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Treatment of Car Wash Wastewater by Electrocoagulation Using Moringa Olifera as a Absorbent: A Review

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ABSTRACT
Water is used for many purpose, nowadays scarcity in water as proved by the survey. So the only way to save water is treating the wastewater. The car wash wastewater is treated and it is reused. The wastewater contains surfactants, COD, oil and greases .The effective and advanced method to treat the car wash waste water by electrocoagulation process. This process is most effective in removal of oil and grease.The parameters pH, turbidity, chemical oxygen demand, total dissolved solids, colour is tested in wastewater. Moringa olifera is used as a natural absorbent to treat the water before electrocoagulation. This paper clearly shows the result of waste water treated after adding natural absorbent and electrocoagulation process.

Keywords: *Car wash wastewater, Electrocoagulation, moringa olifera, reuse, benefits of EC, drawbacks of EC.*

1.INTRODUCTION

One of the basic requirements of a human being is Water. Globalization, un-controlled population and other factors are creating shortage of pure water and the issue is a concern for many countries. Thus, it becomes imperative to think about water purification using effective and inexpensive techniques and its reusability. The number of cars have increased on roads, so has the population; the demand of water being used all over the world to wash the cars is also increasing, as washing should be done in a periodic interval as a maintenance of car. The effective utilization of water resources, reuse of car wash water in an important subject [1],[2]. In many places around the world,car wash water has been directed into underground basin, rivers and sea.This waste water contains detergent, dirt, grease, oil and pollutants.

Electrocoagulation process (EC) has been the subject of several reviews in the last decade, and is still a very active area of research. Most published works deals with applications for treatment of drinking water and urban, industrial or agricultural wastewaters so as to enhance the simultaneous abatement of soluble and colloidal pollution. These also include contributions to theoretical understanding, electrode materials, operating conditions, reactor design and even techno-economic analysis. Even though, the numerous advantages reported in the literature, and the pros and cons of EC in comparison to alternative processes, its industrial application is not yet considered as an established wastewater technology because of the lack of systematic models for reactor scale-up.

M. oleifera (horseradish or drumstick tree), a nontoxic (at low concentrations) tropical plant found throughout India, Asia, sub Saharan Africa and Latin America whose seeds contain an edible oil and water soluble substance, is arguably the most studied natural coagulant within the environmental scientific community. It is widely acknowledged as a plant with numerous uses with almost every part of its plant system can be utilized for beneficial purposes. Moringa is most frequently used as food and medicinal sources within less-developed communities. It has been reported that rural communities in African countries utilize its crude seed extracts to clear turbid river water. Moringa oleifera is a tropical multipurpose tree that is commonly known as the miracle tree. Among many other properties, M. oleifera seeds contain a coagulant protein that can be used either in drinking water clarification or wastewater treatment [3],[4]. It is said to be one of the most effective natural coagulants and the investigation on these kinds of water treatment agents is growing nowadays. Researchers have identified the coagulant component from M. oleifera seed extract as a cationic protein. It is thought to consist of dimeric proteins with a molecular weight the range of 6.5–14 kDa. Using the crude extract as coagulant presented problems of residual dissolved organic carbon (DOC) which makes its use in drinking water not feasible. It is therefore necessary to purify the coagulant. However, the direct application of this isolated agent is not possible under the hypothesis of sustainable and appropriate techno-logy. Consequently, the search for simple and low cost purifications procedures as well as the use of the coagulant in combination with other coagulants and treatment processes needs to be adopted. Some examples of drinking water treatment using crude extract in pilot plant set up have been conducted.

2.RISK IN CAR WASHING WATER

The average water consumption for per car is 150 to 600 L [5].The origin of pollutants in water from car washing is from traffic pollutants and carwash chemicals. The traffic pollutants include road surfacing pollutants and atmospheric fall out pollutants that it requires 173L [6] of water to wash a car .The other important parameter is methylene blue active substances (MBAS).The MBAS method is useful for estimating the anionic surfactant contents of waters and wastewaters. Anionic surfactants are among the most prominent of many substances, and natural synthetic, showing methylene blue activity. Soap do not respond in the method. Nonsoap anionic surfactants commonly used in detergent formulations are strongly responsive to this method [7],[8]. The range of MBAS in typical car wash wastewater ranges from 3 to 68 [2]. Professional car wash systems create wash wastewater that can have a great impact on the environment if not properly managed and discharged. Contaminanats in wash wastewater can cause the worst environmental, include the following:

- Oil and Grease, chemicals, solvent -based solutions which are harmful to living organism.[9]
- Biodegradable soaps also imparts the same ; create bacterial population increase, transmitting through the food chain to protozoa, which are more sensitive to car wash toxins than other aquatic organism such as fish.
- All detergents will destroy fish mucus membranes and gills to some degree.The gills may loss natural oil interrupting oxygen transfer

3. METHODS OF TREATMENT

3.1.1.ELECTROCOAGULATION

In its simplest form, an electrocoagulation reactor is made up of an electrolytic cell with one anode and one cathode. When connected to an external power source, the anode material will electrochemi-cally corrode due to oxidation, while the cathode will be subjected to passivation.

An EC system essentially consists of pairs of conductive metal plates in parallel, which act as monopolar electrodes. It further more requires a direct current power source, a resistance box to regulate the current density and a multimeter to read the current values. The conductive metal plates are commonly known as "sacrificial electrodes." The sacrificial anode lowers the dissolution potential of the anode and minimizes the passivation of the cathode. The sacrificial anodes and cathodes can be of the same or of different materials.

The arrangement of monopolar electrodes with cells in series is electrically similar to a single cell with many electrodes and interconnections. In series cell arrangement, a higher potential difference is required for a given current to flow because the cells connected in series have higher resistance. The same current would, however, flow through all the electrodes. On the other hand, in parallel or bipolar arrangement the electric current is divided between all the electrodes in relation to the resistance of the individual cells, and each face on the electrode has a different polarity.

During electrolysis, the positive side undergoes anodic reactions, while on the negative side, cathodic reactions are encountered. Consumable metal plates, such as iron or aluminium, are usually used as sacrificial electrodes to continuously produce ions in the water. The released ions neutralize the charges of the particles and thereby initiate coagulation. The released ions remove undesirable contaminants either by chemical reaction and precipitation, or by causing the colloidal materials to coalesce, which can then be removed by flotation. In addition, as water containing colloidal particulates, oils, or other contaminants move through the applied electric field, there may be ionization, electrolysis, hydrolysis, and free radicals formation which can alter the physical and chemical properties of water and contaminants. As a result, the reactive and excited state causes contaminants to be released from the water and destroyed or made less soluble.

It is important to note that electrocoagulation technology cannot remove infinitely soluble matter. Therefore ions with molecular weights smaller than Ca^{+2} or Mg^{+2} cannot be dissociated from the aqueous medium.

3.1.2. ELECTRODE MATERIAL

Electrode material defines which electrochemical reactions take place in the EC system. Aluminium and iron electrodes have both been used successfully in EC systems. Aluminium dissolves in all cases as Al whereas there is some controversy as to whether iron dissolves as Fe. Most results indicate that iron dissolves as Fe, and is oxidised in bulk solution to Fe if there are oxidants, such as oxygen, present in sufficient concentration and pH is alkaline. Fe is a poor coagulant compared to Fe due to higher solubility of hydroxides and lower positive charge, which explains some poor results obtained with iron electrodes. Optimal material selection depends on the pollutants to be removed and the chemical properties of the electrolyte. In general, aluminium seems to be superior compared to iron in most cases when only the efficiency of the treatment is considered. However, it should be noted that aluminium is more expensive than iron. Inert electrodes, such as metal oxide coated titanium, are used as cathodes in some constructions. When water has significant amounts of calcium or magnesium ions, the inert cathode material is recommended .There are also some studies where combinations of aluminium and iron electrodes have been used to obtained high removal of colour with aluminium electrodes, while iron was more effective than aluminium in reducing COD from industrial wastewater. A combination of iron and aluminium removes both colour (71%) and COD (69%) with high efficiency. Similar results were obtained when paper mill wastewaters were treated with various aluminium and iron electrode combinations. Aluminium electrodes were most effective in removing colour of the wastewater, whereas iron electrodes removed COD and phenol from the wastewater more effectively than aluminium electrodes. A combination of aluminium and iron electrodes removed colour, COD and phenol with high efficiency. Combination electrodes have been studied for arsenic removal from groundwater Iron electrodes and a combination of iron and aluminium electrodes gave the highest arsenic removal efficiencies. Similar results were obtained for copper,chromium and nickel removal from metal plating wastewater. Fe-Al pair has been most effective in removing indium from water.

3.1.3. REACTIONS WITHIN THE ELECTROCOAGULATION REACTOR

Within the electrocoagulation reactor, several distinct electrochemical reactions are produced independently. These are:

- **Seeding,** resulting from the anode reduction of metal ions that become new centers for larger, stable, insoluble complexes that precipitate as complex metal ions.

- **Emulsion Breaking,** resulting from the oxygen and hydrogen ions that bond into the water receptor sites of emulsified oil molecules creating a water insoluble complex separating water from oil, driller's mud, dyes, inks and fatty acids etc.
- **Halogen Complexing,** as the metal ions bind them-selves to chlorines in a chlorine-ated hydrocarbon molecule resulting in a large insoluble complex separating water from pesticides, herbicides, chlorinated, pcbs etc.
- **Bleaching** by the oxygen ions produced in the reaction chamber oxidizes dyes, cyanides, bacteria viruses, biohazards, etc. Electron flooding of electrodes forced ions to be formed to carry charge into the water, thereby eliminating the polar effect of the water complex, allowing colloidal materials to precipitate and the current controlled ion transport between the electrodes creates an osmotic pressure that typically ruptures bacteria, cysts, and viruses.
- **Oxidation Reduction** reactions are forced to their natural end point within the reaction tank which speeds up the natural process of nature that occurs in wet chemistry, where concentration gradients and Solubility Products (KsP) are the chief determinants to enable reactions to reach stoichiometric completion.
- **Electrocoagulation Induced pH** swings toward neutral.

3.2.ABSORPTION WITH MORINGA OLIFERA

3.2.1.Reduction of turbidity

The optimum concentration of M. oleifera coagulant to reduce wastewater turbidity was 100 mg/L, while the ground water only need 80 mg/L of Moringa oleifera, which reduced 97.9% and 97.5% turbidity, respectively. M. oleifera coagulant has better coagulation capability to reduce water turbidity compared with PAC at concentration of 100 mg/L that was able to reduce turbidity by 89.6% in wastewater and 89.4% in ground water. When the coagulant was added to the sample and followed by rapid stirring, the resulting cationic protein from M. oleifera was distributed to all parts of the liquid and then interacted with the negatively charged particles that caused dispersed turbidity. Such interactions disturb the force that stabilize the particles, so that it can bind to small particulates to form precipitate. This process is called coagulation.

An additional advantage in this case is, that all the mud that comes from grain coagulation M. oleifera is biodegradable and is an organic material. Unlike alum, coagulation activity is strongly influenced by the natural alkalinity of the water itself. So it is necessary to add material, such as lime, to increase alkalinity or pH of the water that will be coagulated using alum. As a result, the sludge that is produced through this process has a larger volume than the one produced by the coagulant M. oleifera seeds[11]

3.2.2. Reduction of pH

At 95.0% confidence level, there was significant differrence ($p < 0.001$) among all the treatments at the varying loading dose concentrations on the pH. The recommended acceptable range of pH for drinking water specified by WHO (2006) is between 6.0 and 8.0 [12]. The treatments gave a range of 7.2 to 7.9 which falls within the reduced as the concentrations of the dosing solutions were increased. This could be explained by the fact that the solutions were becoming more acidic. This was attributed to the fact that the alum in the treatment procedure produced sulphuric acid which lowered the pH levels. The increase in acidity could be due to the trivalent cation aluminium which serves a Lewis acid. Thus it can accept a lone pair of electrons. The reverse was observed with the Mori-nga treatment. The pH increases with increasing concentrations of the Moringa coagulant. Ndabigen-gesere et al. (1995) reported that the action of M. oleifera as a coagulant lies in the presence of water soluble cationic proteins in the seeds. This suggests that in water, the basic amino acids present in the protein of Moringa would accept a proton from water resulting in the release of a hydroxyl group making the solution basic. This accounted for the basic pH values observed for Moringa treatments compared with alum treatments.

3.2.3.Reduction of heavy metals

Moringa oleifera seed acts as a natural coagulant, absorbent and antimicrobial agent. It is believed that the seed is an organic natural polymer. The coagulation mechanism of the Moringa oleifera coagulant protein has been described as adsorption, charge neutralization and interparticle bridging. It is mainly characteristic of high molecular weight polyelectrolyte. Analysis of the heavy metals cadmium, copper, chromium, and lead were performed before and after treatment of water with Moringa oleifera seed coagulant. The results showed that Moringa seeds were capable of adsorbing the heavy metals tested in some water samples. The percentage removal by Moringa seeds were 95 % for copper, 93 % for lead, 76 % for cadmium and 70 % for chromium. In this study the advantage of proposing a sequential process using coagulation with Moringa oleifera seed [14].

4. BENEFITS OF EC

- EC requires simple equipment and is easy to operate with sufficient operational latitude to handle most problems encountered on running.
- Wastewater treated by EC gives palatable, clear, colorless and odorless water.
- Sludge formed by EC tends to be readily settable and easy to de-water, compared to conventional alum or ferric hydroxide sludges, because the mainly metallic oxides/hydroxides have no residual charge.
- Flocs formed by EC are similar to chemical floc, except that EC floc tends to be much larger, contains less bound water, is acid-resistant and more stable, and therefore, can be separated faster by filtration.
- Removes heavy metals as oxides that pass TCLP.
- Removes suspended and colloidal solids.
- Breaks oil emulsions in waterRemoves fats, oil, and grease.
- Removes complex organics.
- Destroys & removes bacteria, viruses & cysts.
- Meet Discharge Requirements.
- Reduce Sludge Volume.
- Eliminate Chemicals.
- Process Multiple Contaminants.
- Process Waste Streams with up to 5% solids.
- Harvest Proteins, Oils, and Metals.
- It removes the smallest colloidal particles efficiently compared with the conventional chemical and biological techniques. Because the smallest charged particles have greater propability of being coagulated by the electric field that steps them in motion.
- Wastewater treated by EC gives palatable, clear, colourless and odourless water.
- Gas bubbles produced during electrolysis can enhance floatation
- It requires low maintenance cost with no moving parts.

5. CONCLUSION

This paper concluded saying that car wash waste water can be treated and reused by the advanced method of electrocoagulation and using the natural absorbent Moringa olifera which helps to reduce the parameter levels which will satisfy the required need of reuse of water.

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