DEGRADATION OF HERBICIDE ISOPROTURON USING RUO2 ELECTRODES

[1]VINAY KUMAR, [2]SHIVANI A GNIHOTRI, [3]MANISHA JAISWAL

[1]JSMB Agrodevelopers Pvt Ltd. INDIA,
[2]Thapar Institute of Engineering and Technology, INDIA.
[3]Shaheed Bhagat Singh State Technical Campus, INDIA.
E-mail: [1]Kumar.vinay@engineer.com, [2]Shivaniagnihotri81@gmail.com, [3]manishajaiswal23@gmail.com

Abstract - The impact of rapid population growth is directly exerting pressure on depleting freshwater resources in many parts of the world. Trace concentrations of numerous organic compounds (emerging contaminants (EC), and endocrine disrupting compounds (EDCs) such as pharmaceuticals and personal care products (PPCP), including prescription drugs and biologics, nutraceuticals, fragrances, sunscreen agents, and numerous others are reported in various wastewater effluents and aquatic systems. Herbicide industry is a large consumer of water, as well as a major wastewater generator, its effluents contain priority organic pollutants in very high concentrations which have severe effects on human health and on the environment due to their toxicity and bio-recalcitrant nature, persistence in the environment and bioaccumulation. More than three quarters of the total herbicide load of the effluent of the rural waste water treatment plant consists of isoproturon. Isoproturon is an herbicide especially used in Asia to control of annual grasses and broad leaved weeds in cereals. Its half-life in water is 30 days, in soils 40 days. The recent study basically deals with only which is tedious and requires large amount of energy. The present work discusses the treatment of isoproturon by electroxidation using RuO2 electrodes .The parameters varied were initial concentration of herbicide, pH of the sample solution, electrolyte concentration and time of degradation. The optimized degradation was found at 40ppm concentration of herbicide at pH 6 with an electrolyte concentration of 1g/l. The degradation time was observed to be 4 hours which was much less than 8 hours in the case of photo catalysis as studied in literature.

Keywords - Pesticides, Herbicides, Electroxidation and Isoproturon.

I. INTRODUCTION

To fulfill the requirement of human being industrialization and urbanization due to population growth are exerting pressure on the depleting freshwater resources in many parts of the world. Recent published UN report [1] mentioned that the worlds freshwater is not being used sustainably and calls for a radical rethink of policies to manage competing claims. The long-term sustainability of clean water supply is dictated by source water protection [2], management of water resources, and the efficiency of water reclamation from various effluents. Trace concentrations of numerous organic compounds [3] (emerging contaminants (EC), and endocrine disrupting compounds (EDCs)) such as pharmaceuticals and personal care products (PPCP), including prescription drugs [4, 5]

Many others are reported in various wastewater effluents and aquatic systems [6]. In acquisition to these, increasing levels of naturally occurring organic materials (NOM) directly linked to societal nutrient management practices are of serious consequence for managing water resources. These compounds in the form of their bioactive metabolites are continually being introduced to the aquatic environment as complex mixtures via various routes constituting both untreated and unsatisfactorily treated sewage [7]. Growing health and environmental concerns have made PPCPs of particular interest as prolonged exposure to low levels of PPCPs could have adverse effects on aquatic and terrestrial ecosystems and human health [8-10]. For example, extreme prolonged exposure to small levels (2-6 ng/L) of the synthetic estrogen utilized in birth control pills (ethynylestradiol-EE2) has been shown to affect wild fish populations in Canadian lake systems [3]. Earlier, many countries including Canada have relied on "dilution being the solution" for discharging of micropollutants, but with increasing populations along major waterways, increasingly high loads of micropollutants, and higher water demands, dilution is proving to be no longer a cheap, viable solution. The occurrence of micropollutants, therefore, poses problems for two major water management aspects, protection of source water, and reuse potential of a vast majority of municipal and industrial wastewater effluents.

The traditional techniques like secondary biodegradation cannot appreciably remove many of these contaminants of emerging concern. While advanced treatment technologies such as activated carbon and reverse osmosis can produce high quality water, they only transfer and concentrate the pollutants from one phase to another, requiring further processing to render the compounds inert.

II. RESEARCH AND METHODOLOGY

Main Objective of the study is to treat technical grade herbicides isoproturoun using electroxidation treatment. On the basis of the literature survey, isoproturoun is selected to carry out degradation .Different parameters were varied to obtain maximum

efficiency of degradation.

The study is undertaken considering the following objectives:-

1. To study the degradation of isoproturon using electroxidation process
2. Process optimization using parameters initial concentration of isoproturon, and pH.

A. Methodology

In EO (Electroxidation) process of wastewater treatment organic contamination are oxidized directly at the surface of the electrode or oxidizing agent is generated electrochemically to perform oxidation. This research reports the use of electro-oxidation for the treatment of textile wastewater with Ti/RuO_2 as a cathode and stainless steel plate as an anode. Experiments were conducted in a batch setup to investigate the effects of current (I), pH, time on % degradation of isoproturon and initial molar concentration of herbicide isoproturon. Raw sample of technical grade herbicide isoproturon was purchased directly from market and was prepared in double distilled water.

III. RESULTS

Isoproturon urea is an herbicide used for pre and posts emergence control of many broadleaf weeds in spring and winter wheat barley and winter rye. The effect of operating parameters on % degradation of isoproturon was studied by electroxidation process. The experimental results and their interpretation regarding isoproturon degradation have been discussed in detail further.

A. Calibration curve for isoproturon

Because Calibration curve of isoproturon is prepared by plotting a graph between varying known concentrations ranging from 0-25mg/l and its maximum absorbance is at 240nm. From this graph we can calculate unknown concentrations for solution. Value for R^2 is 0.998 and slope is 0.051

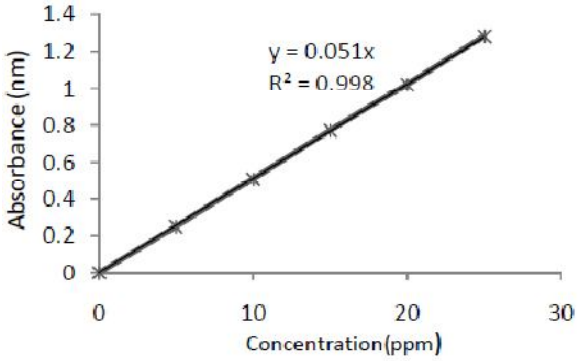


Fig .1 Calibration curve for isoproturon

B. Effect of pH on degradation percentage of isoproturon

Fig .2 shows the effect of the initial solution pH on the degradation percentage of 50 ppm isoproturon. All the experiments were conducted with an applied current of 1A with an electrolyte (NaCl) concentration of 0.5g/l. Isoproturon sample solution was maintained 1.5 l. concerning the degradation percentage of isoproturon. A decrease on the degradation rate was observed when the pH was increased from 6 to 8.

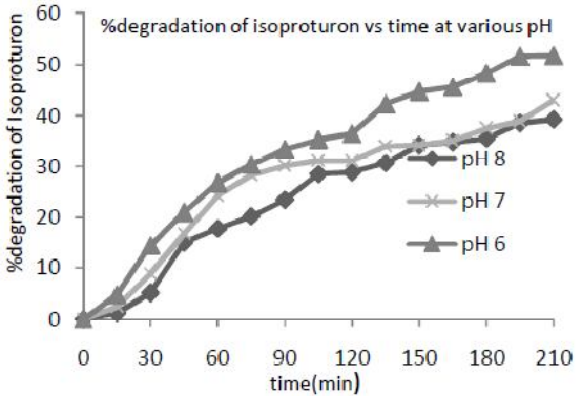


Fig .2 Effect of pH on degradation of isoproturon in wastewater

C. Effect of molar concentration on degradation percentage of isoproturon in waste water

From Fig .3 shows all the experiments that were conducted with an applied current of 1A with an electrolyte(NaCl) concentration of 0.5g at pH 6 with concentration 50 ppm and 10 ppm. Concerning the isoproturon degradation, the experiments demonstrate, as can be seen in Fig.5.3, that a decrease on the degradation rate constant was observed when the concentration was decreased from 50 ppm to 10 ppm.

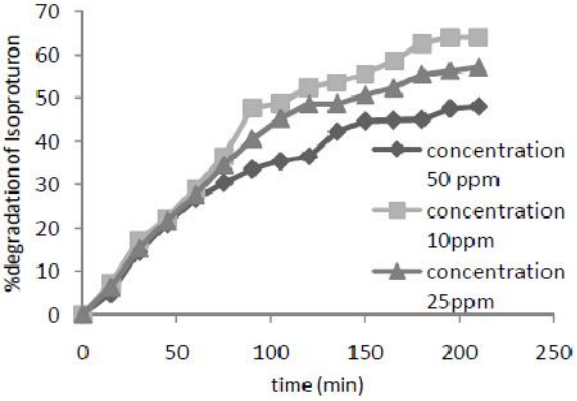


Fig .3 Effect of molar concentration on degradation percentage of isoproturon in wastewater

CONCLUSION

From the present study for degradation of herbicide isoproturon in wastewater by electroxidation method with Ti/RuO_2 coated plate as an anode and stainless steel plate as a cathode. The following conclusions were made during this work.

- Direct anodic oxidation process was observed where isoproturon is adsorbed on the anode surface followed by destruction by the means of the anodic electron transfer reaction which generates physically adsorbed “active oxygen” (adsorbed hydroxyl radicals, •OH) or chemisorbed “active oxygen” (oxygen in the oxide lattice, MO_{x+1}).

- The degradation was found to be effective in acidic pH. With the decrease in pH; the percentage degradation of isoproturon is increased.
- The degradation percentage was found to be effective at a current supply of 1A and an electrode spacing of 1 cm.
- The degradation percentage was increasing with the increase in the initial concentration of herbicide.

REFERENCES

[1] Ye X, Guo X, Cui X, Zhang X, Zhang H, Wang M, et al. Occurrence and removal of endocrine-disrupting chemicals in wastewater treatment plants in the Three Gorges Reservoir area, Chongqing, China. Journal of Environmental Monitoring. 2012;14:2204-11.

[2] Caliman FA, Gavrilescu M. Pharmaceuticals, personal care products and endocrine disrupting agents in the environment–a review. CLEAN–Soil, Air, Water. 2009;37:277-303.

[3] Kidd KA, Blanchfield PJ, Mills KH, Palace VP, Evans RE, Lazorchak JM, et al. Collapse of a fish population after exposure to a synthetic estrogen. Proceedings of the National Academy of Sciences. 2007;104:8897-901.

[4] Levine AD, Tchobanoglous G, Asano T. Characterization of the size distribution of contaminants in wastewater: treatment and reuse implications. Journal (Water Pollution Control Federation). 1985:805-16.

[5] Sun J-H, Sun S-P, Sun J-Y, Sun R-X, Qiao L-P, Guo H-Q, et al. Degradation of azo dye Acid black 1 using low concentration iron of Fenton process facilitated by ultrasonic irradiation. Ultrasonics sonochemistry. 2007;14:761-6.

[6] Stasinakis A. Use of selected advanced oxidation processes (AOPs) for wastewater treatment—a mini review. Global NEST Journal. 2008;10:376-85.

[7] Kulshrestha G, Mukerjee SK. The photochemical decomposition of the herbicide isoproturon. Pest Management Science. 1986;17:489-94.

[8] Manolikar M, Sawant M. Study of solubility of isoproturon by its complexation with β-cyclodextrin. Chemosphere. 2003;51:811-6.

[9] Merlin G, Vuillod M, Lissolo T, Clement B. Fate and bioaccumulation of isoproturon in outdoor aquatic microcosms. Environmental toxicology and chemistry. 2002;21:1236-42.

[10] Mahamuni NN, Pandit AB. Effect of additives on ultrasonic degradation of phenol. Ultrasonics sonochemistry. 2006;13:165-74.

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