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Evaluating the thermal behavior of materials and determining the kinetics of thermal phenomena for industrial applications

Abstract: In the industry, there is a constant demand for advancements in material technology to develop new products. Thermal stability is a critical factor for the development and application of materials. Among the most crucial aspects are the thermal properties, as temperature plays a key role in various unit operations for transformation purposes. Thermoanalytical techniques, such as thermogravimetry (TG) and differential scanning calorimetry (DSC), are particularly important for evaluating thermally reactive or sensitive materials. Thermodynamic properties such as the specific heat capacity (Cp), glass transition (Tg), solid-liquid and solid-solid transitions, melting range, crystallization, heat-induced polymorphic conversion, thermal stability, and enthalpy variation (DH) were determined. Consequently, research on identification, characterization, pre-formulation, compatibility, and quality control is enriched with insights into the thermal behavior of materials.

By analyzing the enthalpy and mass variations during a controlled heating program, it is possible to establish a conversion factor (a) for the material and calculate the kinetic parameters, activation energy (Ea), effective collisions, and mechanisms based on the Arrhenius equation. This information is vital in determining the stability, manufacturing, and usage parameters of industry. Thermally stable materials maintain their chemical structures, physical properties, and performance throughout their storage, transportation, and use. For instance, stability is essential for preserving the efficacy and safety of drug products and preventing degradation or unwanted chemical reactions that could compromise patient safety. In industrial applications, beyond ensuring safe manipulation through temperature and heating time, calorimetry aids in safely determining the shelf life of products and provides essential insights across various sectors, including health and food. The thermal stability of health materials directly impacts their performance, reliability, and ability to meet regulatory standards in the healthcare industry.

Keywords: calorimetry, thermal analysis, critical material attributes, critical process parameters

Biography: Undergraduate Pharmacy at the Universidade Federal de Alfenas (Unifal-MG). Master of Science in Pharmaceutical Sciences from Unifal-MG. PhD in Pharmaceutical Sciences, Universidade Federal de Minas Gerais (UFMG). She holds the 1st and 4th Post-doctorate in Chemistry from UFMG, the 2nd Post-doctorate in Pharmaceutical Sciences from UFMG and the 3rd Post-doctorate in Pharmaceutical Sciences from the Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM). Research on the evaluation of thermal behavior and thermostability of materials and determination of kinetics in phenomena and phase transitions induced by heat.