

Reaction Kinetics for the Pyrolysis of Urea Phosphate

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Abstract : The production of the clear liquid fertilizer ammonium polyphosphate (APP) is best achieved by the pyrolysis of urea phosphate, as it produces a product that is free from any of the impurities present in the raw phosphoric acid it was made from. This is a multiphase, multi-step reaction that produces carbon dioxide and ammonia as gasses and ammonium polyphosphate as liquid products. The polyphosphate chain length affects the solubility and thus the applicability of the product as liquid fertiliser, thus proper control of the reaction conditions is thus required for the use of this reaction in the production of fertilisers. This study investigates the reaction kinetics of the aforementioned reaction, describing a mathematical model for the kinetics of the reaction along with the accompanying rate constants. The reaction is initially exothermic, producing only carbon dioxide as a gas product and ammonium diphosphate, at higher temperatures the reaction becomes endothermic, producing ammonia gas as an additional by-product and longer chain polyphosphates, which when condensed too far becomes highly water insoluble. The aim of this study was to (i) characterise the pyrolysis reaction of urea phosphate by determining the mechanisms and the associated kinetic constants, and (ii) to determine the optimum conditions for ammonium diphosphate production. A qualitative investigation was also done to find the rate of hydrolysis of APP as this provides an estimate of the shelf life of an APP clear liquid fertiliser solution.

Keywords : ammonium polyphosphate, kinetics, pyrolysis, urea phosphate

Conference Title : ICRKRR 2018 : International Conference on Reaction Kinetics and Reaction Rate

Conference Location : Paris, France

Conference Dates : August 27-28, 2018