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A Short Note to Photocatalytic Degradation of Methomyl Pesticide

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Abstract

The methomyl pesticides are among the

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extensively used pesticides for agricultural and several other purposes as well as applications. The massive use also created an alertly request to develop its mitigation and remediation through scientifically sounded processes to regulate this pesticide in to the environment. The photo catalysis attracted a significant attention in this regards due to its simple and environmental friendly prospects.

The present short note highlights the potential of photo catalysis process and its application towards the Methomyl pesticide environmental remediation. The chapter also discussed a detailed recent literature review to understand the scientific domain of this carbamate pesticide degradation through phtocatalysis.

Keywords—Carbamate, Pesticide, Photocatalysis, Methomyl, Catalysis.

Introduction

Those technologies that utilize the hydroxyl radical (·OH) for oxidation process known as Advanced oxidation processes (AOPs) [1]. In twentieth century, AOPs have received increasing attention by environmental scientist because of highly successful removal of various types of hazardous pollutants from waste water. Hydroxyl radical (·OH) is the most reactive

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species having oxidative potential 2.8 V, which makes non selective method to AOPs [2]. Various types of pollutants have been successfully degraded by AOPs. AOPs mainly classified in to two categories i. e. homogenous and heterogenous catalysis [3]. In homogenous catalysis reactant and catalyst are in same phase. In contrast, heterogeneous catalysis is a form of catalysis wherein the reactants and the catalysts are in different physical state, such as that one involving solid catalysts acting on substrates in a liquid or gaseous phase [4,5]. Photocatalysis is the type of hetegogenous catalysis. Recently photocatalysis attracted attention due to simple and environmental friendly procedure [6]. Various types of pollutant including dye, pesticides, pharmaceuticals etc. were easily degraded using this method. During catalysis various types of reactive spices including oxygen radical, hydroxyl radical, reactive oxygen and nitrogen species have been generated. These reacting species could easily degrade the pollutant in the presence of any light/energy source [7,8]. Various types of photocatalyst such as metal oxide, metal sulphides, ternary compounds, non-metal semiconductore and metal –nonmetal semiconductors have been already introduced by the environmental

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scientists [9]. Now a days a lot of work have been done the size and shape of the photocatalyst. Photocatalyst having various hierarchical structures have been top on the list of photocalyst. High Surface area, high surface to volume ratio and multiple reflection in the interior structure of the hierarchical structure could enhance the photocatalytic activity [10].

Carbamates are pesticide of large family. Firstly, introduced in 1950s as commercial pesticides. Various types of insecticides, herbicides, and fungicides, are present in carbamate family [11].

Pesticides are introduced into the environmental system through various unwanted processes. Therefore, they notified as the dangerous and major pollutants. In the present study Methomyl a carbamate pesticides has been used as the target molecule. A brief literature review has been done on degradation studies of this carbamate pesticide using photocatalysis.

Review of literature

Malato et al. studied photocatalytic degradation of methomyl using TiO_2 and photo-Fenton at pilot scale using solar light. They reported that methomyl difficultly degraded under experimental conditions but achieved 90 % mineralisation under experimental conditions [12,

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13]. Same studies have been done by Fernández-Alba et al. using same system. They reported that 100 % degradation of methomyl has been observed in 60 min and 100 min by photo-Fenton and TiO_2 respectively [14]. Poulios et al. studied methomyl degradation using TiO_2, ZnO photocatalyst and solar light system. They conclude that both photocatalyst degraded methomyl in 4 h under experimental conditions [15].

Tamimi et al. used TiO_2 and UV light heterogenous system for methomyl degradation. They concluded that 1.23 x 10^{-4} mol/l methomyl completely disappeared in 45 min. and 80 % TOC removed in less than 4 h [16]. Tomašević et al. used supported Iron catalyst (AlFe-pillered & Fe-ZMS-5) and visible light for the degradation of Methomyl. They reported both catalysts exhibit good photocatalytic activity under experimental conditions. Fe-ZMS-5 exhibit superior activity over AlFe-pillered [17,18]. A detailed study using various light source (UV, visible and solar light) and various catalyst (TiO2 and ZnO) as well as photo-Fenton system (AlFe-pillered & Fe-ZMS-5) have been carried out by Tomašević et al [19]. Tomašević et al. studied influence of polychromatic light on methomyl degradation using ZnO (merck) and various TiO2 (P-25

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Degussa, anatase, rutile). They reported that degradation rate was higher in acidic medium. [20] Juang et al. used UV/TiO_2 system for the methomyl pesticide degradation study. They concluded that that degradation rate was higher in basic medium pH 10 [21].

Barakat et al. used $CdSO_4$ doped TiO_2 nanoparticles for methomyl degradation under solar light. This is the first report where nanoparticles were used for methomyl degradation and successfully degraded in 1 h [22]. Pookmanee et al. applied TiO_2 nanopowder prepared by solvothermal process for degradation of methomyl. In this study experiments were performed using UV light. They reported TiO_2 synthesized at 100 °C for 2 h has exhibit highest degradation efficiency [23]. Ibrahim et al. performed heterogenous catalysis using TiO_2 supported activated carbon in presence of sunlight and UV light. They concluded that methomyl sample 57 of the COD value was degraded under sunlight and 60 under UV light [24].

We reported first time flowerlike BiOCl and solar light system for methomyl degradation. [2]. Boonprakob et al. used BiOI/ZnO film and visible light for photocatalytic studies of methomyl. They reported that

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0.25 mol % BiOI/ZnO film exhibit higher photocatalytic activity than pure ZnO, pure BiOI and commercial ZnO [25]. Tony et al. used amorphous and nanocrystalline TiO2 photocatalyst for the degradation of methomyl under UV light. Just half amount of nanocrystalline TiO_2 is sufficient for same degradation efficiency in comparison to amorphous TiO_2 [26]. Tomašević et al. used methomyl and its commercial product Lannate-90 using TiO2 and ZnO catalyst under Osram ultra-vitalux lamp (315-400 nm). They reported that degradation of pure methomyl was found slow than Lannate-90 [27]. Tomsavec et al. studied TiO_2/UV and ZnO/UV system for degradation of methomyl insecticide. They reported that ZnO is batter catalyst than TiO_2 under experimental conditions [28].

Conclusion

Photocatalysis is latest, simple, inexpensive and environmental benign method for environmental remediation. Various types of hazardous as well as persistent contaminants including the Methomyl pesticide etc. are good targets for photocatalysis process. The chapter review showed that selected catalysts including ZnO, TiO_2, BiOCl etc. have been successfully applied for the photo-degradation of

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Methomyl pesticide using photocatalysis. This short note also emphasized the potential of various energy zones including solar light and UV light in the photocatalysis process. 100% pure pesticide as well as commercial formulations also easily degraded using photocatalysis method. This short chapter has been worthy as an instant notes to understand the importance of photocatalysis in Methomyl pesticide degradation and the use of various types of selected catalyst in this process. The note surely create a curiosity in the new researches in the field of photocatalysis and help them to do further research and expand this technology in to the new horizons.

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