RECYCLING OF CARBON FIBERS FROM AERONAUTICAL WASTE AND TREATMENT OF BY-PRODUCTS USING HYDROTHERMAL PROCESSES

J.R. PORTELA[1], J.M. VÁZQUEZ-FERNÁNDEZ[1], E.TAVIRA ZAMBRANO[1], J.M. ABELLEIRA-PEREIRA[1], B. GARCÍA-JARANA[1], , E. MARTÍNEZ DE LA OSSA[1],

[1] *University of Cádiz, Puerto Real (Cádiz), Spain.*

1. **Keywords**

Carbon Fiber Recycling, Aeronautical Waste, Hydrothermal Liquefaction, Hydrothermal Crude, Supercritical Water Gasification, Circular Economy.

2. **Purpose**

The increasing use of carbon fiber-reinforced polymers (CFRPs), especially in the aeronautics industry, has led to a significant accumulation of waste, requiring sustainable recycling strategies. The RECICOM project develops a high-pressure hydrothermal (HT) process to degrade epoxy resin and recover clean carbon fibers while preserving their mechanical properties.

During this process, organic compounds dissolve in the solvent, where hydrothermal liquefaction occurs, forming crude oil as a by-product. Additionally, supercritical water gasification (SCWG) is being explored to valorize the liquid effluent, converting organic matter into hydrogen and methane, significantly reducing its organic load.

3. **Materials and methods**

The HT recycling process was conducted in a stirred batch reactor using aerospace-grade CFRP samples, composed of carbon fibers (CFs) embedded in an epoxy resin matrix. Multiple tests showed that HT recycling conditions varied depending on CFRP characteristics, typically ranging from 300 to 350°C, 80 to 160 bar, and 30 to 120 min in an alkaline medium (KOH, ~0.03 M).

For effluent valorization, SCWG experiments were performed at 600°C and 240 bar, measuring gas production and organic matter removal. Additionally, the hydrothermal crude fraction was analyzed for HHV (Higher Heating Value), elemental composition (H/C, O/C), and yield under varying operating conditions, including temperature, reaction time, catalyst concentration, and water-to-composite ratio.

4. **Results and discussion**

The HT treatment achieved high resin decomposition rates, producing clean, flexible fibers. SEM confirmed the preservation of the CF sizing, and tensile tests showed that fibers retained over 95% of their original strength, making them suitable for reuse.

SCWG of the liquid effluent produced a hydrogen-rich gas stream (85% H_2, 7% CH_4), demonstrating its potential for energy recovery.

Hydrothermal crude is generated as a secondary by-product, with a HHV of ~7500 cal/g. Elemental analysis was conducted to assess its potential for energy applications.

5. **Conclusions and perspectives**

This study integrates carbon fiber recycling with hydrothermal by-product valorization, enabling a multi-path waste utilization approach. Hydrothermal treatment recovers high-quality fibers, while SCWG and crude production offer additional valorization routes.

Future research will focus on optimizing crude formation, improving fiber recovery, and scaling up SCWG for waste-to-energy applications.