Case (RCC) subassembly material-wise, is as shown in the figure-5 and parts of Left Crank Case (LCC) subassembly material-wise, is as shown in the figure-6.

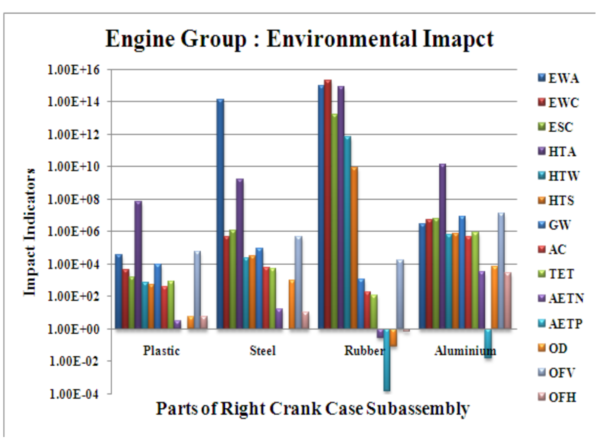

Figure-5: Environmental Impact of Parts of Right Crank Case subassembly (RCC)

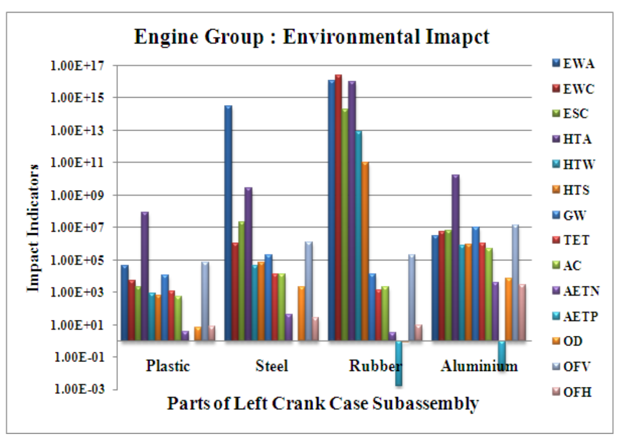

Figure-6: Environmental Impact of Parts of Left Crank Case subassembly (LCC) (material- wise) (material- wise)

Though the weightage of rubber parts is very less in both assembly, but the impact on Ecotoxicity group and Human toxicity group is very much dominating. This is just because of few substances, which are having very high emission value. The impact of steel parts and aluminium parts is very much high. The weightage of steel parts is less as compared to aluminium parts, but impacts are substantial.

VI. CONCLUSION

This investigation evaluates the environmental impact of parts of different materials and at different life cycle stages. This will helps the product designer for further development of the product by alternative material selection and manufacturing processes, which would be more eco-friendly for the society.

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