Thermal hazard evaluation of autocatalytic reaction for benzoyl peroxide by DSC and TAM III

S. H. Liu, H. Y. Hou, C. M. Shu*
Department of Safety, Health, and Environmental Engineering, National Yunlin University of Science and Technology, 123 University Rd., Sec. 3, Douliou, Yunlin 640, Taiwan
*Corresponding Author’s E-mail: shucm@yuntech.edu.tw

Abstract
A new approach was employed to measure the autocatalytic reaction for benzoyl peroxide (BPO) combined with non-isothermal kinetic model and isothermal kinetic model by differential scanning calorimetry (DSC) and thermal activity monitor III (TAM III), respectively. In general, autocatalytic reaction will generally start with a slow rate, and then greatly accelerate as the reactant is consumed and the autocatalyst is produced. Because of this behavior, an autocatalytic reaction may require special design considerations under certain condition, such as the potential for runaway hazard with exothermic reactions. In this study, thermal hazard analyses were conducted with various products, benzoic acid, benzene, and phenol, which were deliberately selected to individually mix with BPO for investigating the degree of thermal hazard. First, DSC was applied to measure the heat of decomposition reactions, which can contribute to understand as well as glean the reaction characteristics and thermokinetic parameters of BPO at non-isothermal condition. In addition, we employed TAM III to assess the exothermic characteristics under isothermal circumstance, such as exothermic onset temperature ($T_0$), heat power, heat of decomposition ($\Delta H_d$), self-heating rate, peak temperature of reaction system, and time to maximum rate under isothermal conditions ($TMR_{iso}$). The present results clarified that the proposed procedure would obtain an evaluation for receiving information on thermal decomposition characteristics and reaction hazard of an autocatalytic reaction.

Keywords: Autocatalytic reaction; Benzoyl peroxide (BPO); Differential scanning calorimetry (DSC); Exothermic characteristics; Thermal activity monitor III (TAM III)

References