Development of efficient hybrid system for degradation of Abamectin pesticide based on the advanced oxidation processes

Abamectin is one of the widely used pesticides in veterinary medicine and agriculture, which its widespread usage poses a potentially serious environmental and health problem. Presence of Abamectin in the both ground and surface water resources can cause potential impact on the human health and environment due to its toxic and hazardous nature. The conventional treatment method such as adsorption, flocculation, coagulation, and biological treatment and membrane process have failed to mineralize or destroy the pesticides. These methods separated pesticides or transfer them to another phase which requires further separation process, leading to additional costs of operation unit. Therefore development of effective, non-toxic and low cost processing technology is an essential step in environmental protection.

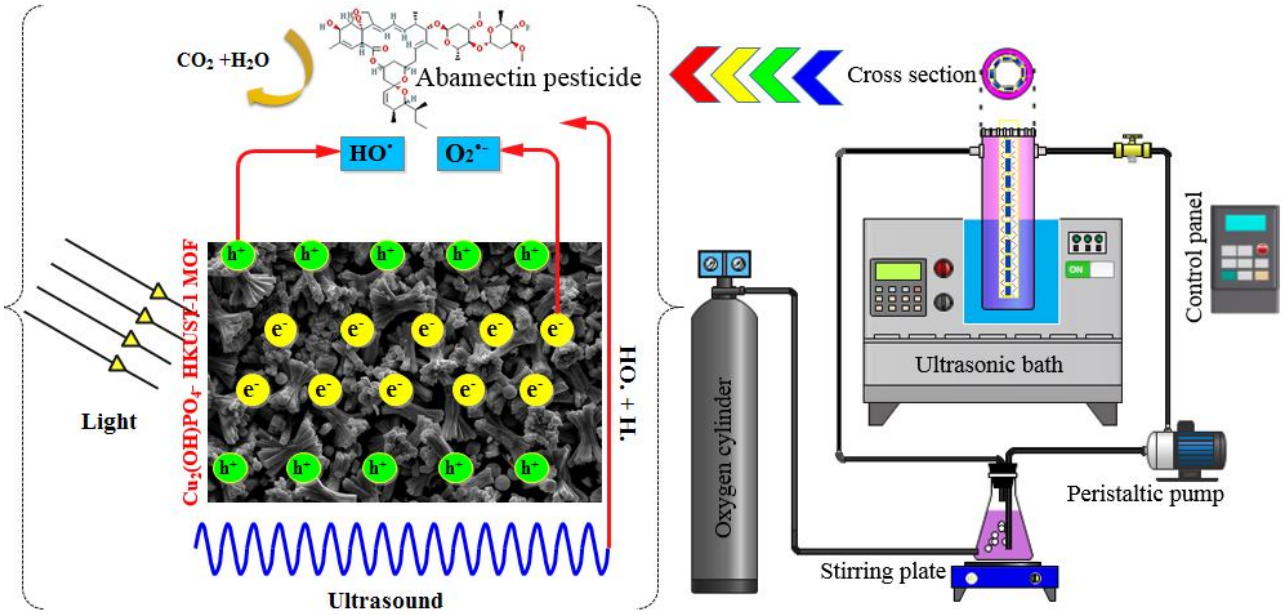

Fig. 1. Scheme of sonophotocatalytic system for degradation of Abamectin pesticide.

Recently, alternative technologies such as advanced oxidation processes (AOPs) were proposed to avoid the secondary pollutions and the perilous effects caused by the environmental contaminants. AOPs include various methods such as Fenton, photo-Fenton, sonolysis, photocatalysis and ozonation, etc. which operate based on the generation of hydroxyl radicals (•OH). In order to improve the degradation efficiency, hybrid systems including two or more individual AOPs processes can be used. The effective utilization of the ultrasound and its combination with the various AOPs is a great idea to achieve the maximum degradation of

environmental pollutants and avoids the secondary pollutants generation. In this research, combination of ultrasonic sound waves, visible light radiation and a catalyst was applied as an alternative, low-cost and effective technique for degradation of Abamectin pesticide (Fig. 1). The $Cu_2(OH)PO_4$-HKUST-1 MOF was synthesized as visible-light driven photocatalyst. The combination of photocatalysis and ultrasound indicated synergistic effects on the Abamectin degradation. The synergistic effects of ultrasonic refer to phenomenon of acoustic cavitation which is the growth of pre-existing bubbles and their collapse in a liquid. Cavitation creates the hot spots with extreme temperature up to 5000 ?C and pressures of about 2,000 atm with lifetimes of a few microseconds which causes mass transfer improvement ae well as leads to higher reaction rate. Furthermore, coupling of ultrasonic irradiation with photocatalytic process leads to the cleavage of dissolved oxygen and water molecules, which subsequently leads to generation of a greater number of oxidative free radicals, thereby increasing the rates of reaction. For the purpose of evaluation of the feasibility of the sonophotocatalytic process for the intensification of Abamectin pesticide degradation, synergistic index was used, which is the ratio of the sonophotocatalytic rate constant to the sum of the rate constants of the individual processes i.e. photocatalysis and sonocatalysis. Synergistic effect values greater than 1 show a positive effect. evaluation of the synergism in the combination of ultrasonic and photocatalysis lead to a synergistic index of 2.19, which reveals that coupling of ultrasonic and photocatalysis has a greater efficiency than the sum of individual procedures for degradation of abamectin. Removal of abamectin pesticide was carried out, using different treatment processes to investigate the contribution of each treatment process. The effect of operational parameters (initial pesticide concentration, pH, solution flow rate, photocatalyst dosage, oxygen flow rate and irradiation time) on the sonophotodegradation degradation process was investigated to find the optimal conditions for the purpose of achieving maximum efficiency based on the response surface methodology. Based on the results in the optimum conditions, the removal percentage of Abamectin using adsorption, sonolysis, photolysis, sonocatalysis, photocatalysis and sonophotocatalysis processes was found to be 4.20% 4.38%, 10.20%, 17.88%, 57.46%, 99.93%, respectively, which indicated that combination of ultrasonic cavitation and photocatalytic process lead to process intensification of Abamectin pesticide degradation.

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