

Dynamic Thermogravimetric Analysis of Recycled Carbon Fiber Composites: Mini Review

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Abstract

Thermogravimetric analysis (TGA) is one of the most popular analysis techniques to study the decomposition process of polymeric materials in controlled atmospheres at various temperatures. In this review, dynamic TGA was carried out to determine the thermal stability of the recycled epoxy-based and vinyl ester-based carbon fiber composite (CFC). The specimens were heated from ambient to 800 °C under nitrogen and air at different heating rates. Results indicates that different heating rates has no significant influence on the degradation of the epoxy-based CFC.

Keywords: Recycling, TGA, Carbon Fiber Composite,

Introduction:

TGA can be used to evaluate the thermal stability of a material. In a desired temperature range [1-2], if a species is thermally stable, there will be no observed mass change [3]. Negligible mass loss corresponds to little or no slope in the TGA trace [4-5]. The dynamic TGA results of recycled epoxy-based CFC materials at different heating rates indicate that there is no significant difference among the thermal degradation profiles (Figure 1). For the heating rate of 5 °C m⁻¹ degradation events started around 300 °C and at the heating of 10 °C m⁻¹ and 20 °C m⁻¹ it started around 330 °C [6-7]. At 800 °C the TGA results of recycled epoxy-based CFC material shows the residue around 75% that remained, this can be assigned to the carbon fiber content of the sample [8-10].

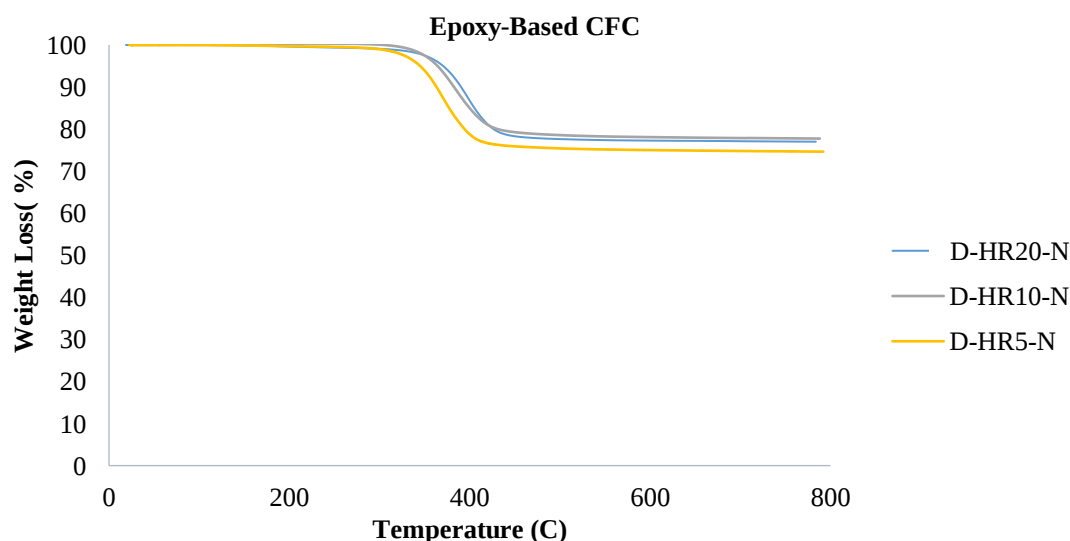


Figure 1. Dynamic TGA curve recorded in nitrogen at different heating rates. (Note: HR indicates heating rates)

Based on this fact that heating rate has no significant influence on the TGA results of recycled CFCs [11], for recycled vinyl ester-based CFCs we just consider the 20 °C min⁻¹ heating rete (Figure 2). For vinyl ester-based CFC material degradation event occur between 300 °C to 456 °C. At 800 °C the TGA results of recycled vinyl

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ester-based CFC material shows the residue around 77% that remained, this can be assigned to the carbon fiber content of the sample [12].

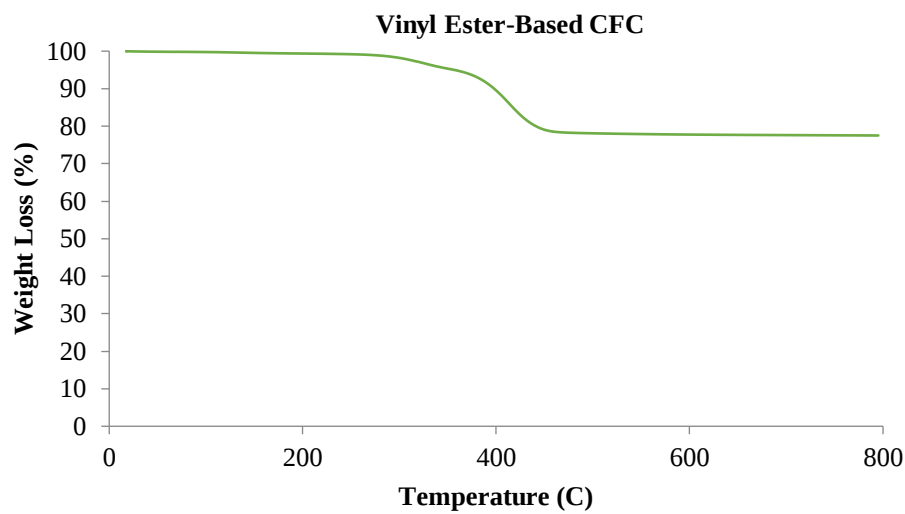


Figure 2. Dynamic TGA curve recorded in nitrogen at heating rate of 20 °C min⁻¹.

Comparing the TGA results of recycled epoxy-based CFC and vinyl ester-based CFC shows that there is no significant difference between degradation behavior of them.

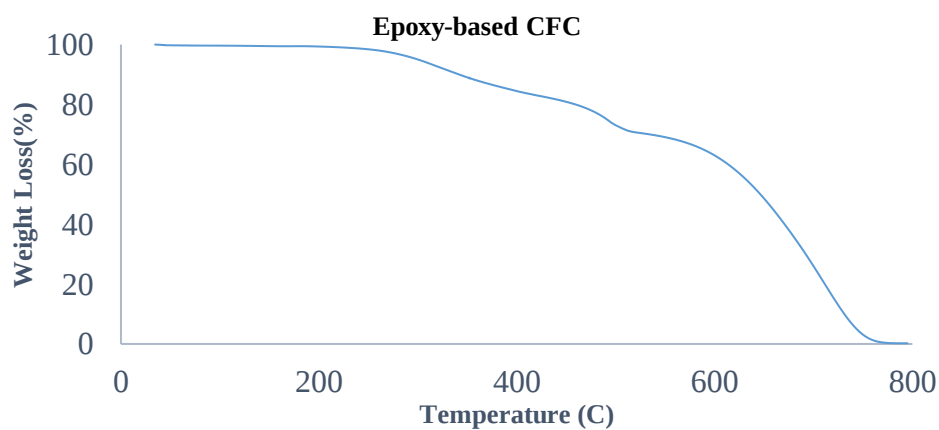


Figure 3. Dynamic TGA curve recorded in Air at heating rate of 20 °C min⁻¹.

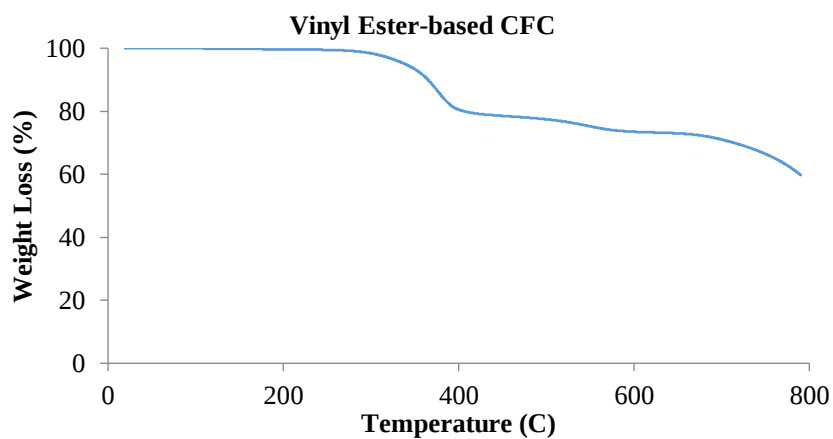


Figure 4. Dynamic TGA curve recorded in Air at heating rate of 20 °C min⁻¹.

The TGA results of recycled CFCs in air show that recycled vinyl ester-based CFC have better thermal stability comparing to epoxy-based CFCs. At 800 °C the TGA results of recycled vinyl ester-based CFC material shows the residue around 59% that remained, and results of recycled epoxy-based CFC material shows the residue around 0 %, it shows the significant thermal stability of vinyl ester-based CFC in air.

Conclusion:

Recycled CFCs are a viable material for making second generation composites. The obtained results from dynamic TGA of recycled carbon fiber composite materials demonstrate that recycled CFCs have superior thermal stability. Results indicates that different heating rates has no significant influence on the degradation of the epoxy-based CFC.

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