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Biobased composites bodywork vehicle wins AER 2024

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VESO Concept developed a composites bodywork for rally vehicles that integrates biobased and recycled materials, such as flax, recycled carbon and partly biobased polymers. The whole bodywork weights less than 80 kg and withstood the desert conditions (rocks, sand and high temperatures) without breakage during the Africa Eco Race 2024 (AER). The equipped vehicle won the race.

The 15th AER race ended on January 14, in Dakar. It was the inaugural event for APH-01 vehicles, the new-generation hybrid and sustainable side-by-side vehicles (SSV) developed by Apache Automotive (Belgium), a subsidiary of GCK Performance (Auvergne, France). The SSV driven by G. Paulin (copilot R. Boulanger) ended on the 1st position, while the one driven by P.-L. Loubet (copilot F. Borsotto) won 5 of the 12 race stages. Both results confirm the high performance level of the vehicles and teams (Figure 1).

Fig. 1: Composite-bodywork T3U in the desert © Africa Eco Race

Project origin and prototyping

Due to strong weight limitations and its environment-friendly approach, Apache Automotive was aiming for biobased composite bodyworks, and thus chose to collaborate with VESO Concept (Veso) (Occitanie, France). Acronym of "vehicle, Earth, space, ocean", this 15-year SME is known for its expertise in the development and prototyping of high-performance biobased and recycled composite solutions for mobility sectors. Once the design of the bodywork parts was validated, Apache Automotive entrusted Veso with the part prototyping and production stages. The reinforcements, polymers and processes were defined by the Veso team using an eco-design approach, to finally deliver the 2 bodyworks in 4 months.

This process was chosen given Veso's long-term infusion moulding solutions expertise (Figure 2). Glass fibre/vinylester moulds were designed in-house and manufactured by subcontractors. The first APH-01 prototype, the predecessor of the AER prototypes, was developed in 4 months, continuously improving the infusion process (draping, process, curing), in order to deliver parts with

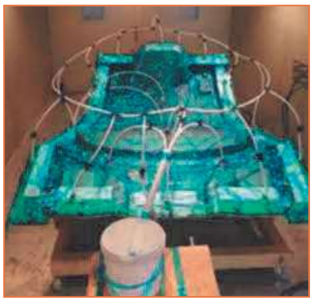

Fig. 2: Roof panel under vacuum
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high structural properties and a high-quality finish. Special attention was paid to the draping protocol, the vacuum infusion process and the curing conditions (pressure, temperature and time).

Fully biobased or recycled reinforcement materials

Several types of reinforcements were selected depending on each part's requirements. For instance, recycled carbon mat was used for the dashboard (Figure 3), especially for its aesthetic aspect when integrated as a reinforcement. Flax was chosen for the bodywork exterior parts due

Fig. 3: Equipped dashboard integrating recycled carbon mat © VESO Concept

to its very low environmental footprint, in accordance with Veso's DNA, but also for its low weight and damping properties (Figure 4). Moreover, this natural fibre is available under different forms, as fabrics and mats. Basalt was used for the interior parts and for the rocker panels, due to its high mechanical properties.
The weights and weaving were selected depending on the required properties, but also to ensure that the part thicknesses fully comply with the International Automobile Federation (FIA) standards. When needed for structural reinforcement, core materials where integrated in the monolithic parts. Following the initial eco-friendly strategy, recycled PET foams and cork panels were integrated as core materials. These choices ensured that 100% recycled/biobased reinforcements were used.

Fig.4: Flax-reinforced door © VESO Concept

Multi-parameter polymer selection

The matrix choice was multi parameters, as it should include:

- the polymer's socio-environmental impact: production, recyclability, biobased percentage, and toxicity for operators);
- curing conditions: low to medium temperatures (to avoid high energy consumption), with medium to fast curing times;
- performance: glass transition temperature, impact resistance and density.

Different matrices were used along the project, such as acrylate-urethane polymers, thermoplastic resin and partially biobased epoxy resins (up to 30%). The curing temperatures ranged from room temperature to 100°C, with curing times from 1 hour to overnight curing.

Regarding the process, dry fabrics and mats were first draped following the defined stacking sequences. The infusion consumables were then added, and the parts were put under a vacuum for infusion with the desired polymer and curing. Once cured, the parts were carefully demoulded, cut out and, when needed, reworked.

Resolving highly complex technical issues

All these choices resulted in the production of bodywork parts that were quite complex for an infusion process. The first major technical issue was the strong shape incidences (e.g. fenders, door interior skins), which required extreme attention when laying up the fabrics in these areas, in addition to specific concerns during the infusion phase to avoid dry and poorly impregnated areas. The trickiest areas were the skins around the rear bonnet's internal PET foam. The undercuts were another difficulty, especially on the front and rear hoods. The moulds were designed in several (up to 6) bolted parts to produce single-part composite hoods, a major concern being to obtain an airtight system in order to avoid porosities.

Once these moulds centred and bolted together, a bonding element is added to ensure a seal and prevent leakage during vacuuming, It confirms the quality of the assembly and preparation of the parting lines. Figure 5 shows

Fig. 5: Before the mould dismantlement stage © VESO Concept

Fig.5: Assembled flax-based door interior © VESO Concept

consumables being pulled out of a rear bonnet after infusion and before mould dismantlement.

The last major challenge was the surface aspect. Veso wanted to produce porosity-free parts straight out of the moulds without using gel-coats, in-mould paints or glass veils as surface finishes. This resulted in car bodyworks with apparent weaving patterns and minimal weight that were then dust-protected by a surface layer added by Apache Automotive.

Challenging part assembly and adjustment

In addition to being eco-designed, complex-shaped and aesthetic, it is important to keep in mind that the parts will equip the APH-01 and, thus, contribute to the vehicle's harmony. Therefore, Veso paid special attention to part adjustment and functionality. For instance tailored inserts are integrated when required by the Apache Automotive team. Some parts were assembled by Veso, such as the two-part doors which required careful bonding of the pre-adjusted exterior and interior skins. Then, the bonded part were fully readjust to deliver a ready-to-use part (Figure6).

High-performance eco-designed bodywork

The bodywork offers some remarkable technical characteristics such as:

- multifunctional hoods: the front and rear hoods include an engine protection, holes for lights, fenders and spoilers, while still being manufactured as a single part;
- final weight 10% lower than Apache Automotive's specifications;
- 5,000 km driven for the APH-01 prototype and 3,900 km for the AER ones (in desert conditions), without any bodywork part breakage.

A life cycle analysis (LCA) was conducted at the beginning of the project to assess its environmental validity compared to more traditional composite solutions. The objective of this multi-parameter LCA (acidification, climate change, eutrophication, photochemical ozone formation and fossil resource use) was to incorporate all the potential environmental impacts of the vehicle. Focusing on the 'climate change' parameter, the LCA concludes that the Veso solution releases 50% less kg CO_2eq than a traditional carbon/epoxy solution, highlighting the interest of partially biobased/recycled composite materials.

To conclude, this challenging project was a great opportunity for VESO Concept to produce one of the first composite bodyworks made of biobased/recycled reinforcements and environment-friendly polymers, validated by the FIA as T3U vehicles. Beyond motorsport vehicles, this can be seen as a successful attempt to open the automotive sector to more sustainable composite solutions. □

More information:
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