Environmental impact of Fibre-Reinforced Polymers application in shipbuilding industry.

1. Introduction

Nowadays, fibre-reinforced polymers (FRPs) are one of the most attracting materials for engineering application. It can be said that fibrous composites have become a strong alternatives to the steel in construction industry [1]. The general advantages of FRP to conventional materials include high durability, cost-effective fabrication, and excellent resistance to corrosion, fatigue and fire [2,3]. Owing to their unique properties, FRP composites can be successfully used in automobile [4], aerospace [5] and marine industry [6], especially for lightweight constructions [7].

Application of FRP in shipbuilding needs to qualify a specific marine standard. The main requirements are: environmental stability, fracture toughness, resistance to cyclic fatigue, low creep, low relaxation, ease of joining and maintainability, as well as cost of investment and processing [6,8]. However, the production capacity in numbers of FRP ships does not achieve its full potential due to high total production costs. This limitation is due to the lack of automated procedures and the current semiartisanal methods used in FRP shipbuilding. Therefore, meeting the shipyards sector's requirements requires a transformation of traditional composite manufacturing processes. Fibre4Yards (FIBRE composite manufacturing technologies FOR the automation and modular construction in shipYARDS) Horizon2020 project brings together a unique multi-disciplinary consortium to successfully introduce of advanced and innovative FRP manufacturing technologies in shipyards. The project aims to transfer, adapt and combine targeted advanced production technologies from other competitive industrial sectors into a Shipyard 4.0 environment [9]. In the frame of the FIBER4YARDS project, five advanced and highly automated FRP production technologies are applied: hot stamping, UV curved pultrusion process, Automatic Tape (Fibre) Placement (ATP/AFP), 3D printing and adaptive mould. Environmental load of particular technologies were determined by Life Cycle Assessment (LCA) approach. A general conclusion is that the average environmental load of FIBRE4YARDS technologies is relatively low, less than 5 kg CO_2 eq. in relation to 1 kg of the final product.

Results of LCA calculation show that in each technology applied for FIBRE4YARDS the biggest load is produced by material and compounds, from 80 to 95%. The contribution of other elements, including energy is in the range of 6 to 15 %.

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