Industrial Wastewater Treatment by Activated Carbon

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Abstract - *Water pollution is a major global problem. One of the main causes of ground water contamination is the effluent water released from industries. It's very important to protect surface and ground water from contamination. So there is a need for improving water treatment methods. The purpose of this study was to investigate the effect of activated carbon adsorption and advanced oxidation process for treating industrial wastewater. Activated carbon treatment is a simple and cost-effective means of treating domestic wastewater using the treatment mechanism adsorption. The effect of activated carbon on advanced oxidation process was also analysed. The results showed that the use of activated carbon in water treatment process shows maximum pollutant removal. Removal efficiencies obtained are 95.78% of DDT, 88.04% of Dicofol, 7.23% of chlorides, 6.80% of Total solids and 48.72% of Chemical Oxygen Demand. Also, the reduction of Chemical Oxygen Demand in advanced oxidation process is found to be 85.70%.*

***Key Words*: Activated carbon, Effluent water, Chemical oxygen demand, Advanced oxidation process, Adsorption, DDT, Dicofol**

1. INTRODUCTION

Water is the most essential component for life on earth. Waste water from various industries is often contaminated with various compounds such as: pesticides, total solids, dissolved organic compounds, etc., and it is important that it should be treated to an environmental acceptable limit. These organic compounds are difficult to decompose biologically, because these substances resist the self-purification capabilities of rivers and they cannot be removed by conventional treatment plants.

A pesticide is any substance, chemical, biological or otherwise, that is used for the purpose of preventing, destroying, or controlling pests. Pests may mean any species of plants or animals that interferes with the desired plants growth and harms its production, processing, storage, transport, or marketing. Pesticides also include substances that are used before or after the desired plant are harvested to protect it during storage and transport. Ideally, an applied pesticide would target only the specific pest that is bothersome. This would be a narrow-spectrum pesticide. However, most pesticides are broad-spectrum and their effects cannot be limited to target individual pests. Beneficial organisms may be damaged by pesticides as well.

The purpose of this research was to investigate a wide range of treatment methods for removing pesticides from wastewater. This end was accomplished by experimenting with techniques that range from new technologies to traditional methods used in the water treatment industry. Common pesticides DDT, DICOFOL were used as examples from the organochloride families of pesticides, to study the effectiveness of treatment methods for multiple types of pesticides. The data acquired for each treatment method was then evaluated against each other to determine the relative effectiveness of both methods, in addition to inferring reasons for a methods success or failure.

1.1 Treatment by Advanced Oxidation

Advanced oxidation processes are used to oxidize complex organic constituents found in waste water that are difficult to degrade biologically into simpler end products. When chemical oxidation is used, it may not be necessary to oxidise completely a given compound or group of compounds. AOPs rely on in-situ production of highly reactive hydroxyl radicals (•OH). These reactive species are the strongest oxidants that can be applied in water and can virtually oxidize any compound present in the water matrix, often at a diffusion controlled reaction speed. Consequently, •OH reacts unselectively once formed and contaminants will be quickly and efficiently fragmented and converted into small inorganic molecules.

Hydroxyl radicals are produced with the help of one or more primary oxidants (e.g. ozone, hydrogen peroxide, oxygen) and/or energy sources (e.g. ultraviolet light) or catalysts (e.g. titanium dioxide). The AOP procedure is particularly useful for cleaning biologically toxic or non-degradable materials such as aromatics, pesticides, petroleum constituents, and volatile organic compounds in waste water. Additionally, AOPs can be used to treat effluent of secondary treated wastewater which is then called tertiary treatment. The contaminant materials are converted to a large extent into stable inorganic compounds such as water, carbon dioxide and salts, i.e. they undergo mineralization. A goal of the waste water purification by means of AOP procedures is the reduction of the chemical contaminants and the toxicity to such an extent that the cleaned waste water may be reintroduced into receiving streams or, at least, into a conventional sewage treatment.

1.2 Generation of Pesticides

There are mainly two generations of pesticides. First generation pesticides refer to the pesticides commonly produced and used prior to the 1940's. These first generation pesticides were organic pesticides, naturally-occurring, typically withdrawn from plant compounds. When drawn from plants, pesticides are called botanicals. They do not persist in the environment and are easily degraded, but can be very toxic to aquatic life before they have degraded.

Second generation pesticides refer to synthetic pesticides produced after the 1940's, which are modified forms of botanicals to have more targeted effects on pests. These can be more poisonous than first generation pesticides and are more likely to persist in the environment. Their persistence depends on their class and type of pesticide. Currently, over 2,000 types of pesticide products are commercially available.

Organo-chlorine pesticides were not as widely used today since they have a high potential for chronic health effects and they persist in the environment for months or even years. These chlorinated hydrocarbons are broad-spectrum and are primarily used as insecticides. They can include chlorinated ethane derivatives such as DDT, cyclodienes, and hexa-chloro-cyclohexanes, etc. DDT has effects on the human immune system .The most famous type of organo-chloride insecticide is DDT(dichlorodiphenyltrichloroethane) perhaps one of the most well-known of all pesticides.

Organophosphates (OPs) are insecticides that contain phosphorous and kill insects by targeting an enzyme that regulates the neurotransmitter acetylcholinesterase, disrupting brain function. Following the decreased usage of organochloride insecticides, organophosphates have become the most widely used today. Some organophosphates are highly poisonous, comparable to poisons such as arsenic and cyanide. However, they degrade in the environment readily and do not have long-term environmental effects. Some examples of organophosphates include glyphosate, dimethoate, malathion, monocrotophos, chlorpyriphos etc.

Carbamate pesticides are insecticides that were derived from carbamic acid and functions in a way similar to organophosphates, inhibiting the cholinesterase enzymes. Like the other types of insecticides, these can affect the human nervous system with routes similar to those that affect the target insects. Respiratory problems result from poisoning, but the inhibition of acetylcholinesterase is reversible so short-duration exposure may not be extremely detrimental.

Pyrethroids were synthesized to have the same effects as the naturally-occurring pesticide pyrethrum, extracted from the chrysanthemum flower, but be increasingly stable without persisting in the environment. They are widely used. An example of a pyrethroid is cypermethrin. However, the effects of pyrethroids on the human immune system have not been extensively studied since they were developed relatively recently. There are hundreds of types of each of these 4 types of chemical pesticides.

Dermal contact is responsible for the majority of pesticide poisonings, typically during pesticide application, handling, or other routine uses. Ingestion and inhalation are the other means. The seriousness of dermal exposure and the degree of the effects then depend on the rate of absorption of the substance through the skin, the size of the area of skin exposure, the length of contact time, the number and concentration of the substances that contacted the skin, and the level of toxicity of the pesticide. Pesticides that volatilize can be inhaled from the atmosphere. Eye irritation can also result from direct contact with pesticides. Acute toxicity levels are measured by the half lethal dose, or LD50: the dosage at which 50% of animals exposed to the substance were killed. The lower the LD50 is for a particular pesticide, the greater the toxicity.

2. MATERIALS AND METHODS

High purity pesticide samples of Di-chloro Di-phenyl Tri-chloroethane [DDT] and Dicofol are used for preparing the synthetic effluent. Specified quantity of these pesticides are weighed accurately, dissolved in minimum quantity of methanol and diluted with distilled water to get a solution containing 100 ppm each of the pesticides. This is used as the working solution of pesticide removal using activated carbon adsorption technique.

Activated carbon made from coconut shell is used in the study. All the reagents used are of HPLC (High Pressure Liquid Chromatography) grade. All glass wares used are of Borosil. All glass wares are rinsed with concentrated sulphuric acid and then repeatedly washed with distilled water followed by drying in an air oven at 110^0C for 5hrs.

Wastewater sample was collected for analysis. Initially pH of the sample is noted. If pH of the sample is above 7.5, it is lowered and neutralized to the range of 6.5-7.5 by using Sodium hydroxide or any base solution. Then, Activated carbon is added to each 500 ml sample in different amounts (100 mg,250mg,500mg,1000mg,1500mg,2000mg). The solution is mixed well in agitator so that activated carbon is thoroughly mixed. The sample is then filtered and the characteristics of the sample is noted before and after the addition of activated carbon.

The quantification of the pesticides was performed with Agilent Gas Chromatograph (GC) fitted with electron capture detector [ECD]. The chromatogram is then obtained. Identification and quantification of pesticides were accomplished using reference solutions of analytical grade pesticides. The minimum detection limit for pesticides in water is 0.1 μg/ l. The initial calibration of the GC was carried out by injecting, suitable amounts of standard pesticide solutions. Analysis of the solvent blanks confirmed the absence of any of the pesticides under investigation in the solvent.

Firstly, 500ml effluent water sample is taken. To this, ferrous alum(3g,4g and 5g respectively) and 30ml 50%

hydrogen peroxide is added. It is then agitated for 1 hour. Note the pH of the solution. From this, 100ml is removed for analysis. To the remaining water, add lime till pH becomes 11. It is then agitated for 45 minutes. From this, again 100ml is again removed for analysis. To the remaining water, add 1g activated charcoal. Agitate it for 30 minutes. Filter the solution and keep it in a beaker. Then each three samples are tested for COD.

Initially the samples of different pH (i.e.,pH 3, 7 and 11) are tested for COD. The sample which gives maximum reduction in COD is noted and thus, pH is optimized. Further tests are carried out in samples with the optimized pH value alone.

3. CONCLUSIONS

From this study, it can be concluded that activated carbon treatment is very much effective in the reduction of Pesticide content, Chloride content, Total solids and COD from waste water. As the amount of activated carbon is increased, the removal efficiency of various parameters also get increased. But, after 1000 mg addition of activated carbon, further reduction in the properties are negligible. In this study DDT concentration reduces to 1.4 ppm and Dicofol concentration reduces to 5 ppm by the addition of 1000 mg of activated carbon. Removal efficiencies are are 95.78% of DDT, 88.04% of Dicofol, 7.23% of chlorides, 6.80% of Total solids and 48.72% of Chemical Oxygen Demand.

Results showed that activated carbon addition is very effective for removing inorganic characteristics of industrial wastewater. Combination of activated carbon with advanced oxidation process showed a large increase in the reduction of chemical oxygen demand of the waste water. The reduction in COD was found to be 48.72% by the addition of activated carbon in to the water sample, but further when this addition was in-cooperated with advanced oxidation process the reduction in COD increased to 85.7 %.

The result obtained from comparative study of COD reduction between simple adsorption technique and advanced oxidation process showed that Advanced oxidation process shows higher removal efficiency.

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