World Academy of Science, Engineering and Technology
International Journal of Industrial and Manufacturing Engineering
Vol:11, No:04, 2017

Environmental Performance Improvement of Additive Manufacturing Processes with Part Quality Point of View

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Abstract : Life cycle assessment of additive manufacturing processes has evolved significantly since these past years. A lot of existing studies mainly focused on energy consumption. Nowadays, new methodologies of life cycle inventory acquisition came through the literature and help manufacturers to take into account all the input and output flows during the manufacturing step of the life cycle of products. Indeed, the environmental analysis of the phenomena that occur during the manufacturing step of additive manufacturing processes is going to be well known. Now it becomes possible to count and measure accurately all the inventory data during the manufacturing step. Optimization of the environmental performances of processes can now be considered. Environmental performance improvement can be made by varying process parameters. However, a lot of these parameters (such as manufacturing speed, the power of the energy source, quantity of support materials) affect directly the mechanical properties, surface finish and the dimensional accuracy of a functional part. This study aims to improve the environmental performance of an additive manufacturing process without deterioration of the part quality. For that purpose, the authors have developed a generic method that has been applied on multiple parts made by additive manufacturing processes. First, a complete analysis of the process parameters is made in order to identify which parameters affect only the environmental performances of the process. Then, multiple parts are manufactured by varying the identified parameters. The aim of the second step is to find the optimum value of the parameters that decrease significantly the environmental impact of the process and keep the part quality as desired. Finally, a comparison between the part made by initials parameters and changed parameters is made. In this study, the major finding claims by authors is to reduce the environmental impact of an additive manufacturing process while respecting the three quality criterion of parts, mechanical properties, dimensional accuracy and surface roughness. Now that additive manufacturing processes can be seen as mature from a technical point of view, environmental improvement of these processes can be considered while respecting the part properties. The first part of this study presents the methodology applied to multiple academic parts. Then, the validity of the methodology is demonstrated on functional parts.

Keywords : additive manufacturing, environmental impact, environmental improvement, mechanical properties
Conference Title : ICSMPM 2017 : International Conference on Sustainable Manufacturing and Production Management
Conference Location : Venice, Italy
Conference Dates : April 13-14, 2017