Investigating the Catalytic Effects of MOF-199 on the Thermal Decomposition of Ammonium Dinitramide (ADN)

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Understanding the decomposition behavior and combustion products of composite solid propellants is of significant interest. Nowadays, ammonium perchlorate (AP) is extensively used in composite solid propellants as an oxidizer [1, 2]. AP has the highest effective oxygen content among the oxidizers, i.e., its oxygen balance is up to +34%. However, since AP contains Cl, the combustion of AP-based propellants generates significant quantities of HCl as a reaction product [3], which is a toxic gas and its emission is an environmental concern. Moreover, the HCl produce a large amount of smoke in the tail of the rocket [4]. In order to overcome this problem, a new green oxidizer as a possible replacement for ammonium perchlorate (AP) has been investigated in the recent years. ADN is a metal-free energetic compound with the chemical formula of $NH_4N(NO_2)_2$ and is composed of ammonium cation (NH^{4+}) and the dinitramide anion ($N(NO_2)^{2-}$), It has a high oxygen balance (+25.8%), which is used in military explosives and smokeless solid propellants or green propellants [5]. In this work, the effect of MOF-199 on the thermal decomposition behavior of ADN was studied. Different compositions of ADN/MOF-199, i.e. 98:2, 95:5, 92.5:7.5, and 90:10%, were prepared by the solvent method and their thermal behavior has been studied by DSC. Accordingly, MOF-199, in spite of its low weight, improves the thermal decomposition behavior of ADN significantly. In addition, the rapid catalytic combustion of ADN/MOF-199 (90:10) was showed in a sharp exothermic peak. The results showed that MOF-199 can be introduced as an excellent catalyst for modifying the combustion of ADN, due to its porous structure, Lewis/Bronsted acid sites, and dispersed metallic sites

Keywords: Ammonium dinitramide, Thermal decomposition behavior, Decomposition temperature, Metal-organic frameworks, MOF-199.

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