COMPARATIVE LIFE CYCLE ASSESSMENT (LCA)

OF THE HULL OF A HIGH SPEED CRAFT

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ABSTRACT

A comparative Life Cycle Assessment (LCA) has been performed on the hull of a 24 meter long high speed patrol craft. The aim of the study is to compare different structural materials concepts to determine differences and sensitivities in environmental impact, especially in relation to the total impact including fuel burn. The material concepts studied are aluminium and various composite combinations consisting of glass fibre and carbon fibre with vinyl ester resin both as single skins and as sandwich with a Divinycell foam core. For each material concept a unique and weight optimized structural design was employed fulfilling the DNV high speed craft design code [1]. All identical systems and components for the five hull concepts are omitted in the LCA and hence a comparative study is performed focused on the hull structure. The commercial software SimaPro have been utilized for the LCA calculations and the impact assessment method chosen is the CML Baseline 2000.

The structural optimization carried out in [1] show that a weight reduction by up to 50% (on the hull) could be achieved by switching from aluminium to a carbon fibre sandwich concept. The weight reduction switching from glass fibre single skin to a carbon fibre sandwich concept is roughly 20%.

The LCA study performed herein shows that, regardless of hull material concept, the environmental impact is by large dominated by the usage phase due to relatively large fuel consumption. A lower structural weight will reduce the fuel consumption and hence the environmental impact. This is illustrated in fig. 1 for the aluminum hull. All different phases of the life cycle are plotted for all environmental impact categories assessed herein. The green color is related to the operation phase and the red is the manufacturing phase. As observed the operation phase is dominating.

In fig. 2 are the results from the LCA presented for all hull concepts and for all environmental impact factors. The Al-hull is the concept with highest structural weight (red bars) and hence was found to have the highest environmental impact. The carbon fibre sandwich hull (green bars) had the lowest weight of the five and consequently the lowest environmental impact.

In the normalization analysis performed, in which different impact factors are assessed using
a common impact unit, three impact factors stand out as dominating, independent of hull concept; *Abiotic depletion, Global warming and Acidification*. All these impact factors are herein associated with the usage phase and diesel consumption. If the operation phase is omitted and only the manufacturing phase (including the material extraction/manufacturing) is studied the observation is that the aluminium concept still will have the largest environmental impact for all categories. The most significant environmental impact is now on the marine and the fresh water aquatic ecotoxicity which is associated with the aluminium raw material excavation and manufacturing processes.

![Figure 1: LCA results for the Al-hull concept, impact per category and life cycle phase, normalization data](image1)

![Figure 2: LCA results for the all hull concept, impact per category, normalization data](image2)

**REFERENCES**


[2] Det Norske Veritas Rules for Classification of High-Speed, Light Craft and Naval Surface Craft. DNV. Veritasveien 1, NO-1322 Høvik, Norway