Review on Thermal analysis of Polymer Matrix Composites

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Abstract. Natural fibers are widely used for reinforcement in composite materials and well tried to be effectively exchange fibre strengthened chemical compound composites to some extent in applications like domestic, automotive and lower finish region elements. A few explores have been investigated in last decades to research the conduct of natural fiber composites. The natural fibre strengthened composites are atmosphere friendly, have high strength to weight quantitative relation like artificial optical fiber strengthened composites. Differential scanning calorimetry (DSC) and Thermogravimetric analysis (TGA) were used to evaluate the thermal properties. TGA is used to measure temperature change and mass loss of samples and DSC enables the measurement of glass transition temperature. This article presents an extensive study on the thermal properties of polymeric composites; the examination on polymeric composites is consistently in the phase of improving the properties.

Keywords: Natural Fibers, Thermal analysis, DSC, TGA

1. Introduction

Polymers and polymer composites are used presently in a wide variety of industrial applications ranging from construction materials to electronics, and in our everyday lives from chopsticks to trash bins due to their versatility, light weight, low cost and excellent chemical stability. In some fields, low thermal conductivity of polymers limits their applications. [1-4]. For instance, Due to the limited heat spreading power and low thermal conductivity, polymers can be one of the major technical barriers for flexible electronics based on polymer. The composite properties improved the lignocellulose fibres and they obviously contribute to the individual properties of their components but also to the interface of the fibre matrix. Mechanically these composites fail mainly due to fibre pullout, fibre debonding and fibre breakage. In reality, the matrix’s function in the fibre-reinforced composites used to move the load to the rigid fibres through Interface Shear stresses. That process calls for a Composite cannot be optimised and leaves it vulnerable to impacts on the environment that can degrade it, thereby reducing its lifespan. Insufficient adhesion between hydrophobic polymers and hydrophilic fibres contributes to weak natural mechanical properties in composites lined with silicone fibre. Recently, several studies have reported lignocellulose fibre chemical modifications has reasonable attachment of polymer matrix to fibres. Bad interface adhesion means full interface functionality. [5-13]. Several researchers studied the thermal effects and hybrid composite materials reinforced with various vegetable fibres (i.e., jute, sisal, ramie, coconut, sugar palm, etc.) or natural fibres mixed with glass fibres. FRP is also reinforced with various types of fibres to boost basic mechanical and thermal properties by means of different processing methods. Therefore, it is important to research any hybrid composite's thermal conductivity, specific heat, transition step, thermal stability and thermal degradation. The DSC is also one of the analyses required to assess the materials chemical properties. Glass transition reveals somehow the transition from glass to elastic Polymer-state [14-24].
2. Studies on Thermal Analysis

Literature studies of various natural fibers thermal properties are studied. The main thermal analysis are TGA and DSC. TGA is to measure the temp changes, mass loss of sample is measured and any material is heated at particular temp of the material is starting to decompose to particular mass. It is mainly focused on the thermal stability of material. DSC enables the measurements of the transition such as glass transition melting and crystallization. The thermal properties of various natural fibers values are listed in table 1.

2.1 Thermal degradation of Lignocellulose fiber

In DSC and TGA analysis, lignocellulose fibres exhibit related patterns. Illustrates the three major stages of natural fibre thermal decomposition in which Main decomposition that occurs between 200-400 °C. The thermal analysis relies on the respective atmosphere. Since Instance, the DSC test for cellulose under inert atmosphere changes the endothermic peak to oxidative (air or oxygen) exothermic peak.

2.2 Thermal degradation of Jute fiber

The jute composites at about 1000°C indicating the elimination of moisture from the fibre. All composites showed the precise thermal decomposition inside the temperature range of 210° C to 280° C. The degradation temperature of the untreated and dealt with Jute/Epoxy composites takes location at 210 to 265° C respectively. However, inside the case of watermelon stuffed composite, the decomposition takes region at 275°C. A small lift within the degradation temperature can be visible from the above composite suggests a huge discount in weight reduction. In the direction of higher temperatures, the weight loss is extensively reduced for treated composite while compared to untreated one. The better degradation temperature of the treated composite may be attributed to the presence of filler content, which led to multiplied thermal balance [20].

2.3 Thermal degradation of maize fiber

The maize fibers are presume that it is essential need to get great grip between fiber and network, to get a decent composite material strands should change from hydrophilic to hydrophobic characters. The maize fiber and polyester tar covered maize fiber gives a valuable data on warm corruption estimations of composites. Properties of normal filaments rely upon developing conditions and handling conditions. This variety makes more troublesome to break down the impacts of the strands and their interfaces on the warm properties of the composite material, these challenges call for improvement of new techniques [7].

2.4 Thermal degradation of Borassus fiber

In this study, examine the variation in particular heat, thermal conductivity of composite with honour to temperature, fiber and fly ash. The fly ash varies from 10 to 30% and the temperature range between 30 to 120°C. The composites with and without fly ash were keen with Borassus Flabellifer strengthened Composites in polyester matrix. Borassus Flabellifer Reinforce Composites acts as a thermal insulating component and it doesn't require any corrosion so, the longer styles is finished and besides prefabricate to totally shapes, set up time is very less, for this reason they're friendly reinforcing materials for the advance of load bearing.
2.5 Thermal degradation of Palm fiber

Thermal conductivity and thermal diffusivity of date-palm tree fiber reinforcement gypsum were estimated. The goal is to make use of the composite supplies with manufacture of thermal insulation for buildings. Thermo physical property measurements of composites were bought utilizing the method of a periodic temperature slope. The implications have shown that the incorporation of date palm tree fibers induces a lower in each thermal conductivity and thermal diffusivity. This demonstrates that the thermal conductivity of the insulating plate realized in our laboratory to be to be more important in palm fibers more essential than date palm tree fibers [13].

2.6 Thermal degradation of kenaf and pineapple fiber

The finding of this investigation demonstrated that NaOH treated fiber explicitly the kenaf and mengkuang delivered higher greatest pinnacle temperature than the UT strands. Notwithstanding, for glass progress temperature, the treated PALF, kenaf and mengkuang fiber, the result demonstrated lower an incentive when contrasted with the untreated fiber. Further examination needs to investigate on physical properties testing, for example, the water assimilation, softening point and thickness. The DSC examination results that can just give glass progress temperature. The examination of warm properties for PALF, kenaf and mengkuang strands could bring an improvement of utilizing characteristic fiber composites for the utilization of creating the games gear [12].

2.7 Thermal degradation of hair fiber

The effects of the loading of fibres and the alteration of the surface on the HF-/HDPE-reinforced composites have thermal properties been investigated. The thermal characteristics (TGA, DTG and DSC) is enhanced by the application of the surface modification of AT fibres 0.25-N. Via the implementation of more therapies (0.5-N AT) on HF, the fibre properties were reduced because of the Fiber Surface Fracture. Compared to untreated and other levels of AT-reinforced composites, the degradation of the 0.25-N AT 15 percent HF-/HDPEreinforced composite showed optimal performance. It has been observed that the exothermic peaks have moved to a higher temperature of the 0.25-N treated fibre compared with the untreated and another stage of AT fibre in DTA analysis [18].

2.8 Thermal degradation of sisal fiber

DSC studies have shown that the mode of sisal degradation Fiber is a feature of the environment involved. In inert ambience, The DSC curves showed distinct peaks for each portion of the Sisal fibres, and two exothermic peaks in the air are watched. Cellulose degradation in inert environment whereas in the oxidative atmosphere, endothermic processes occur, It happens by exothermic processes. The withdrawal of lignin Holocellulose and cellulose thermally degraded from fibre occurring in both inert and oxidant at lower temperatures, Atmospheres, since the thermal usability of these constituents is simpler. The TGA studies have corroborated DSC’s results the degradation actions of sisal fibre and its degradation help to summarise for constituents the finding has been that sisal thermal degradation fibre has better results compare to other fibers [21].
| Fiber       | Peak Temperature of Derivative Weight Change (°C) | Residue (wt. %) |
|------------|---------------------------------------------------|-----------------|
| Jute       | 335-350                                           | 14-19           |
| Kenaf      | 380-430                                           | 10-13           |
| Pine apple | 220-280                                           | 26-62           |
| Sisal      | 300-375                                           | 20-45           |
| Palm       | 220-270                                           | 18-55           |
| Borassus   | 350-400                                           | 22-65           |
| Lignocellulose | 200-400                                         | 18-40           |

3. Conclusions

- The work made on a review of thermal properties of natural fibers such as jute, kenaf, maize, palm, pineapple, and Lignocellulose and Borassus fibers.
- Apparently, the thermal activity of natural fibres brings a Correlation with their chemical constituents, such as cellulose, lignin, and hemicellulose.
- Weight loss initially in natural Fibers are correlated with temperatures between 50 and 100 °C Hydroxyl groups evaporate from the fibre surface.
- Thermogravimetric isothermal and non-isothermal Study shows how pyrolysis acts in both the process.
- In advanced polymer composites, enhancing thermal stability in natural fiber-reinforced polymer composites is of great concern about materials.
- There are several works mentioned above in Different conditions that could be helpful for a particular reason in choosing products.
- However, the composites of natural fiber-reinforced polymers are being studied to improve their thermal resistance properties.

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