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A Novel Comparative Study: Synthesis, Characterization, and Thermal Degradation Kinetics of a Copolymer and Its Composites with Activated Charcoal

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Abstract: *A novel composite was prepared by using a copolymer involving 2-amino 6-nitrobenzothiazole– formaldehyde copolymer and activated charcoal. Physicochemical analysis, elemental and spectrum analysis were used to characterize the produced copolymer and its composite. SEM and thermogravimetric analysis (TGA) was used to study the surface morphology and thermal stability of the copolymer and its composites, respectively. The composite produced better results, which could be attributed to the particle size, porous nature, and increased surface area. The thermal stability of the copolymer and its composite had been improved. The thermodynamic kinetic parameters activation energy, free energy, apparent entropy, frequency factor, and entropy change were also estimated from TG data using the Sharp-Wentworth and Freeman-Carroll methods, and the findings were found to be similar. First-order kinetics were used to decompose the copolymer and its composite. The copolymer and its composite decomposed using first-order kinetics.*

Keywords: Composites; Charcoal; Activation Energy; Thermogravimetric; Free Energy.

I. INTRODUCTION

Polymeric materials have worldwide uses in polymer science and innovation have been growing quickly and pulled in much consideration towards the polymer researchers. Polymers have been discovered to be helpful applications as adhesive [1], high-temperature, fire-proofing coating materials [2], semiconductors, catalysts, and ion-exchange resins[3]. Terpolymer has been synthesized by the various researcher by different polymerization methods to examine its advanced applications. In recent year, terpolymer was synthesized by using monomers like 2,4-dihydroxyacetophenone-dithiooxamide-formaldehyde[4]8-hydroxyquinoline-guanidine-formaldehyde[5], resorcinol–urea-formaldehyde[6], salicylic acid-thiourea-trioxane[7], 2-hydroyacetophenone-oxamide-formaldehyde [8], 2,4-dihdroxypropiophenone-biuret-formaldehyde [9], 2,2'-dihdroxybiphenyl-urea-formaldehyde [10]. Several researchers have synthesized and characterized various copolymers to study their thermal stability. Further, various polymers and itscomposite have also been studied for the thermal behavior and decomposition kinetics.

Thermal analysis is an important property of polymer as it gives information about thermal stability and processability of the synthesized polymer [11] also it is used to determine the structure and properties of materials [12]. To incorporate polymers having various practical applications, there is a need to explore the impact of heat on the polymers to set up their thermal stability. The thermal behavior study of terpolymers gives the data of degradation of various groups produced in different temperatures and environments[13] The study reported that the TGA technique can be applied to 2,4=dihydroxybenzoic acid –melamine-formaldehyde copolymer to evaluate the activation energy by nonisothermalthermogravimetric methods [14].The thermal stability of copolymer derived from 2-Hydroxyl, 4-methoxybenzophenone, 1,5- diaminonaphthalene, and formaldehydewere determined using Sharp-Wentworth and Freeman-Carroll methods [15]. Terpolymer resin derived from salicylaldehyde, ethylenediamine and formaldehyde