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Technical Report

Environmental impact minimisation in an automotive component using alternative materials and manufacturing processes

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ABSTRACT

Sustainable development is seeking to meet the needs of the present without compromising those of future generations. The need to integrate the principles, values, and practices of sustainable development into all aspects of manufacturing, in order to address the social, economic, cultural and environmental problems is felt widely among the industrialized society. Selecting or identifying a suitable material or manufacturing processes is one way of achieving sustainability of a product by reducing its end of life impacts to a possible extent. But technological changes are unpredictable and so predicting future possible environmental impacts are highly difficult. This paper tries to explore the potential of environmental impact minimisation using alternative materials and alternative manufacturing processes. A case study has been carried out to in this regard in an Indian automotive component manufacturing organization. The results indicate that change in material has higher impact over the manufacturing process in reducing the environmental impact.

1. Introduction

During the middle of industrial revolution, the main concern on regarding material selection process was customarily made by technical demands like price, temperature stability, density, strength of material, hardness etc. [1]. The designers also focus on the optimisation of parameters like lesser weight, lower cost design and minimal of thermal distortion [2]. But due to changing industrial environmental policies in recent years, the major emphasis is now on the technologies adopted for the reducing the environmental aspects especially on the perspective of material selection. The companies still in the past years find pollution prevention as economically beneficial [3]. In order to minimise the environmental load in life as a whole, 'Eco-materials' are considered as a major concept [4,5]. It is found that huge amount of energy and material is lost during production and transportation, including waste material and emissions, particularly for non-recycled products [6]. In the present scenario, even all companies stick to zero emissions, our earth could still seriously face the effects of the emissions made till now [7]. With the problem of environmental pollution becoming more and more serious, engineers and designers must concentrate on the effects that their design decisions have on the eco-systems around us. Thus the selection of materials for a certain product is of vital importance, while the material determines the usage of our natural resources as well as the amount of energy used for the production and the use of the product [8,9]. But it is highly complicated to derive at a suitable material and process for a particular product prior to pilot manufacturing. Hence the need for a feasible methodology to enable the process of material selection is found to be very much essential. In this context, this article reports a study in which the feasibility of alternate materials over manufacturing process has been explored. The results from the study indicate that the alternate materials/user locations has higher influence on environmental impact minimisation than the manufacturing process.

2. Literature review

The literature has been reviewed from the perspective of material and manufacturing process change enabling the minimisation of environmental impact. Weaver et al. [10] developed a design strategy which relates conventional design objectives with environmental impact indicators. The authors in their study focussed on minimising the environmental penalties of the refrigerator insulation material by taking two restricted measures of impact, the energy content and fire resistance of the material. They commented that energy content differ greatly for different materials. Giudice et al. [11] in their study on material selection in the life cycle design process proposed selection procedure that intricate over the conventional and environmental properties of materials and processes, and related the data to the vital performance of product components, and calculates the values assumed by functions which quantify the environmental impact over the whole life-cycle and the cost resulting from the choice of materials. The authors in their case study presented the results evaluated using multi-objective analysis techniques and authenticated their deploy ability.

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