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# TREATMENT OF CAR WASH WATER USING ELECTRO COAGULATION, CHEMICAL AND BIOLOGICAL PROCESS - A COMPARATIVE STUDY

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*Abstract:* Waste water generated from car wash service station contributes to majority of environmental contamination because of the chemical characteristics present in the car wash water. This research work compares the effectiveness of treating car wash water collected from car wash station located in Coimbatore using naturally available water hyacinth, chemical(alum) and electrocoagulation (Cu - Cu, Cu - Al, Al - Al) method. Different parameters like pH, turbidity, Chemical oxygen demand, oil and grease, total organic carbon were characterized for the collected car wash water. Oil and grease, Chemical oxygen demand contributes to majority of pollution. Experimental results show that electro coagulation method have better removal efficiency of oil and grease, Chemical oxygen demand and turbidity. Maximum Chemical oxygen demand removal efficiency of 61% and oil and grease removal efficiency of 70% has been attained by electro coagulation method. Water hyacinth has also shown a good result with Chemical oxygen demand removal efficiency of 50% and oil and grease removal efficiency of 54.5%. Electrocoagulation method has been found to give better results for the treatment of car wash water.

*Index Terms* - Electrocoagulation, turbidity, Chemical oxygen demand, oil and grease, Total organic carbon, car wash water.

## 1INTRODUCTION

Rapid urbanization has led to the growth of automobile industry. Usage of car, trucks, and bikes has been increased at an enormous rate which in turn necessitated the need to have an increased number of automobile service centers. Automobile service station undertake repair, washing and servicing of vehicles. According to the report provided by International car wash association, about 100-170 litres of water is used for a single car wash. Lots of water is used daily for vehicle washing and servicing. The consumption of water in car washing will shorten the urban water.

Water from the wash contains wide range of contaminants especially oil and grease, detergents, phosphates, chemicals and other hydro carbons (Fakhru'l-Razi et al. 2009). After washing, the water is discharged into the surface water which degrades the quality and cause harmfulness to aquatic life. Due to population increase usage of cars and vehicles has also increased. Even though its usage cannot be decreased, the water used for the wash can be treated, recycled and reused. Conventional methods used for treating the car wash water mixed with different pollutants are very costly and requires huge man power. So, the treatment has to be eco-friendly and cost effective too. This study compares the effectiveness of treatment of carwash water with the usage of easily available alum, free floating aquatic plant water hyacinth and electrocoagulation process with different combination of electrodes. The main objective of the study is to

treat the waste water and to achieve the maximum removal of chemical oxygen demand, oil and grease and turbidity.

## 2 COLLECTION AND CHARACTERIZATION OF CAR WASH WATER SAMPLES

The car wash water samples were collected at a car wash service station located at Coimbatore. Wash water was generated by washing different types of vehicles. The waste water generated is drained into the municipal sewage treatment system. The wash water is collected in a 10 litres capacity plastic container. Figure 1 shows the collected car wash water sample.

Fig 1. Car wash water sample collected

The samples collected were characterized for various parameters like pH, turbidity, chemical oxygen demand, total nitrogen, oil and grease, total organic carbon, conductivity as per IS codes (Dash and Nanda 2020). The different test results are compared with general standards for discharge of environmental pollutants as specified by central pollution control board (CPCB) 1986.

## 3TREATMENT METHODS

### 3.1 BIOLOGICAL TREATMENT PROCESS

Eichhornia crassipes or water hyacinth commonly found in lakes or ponds is used for the treatment. Water hyacinth has the capability of absorbing pollutants present in waste water and is suitable for cleaning industrial waste water. This water hyacinth has been collected from the nearby pond. About 3 liters of collected car wash sample is taken in the beaker. The roots of the water hyacinth are washed for the removal of dirt and any other impurities. The water hyacinth is placed in the beaker such that the roots are completely immersed inside the water(Dash and Nanda 2020). The plant is suspended inside the water for about 3 days. The suspended particles present in the water are absorbed by the roots. The sludge gets deposited at the bottom. the plant is taken out and the supernatant liquid is obtained by filtration and can be reused again for washing. Figure 2 shows the water hyacinth immersed in water at a) initial stage b) final stage.


a)initial stage b) final stage

Fig. 2 Water hyacinth immersed in water

### 3.2 CHEMICAL TREATMENT PROCESS

Potash alum (KAl (SO4 )2.12 H2O) is used for the treatment of carwash water sample. pH of the water sample was maintained at 7.5. Different dosage of alum was used for the treatment. 4 samples each of 500 ml were taken in a beaker. Different dosages of 100, 125, 150, 200 mg/l alum were used (Asha et al. 2016). Initially, agitation speed of150 rpm was set for 5 minutes. After 5 minutes, agitation speed was decreased to 50 rpm and allowed to stand for about 30 minutes. This results in the formation of flocs. The flocs are allowed to settle for about 30 minutes. The supernatant liquid is then collected and its characteristics are analyzed after the treatment. As the dosage of alum increases, the quality of the treated water also gets increased. Figure 3 shows the samples in the flocculator a) before treatment b) after treatment.


a) before treatment b) after treatment

Fig. 3 Flocculator

### 3.3 ELECTRO-COAGULATION TREATMENT METHOD

The lab scale reactor of size 15cmx7.5cmx30cm has been used for this experiment. The reactor is made of glass of 1cm thickness. Aluminum and copper electrodes of size 10cmx3cmx0.3cm dimensions with different combinations were used for the treatment process. pH of the samples was maintained at 5,7 and 9. DC power supply of about 12 voltage is maintained. Different combination like Cu-Cu, Cu-Al, Al-Al with a spacing of 2cm is maintained. The electrodes are cleaned with 15% hydrochloric acid solution before treatment. The samples are taken at an interval of 30 minutes, 60 minutes, 90 minutes (Mohammadi et al. 2017) . The samples taken at different intervals are checked for various characteristics. Figure 4 shows the electro coagulation set up.

Fig. 4 Electro coagulation set up

A little change in the colour of water was observed with the various electrode combinations. When Cu-Cu electrode combination was used there was a slight appearance of light green colour. Similarly, with the combination of Cu-Al electrode a light blue colour was observed. But the Al-Al electrode combination gave colourless appearance with very high efficiency. Figure 5 shows the colour variation of various electrode combinations a) Cu-Cu b) Cu-Al, c) Al-Al.

a) Cu-Cu b)Cu-Al c)Al-Al

Fig. 5 Colour variation of treated samples for various electrode combination

## 4 RESULTS AND DISCUSSION

### Characteristics of car wash water after treatment process

Figure 6 shows the variation of chemical oxygen demand with respect to various treatment methods. From the graph it is understood that electro coagulation method using Al-Al electrode combination has reduced the chemical oxygen demand to a greater level.

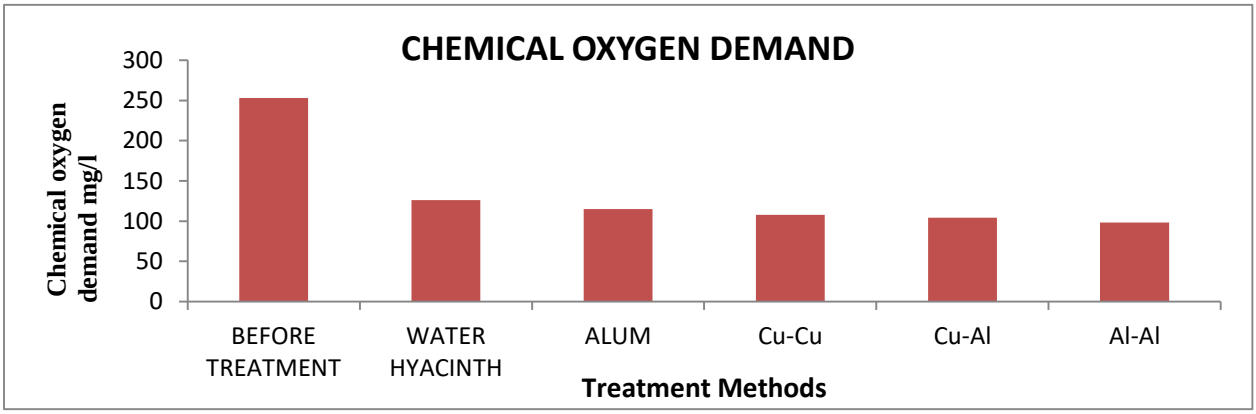


Fig.6 Variation of chemical oxygen demand with respect to various treatment methods

Figure 7 shows the variation of oil and grease present in car wash water with respect to various treatment methods. Using Al-Al electrode combination maximum oil and grease removal efficiency of 69.9% is attained.

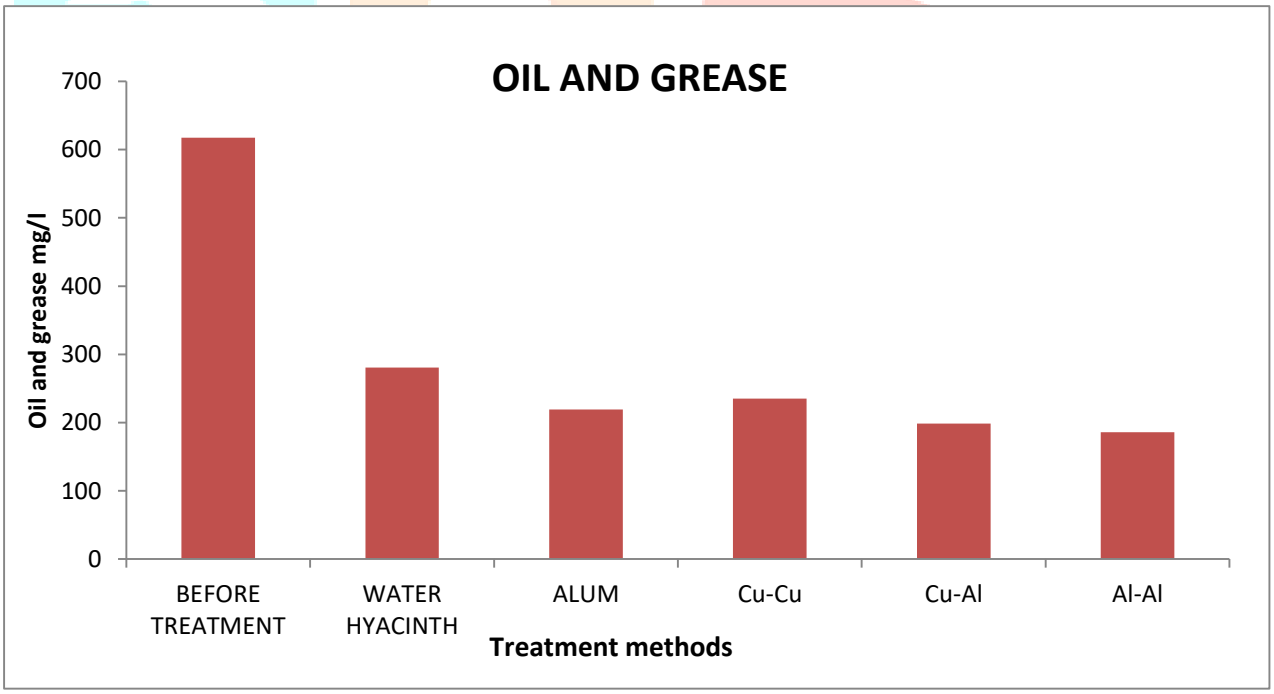


Fig.7 Variation of oil and grease with respect to various treatment methods

Figure 8 shows the variation of total organic carbon with respect to various treatment process. Maximum total organic carbon removal efficiency of 77.5% is attained using Al – Al electrode

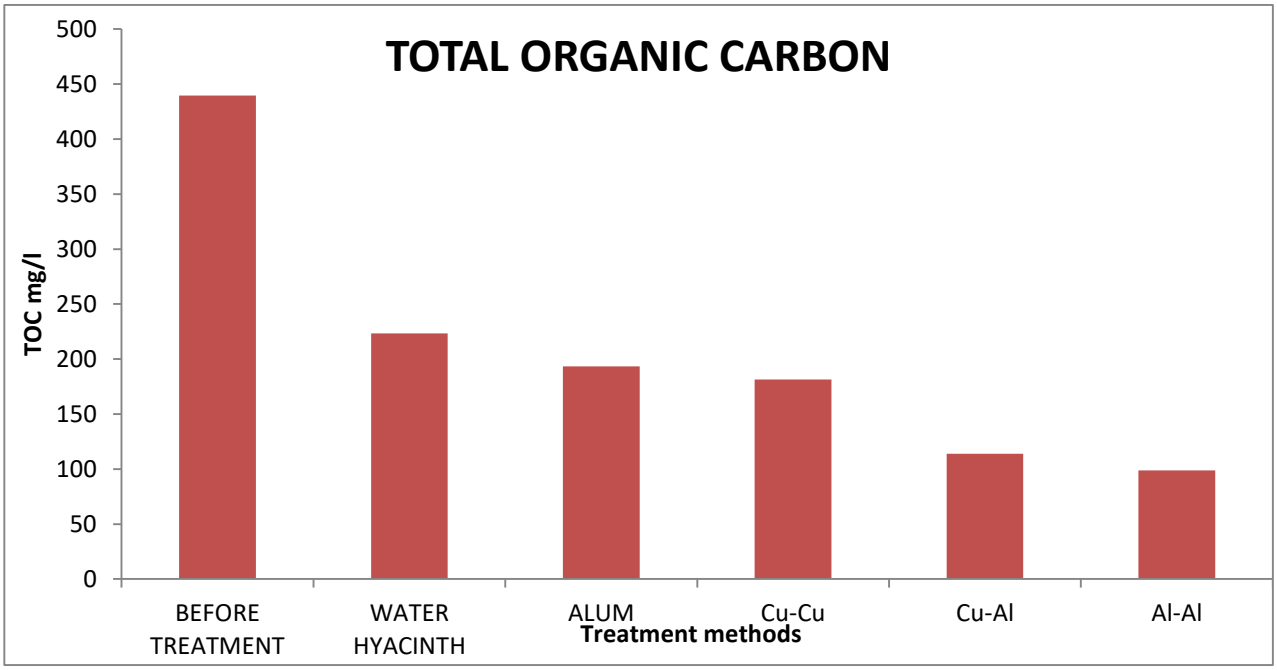


Fig.8 Variation of Turbidity and TOC with respect to various treatment method

Figure 9 shows the variation of total solids with respect to various treatment methods adopted. Total solids present in car wash water have been reduced from 1300mg/l to 574 mg/l.

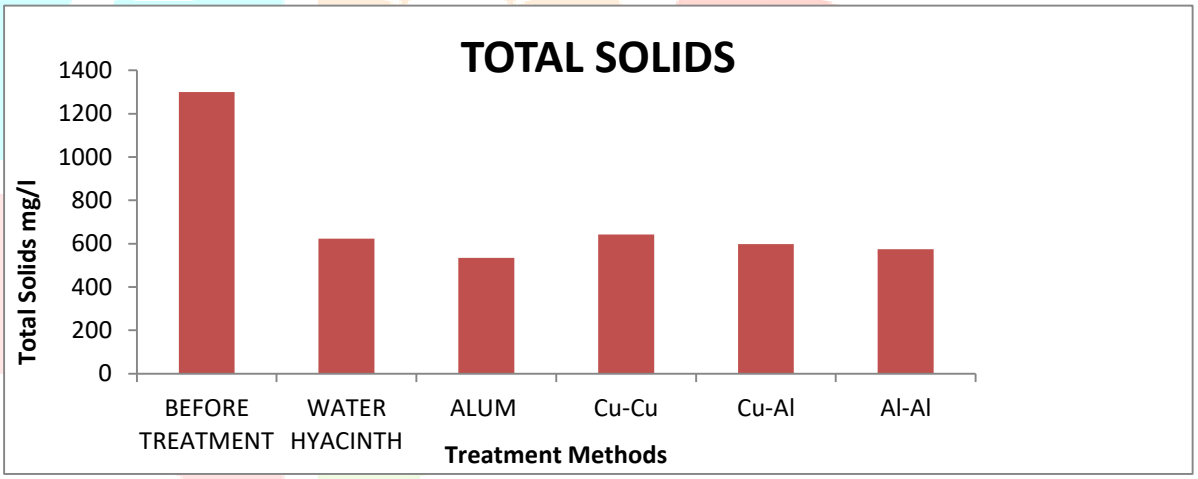


Fig.9 Variation of Total solids with respect to various treatment methods

**EFFECT OF BIOLOGICAL TREATMENT**

In Water hyacinth, the process of treatment is very simple and economical. It is very much cost effective as it is easily available and the plants can be reused again and again. Water hyacinth has shown a good result of 50% Chemical oxygen demand removal efficiency and 54.5% oil and grease removal efficiency. The total solids and turbidity present in the water is also reduced.

**EFFECT OF CHEMICAL TREATMENT**

With the addition of alum at various concentrations and various agitation speed, flocs are formed. The flocs get settled at the bottom. Among various concentrations, dosage of 150 mg/l at pH of 5 has given better results. Thus, with the increase in alum concentration, efficiency of treatment also increases. Alum at 150 mg/l showed a Chemical oxygen demand removal efficiency of 54.5% whereas oil and grease removal efficiency of 64.4%.

**EFFECT OF ELECTRO COAGULATION METHOD**

Based on the investigation carried out, optimal conditions considered are change in pH, voltage and change in contact time. The combination of Cu-Cu electrode at pH of 5 has been found to be optimum with the chemical oxygen demand removal efficiency of 57.3% and oil and grease removal efficiency of 61.89%. The combination of Cu-Al electrode at pH of 7 has been found to be optimum with the chemical oxygen demand removal efficiency of 58.7% and oil and grease removal efficiency of 67.83%. The combination of Al-Al electrode at pH of 5 has been found to be optimum with the chemical oxygen demand removal efficiency of 61.2% and oil and grease removal efficiency of 69.91%. Thus, the combination of Cu-Al electrode at pH of 7 is found to give better removal efficiency of Chemical oxygen demand, oil and grease and turbidity.

## 5 COMPARATIVE STUDY

From the experimental results obtained, biological, chemical, electro coagulation methods were compared. The biological method is found to give better results without causing any contamination. On comparison of all the three-method electrocoagulation method is found to give better efficiency of chemical oxygen demand removal, oil and grease and turbidity. In chemical method, increase in dosage of alum gives better results. The graph showing removal efficiency of Chemical oxygen demand and oil and grease is shown in figure 10.

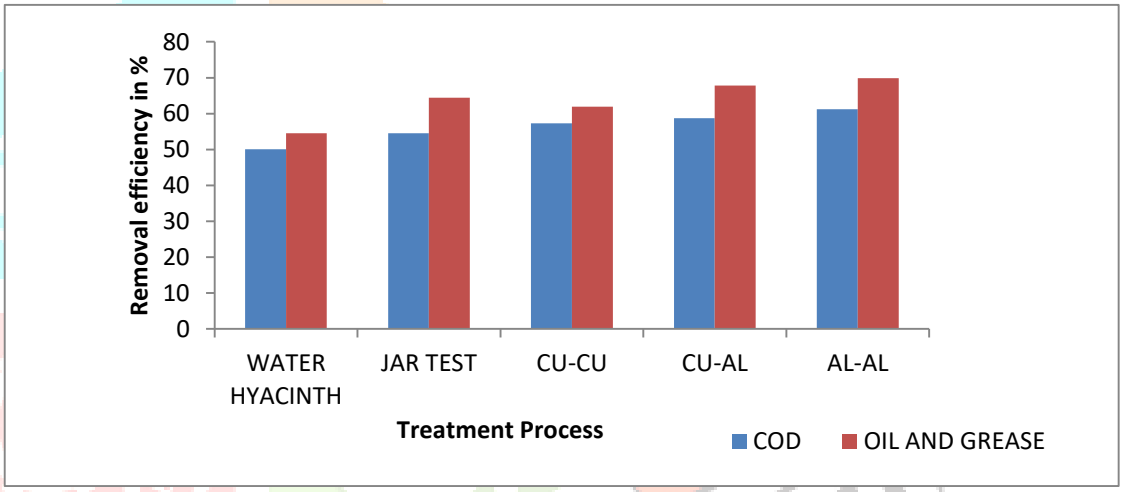


**Fig. 10 Graph showing removal efficiency of Chemical oxygen demand and oil and grease**

## 6 CONCLUSION

As the quantity of water is diminishing at an enormous rate, recycle and reuse of automobile wash water is practiced in many countries as a sustainable solution to meet the water needs. This study reveals that biological, chemical, electrocoagulation method is efficient in removing both the physical and chemical parameters present in the waste water. Among the various method adopted, electrocoagulation method with Al-Al electrode combination gave better chemical oxygen demand removal efficiency of 61.2% and oil and grease removal efficiency of 69.91% . The methods adopted are very simple, cost effective and consumes less human power. It is proven that not only the chemicals can be used for the treatment; naturally available plant can also be used for effective treatment. Water hyacinth has also shown a good result with Chemical oxygen demand removal efficiency of 50% and oil and grease removal efficiency of 54.5%. Thus, about 80% of car wash water can be recycled and reused which can considerably reduce the pollution and ground water contamination.

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