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Electrochemical Oxidation of Industrial Waste Water after Secondary Treatment

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Abstract- **In recent years, there has been increasing interest in finding innovative solutions for the efficient removal of contaminants from water, soil and air. Electrochemical oxidation has gained increasing interest due to its outstanding technical characteristics for eliminating a wide variety of pollutants normally present in waste-waters such as refractory organic matter, nitrogen species and microorganisms.**
Effluents from landfill and a wide diversity of industrial effluents including the agro-industry, chemical, textile, tannery and food industry, have been effectively treated by this technology. Here we will deal with the process of electrochemical oxidation, which is proposed as an alternative for treating polluted waste water. We will be focusing on reduction of the COD of the industrial waste water after secondary treatment.

Index Terms- **Electrochemical reactor, Wastewater Treatment, Anodic oxidation, Electro-oxidation.**

1. INTRODUCTION

In 1990, the countries forming the Organization for Economic Co-operation and Development (OECD) produced 1430 million tons of industrial waste corresponding to 68 % of the world's industrial waste and approximately 90 % of the hazardous and special waste. This amount increased to 1930 tons in the year 2004. Most statistics predict an increase of 40-60 % in pollution generated from chemical processes over the next decade.

The contribution of the chemical industry to the overall worldwide pollution is considerable but in general it is overestimated in comparison to the pollution caused by industries dominating other areas of everyday need, for instance, energy production by fossil fuels burning, transportation and agriculture. In the light of new ever more stringent and more rigidly enforced environmental regulations, the following guidelines should be implemented by the chemical industry in the 21st century and beyond:

1. Avoid and minimize waste, as a priority,
2. Eliminate, recover and recycle waste,
3. Achieve ecological acceptable and benign waste disposal,
4. Significantly lower pollutant generation and power in chemical process industry (CPI), e.g. by using fuel cells which are essentially pollution-free as no combustion of fossil fuels is involved and
5. Clean energy generation and storage.

The United Nations Environment Program (UNEP) defines cleaner production as involving "the continuous application of an integrated preventive environmental strategy to processes and products to reduce risks to humans and the environment". Many options exist in the waste-management hierarchy including; source reduction, recycle and reuse, end of-pipe treatment and suspension of production.

Throughout the chemical process industries, there has been an overwhelming tendency to focus on end-of-pipe treatments to meet environmental regulations. For example, in a high yield process for the production of organic dyes, one ton of by-products and auxiliaries such as solvents and catalysts may arise per one ton of finished dye. The waste is either dumped or treated at the end of the process together with waste from other processes. The traditional approach to waste-water treatment by centralizing the waste streams according to the slogan "dilution is the solution of pollution" is no longer acceptable (ocean dumping is becoming a serious concern). The practice of precipitating metals as hydroxides, carbonates or sulfides which are dumped in landfills, together with poorly soluble organics, such as printed circuit boards (PCBs) is unacceptable for environmental and economical reasons. These "postponing" methodologies offer little scope for recovering valuable process materials and are merely a transfer of waste from one environmental medium to another, often in a highly diluted form. A potential problem in wastewater is the number of pharmaceutical compounds and their degradation products, being detected in the environment. The first priority for the chemical industry must be to avoid wastes, preferably by using clean production techniques (zero/low effluent technologies), minimal amounts of chemicals, water and energy.

Zero discharge has been a long-time goal for firms in the chemical process industries but few organizations have actually achieved it.

Zero discharge is not a compelling goal for most CPI. Even if zero discharge could be achieved it would involve high costs and environmental problems for others. Discharging a weak solution of salt, free of toxic materials, may be more environmentally safer than zero discharge as many solid salts cannot be eliminated (e.g. landfill may be used) without some form of encapsulation. Waste-water discharge permits bear enormous paperwork requirements and harsh enforcement penalties. A zero discharge strategy can avoid these problems.

Biological treatment of waste water has become the most important process controlling the pollution of the aquatic environment by organic chemicals from municipal and industrial sources. The degradability of organic chemicals in a sewage plant depends strongly on the nature of the chemical compounds involved.

Some of the chemicals that get into the waste water from industrial processes are degradable to such a small extent that they pass through the municipal sewage plants and accumulate in the environment. Legal practice in most countries has been to define a percentage of the chemical oxygen demand (COD) of a given waste stream which has to be removed by the biological treatment. In Germany for example, this ratio has been at 75%, in Switzerland 85%. It is most likely that the regulations will be tightened in the near future and that, as a consequence either industrial production will have to be changed and/or the treatment of industrial waste water will need additional processes in order to conform with the legal requirements.

Fate and health risks associated with persistent organic pollutants present in water effluents are one of the major environmental challenges of this century.

2. ELECTROCHEMICAL OXIDATION

Electrochemical oxidation has gained increasing interest due to its outstanding technical characteristics for eliminating a wide variety of pollutants normally present in waste-waters such as refractory organic matter, nitrogen species and microorganisms. The strict disposal limits and health quality standards set by legislation may be met by applying electrochemical oxidation.

Effluents from landfill and a wide diversity of industrial effluents including the agro-industry, chemical, textile, tannery and food industry, have been effectively treated by this technology.

In this method of electro-oxidation, the effluent or the waste water behaves as a electrolyte and various electrodes (discussed later) are used.

The electrodes are connected to the electricity supply via rectifier and the electrodes are dipped into the electrolyte.

When electricity is passed through electrodes then at anode oxidation takes place. This method is also referred to as anodic oxidation (AO). At anode Hydroxyl ions (●OH) are formed. This (●OH) oxidizes the organic pollutants from the waste water.

3. EXPERIMENTAL PROCEDURE

- Take reactor and clean it properly with tap water. Fill water in the reactor and check for any of the leakages.
- Now, take two electrode plates and connect one side of both the electrodes with wires.
- Now keep electrodes in the groves. Give connection of electrodes to the power supply, one to positive and one to negative.
- Positive electrode is Anode and negative one is Cathode(Titanium Electrodes are used).
- Fill 500 ml of sample liquid in the reactor. Start power supply and adjust the required Volt. Ampere reading will be set automatically on the basis of conductivity of the liquid. Run the batch for required time.
- Keep watch on Ampere reading as it will reduce as time passes.
- After desire time period, switch off power supply and take out the electrodes from the reactor.Take

out treated sample in the sample bottle and then measure the COD.

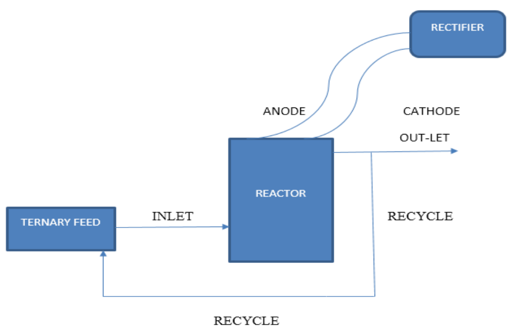
- Compare initial and final COD. It is also done by recycling the feed as shown in figure.

3.1 Reactor Specification

I have prepared acrylic batch reactor having dimensions:

L= 9.4 cm, B= 6.3 cm, H= 12 cm.(500ml) It has grooves at every 04 mm, to fit in electrodes within it. It has two nozzles, input at lower end and output at upper end. It can also be used in a continuous pattern.

Fig. Schematic Diagram



4. RESULTS

Time(mins)	Sample Quantity (ml)	Electrode Gap(mm)	Volt (V)	Initial Ampere	Final Ampere	Initial COD(ppm)	Final COD(ppm)
60	500	08	4.0	0.88	0.70	1000	600
60	500	12	4.0	0.87	0.70	1000	640
60	500	16	4.0	0.88	0.72	1000	800
60	500	12	3.5	0.50	0.37	1000	700
30	500	08	4.0	0.84	0.75	1000	700
30	500	12	4.0	0.65	0.58	1000	750

1. Result Table

5. CONCLUSION

- On reducing electrode gap, at constant parameters, COD reduction increases.
- Reducing Voltage will reduce the COD reduction, eventually it will increase the time for the treatment.
- Reduction of COD will increase with increase in time.
- Decolourisation of sample will take place.
- Ampere will be reduced at constant Voltage, as conductivity of the sample will reduce.

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