11th Hour Racing Team
IMOCA 60 Sustainable Design & Build Report
- 2021 -

SCENARIO ANALYSIS - METAL CHOICES

Supporting the main report, this document - **Metal Choices** compares the environmental impacts of metal

Measurements used are
kilos (kg), metric tons (t), Greenhouse gas (tC02e) or (kgC02e)

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DISCLAIMER

The team's LCA results were calculated using MarineShift360.
Backed by 11th Hour Racing as Founding Sponsor, MarineShift360 is a purpose-built marine industry life cycle assessment tool. MarineShift360 is an ISO 14040:2006 & ISO 14044:2006 compliant and certified life cycle assessment tool. LCA results herein are calculated using MarineShift360, which is under development and is currently in beta stage.
No statements regarding accuracy are made and results may change over time as the development of MarineShift360 continues.

Objectives

- Understand the impact of different metal materials
- Review where the high impact metal materials are located in the build
- Quantify any reductions that can be made by switching to lower impact metals
- Highlight the importance of material selection and processes and assumptions in LCA building.

Process & tools

Comparing metal highlights that titanium alloy is around 10 x the impact of steel. This led us to conduct a number of case studies.

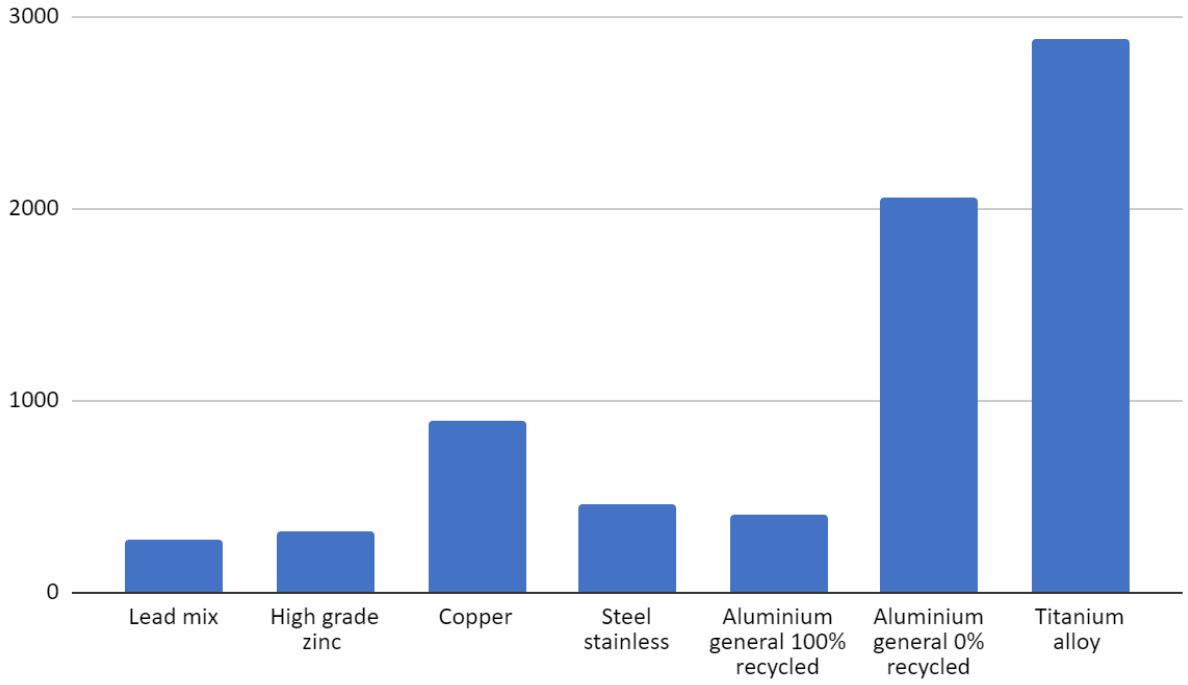

Figure: Comparing relative GHG impacts of different metals, Calculated with MarineShift360 beta software on October 1, 2021

Base Scenario: As built LCA of IMOCA 11-2 containing selection of titanium fittings
Steel Scenario: All titanium assigned to the LCA of building IMOCA 11-2 replaced with stainless steel
Aluminium scenario: All titanium assigned to the LCA of building IMOCA 11-2 replaced with Aluminium (0% recycled)

Assessment	Base scenario with titanium parts			Aluminium scenario	Stainless Steel scenario
	Ordered quantity kg	**Final quantity kg**	**kgC02e**	**kgC02e**	**kgC02e**
Boom Hardware	2	2	79	63	31
Deck Hydraulic System	1.64	1.56	1,539	1414	1,298
Deck Gear	5.797	5.27	1,751	1308	898
Engine	2.71	2.47	2,487	2280	2,088
Furlers	61.834	56.213	11,905	7181	2,806
Keel Hydraulic System	9	9	8,760	8047	7,387
Total	83	76	**26,521**	**20,293**	**14,508**

Figure: Comparing GHG impacts of different metals (kg - kg) used to build 11-2, calculated with MarineShift360 beta software on October 1, 2021

Scenario: Corrected for material performance

To take into account the different performance factors of these metals we asked one of our suppliers for a generic comparison of performance adjusted for weight. With the important qualifier that a detailed evaluation is component/application specific, we applied these factors to re-calculate the base scenario.

Supplier feedback:
Acknowledging that a component is made up of a mix of materials, we used the example of a 12T working load swivel, and estimated the weight of the component made primarily from 3 different materials (Aluminium, titanium and Stainless steel):
Weight:

- *the titanium one : 1120g*
- *the aluminium one 1680g*
- *the stainless steel one : 1762g*

Based on this feedback we calculated a performance factor compared to titanium for each material: Weight alternative material/weight titanium=Performance factor

Applying this performance factor to greenhouse gas emissions

Material	kgC02e Replacing all titanium kg - kg assessed during LCA 11-2	Perf. factor	kgC02e - Replacing all titanium	kgC02e Delta - vs Titanium
			Performance corrected	
Titanium	26,521	1	26,521	-
Aluminium	20,293	1.5	30,439	+ 3,918
Stainless steel	14,507	1.57	22,776	- 3,744

Figure: Comparing GHG impacts of different metals (adjusted for weight and structural performance), calculated with MarineShift360 beta software on October 1, 2021

The performance corrected scenario still offers an interesting GHG reduction (3.7 tC02e) by replacing all Titanium with stainless. and build of an IMOCA launched and ready sail (at 553 tonnes).

Comment

Comparing material impacts is highly dependent on understanding mechanical properties in the context of their respective and specific applications, especially considering such big differences in impacts per material type (often being a factor of 10 or more).

As such this simple study is suggestive rather than indicative, and a more detailed scenario based analysis is required.

Recommendations

At 3.7 tC02e, the potential reduction is only 0.7% across the full system (IMOCA launched and ready to sail) however the application of this Improvement pathway is assessed as easy relying only on an IMOCA Class rule. Certainly some of this benefit quantified above may be lost by the partial use of aluminium as a replacement (a metal with comparable GHG emissions to titanium). However we believe that closer investigation applying more precise mechanical properties adjustments for weight may validate removing titanium from use within the IMOCA class.

Conclusions

This study underlines the Importance of reaching out to suppliers to source the best input data possible.

"Accurate data input and well reasoned assumptions for both material type, quantity ordered vs quantity in final component, and assumptions on waste can significantly affect the accuracy and validity of the LCA results." **Amy Munro, Sustainability officer - 11th Hour Racing team**

Example 1:
Mistakenly applying titanium instead of stainless steel to a 10kg component will cause an error of 242kg CO2e or 600%

- 10kg Titanium = 288 kgCO2e
- 10kg Stainless = 46 kgCO2e

Example 2:
Especially in manufacture of metal components large variances can be found with regards to the original quantity of ordered materials (The billet) prior to machining processes. Even from one supplier, or period to the next this can induce major result differences of anything from 0-300% or more.

Example 3:
Resource recovery/waste management will also vary significantly from material to material, and between suppliers. While most suppliers will be efficient in material use, recovery of off cuts in-house and valuing waste, nothing replaces engaging the supplier directly on these questions