

Characterisation and Treatment of Automobile and Battery Water Waste Using Coagulation and Adsorption Technique

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Abstract. Adsorption processes have seen a broad level of usage by various researchers over the years to remove heavy metals from waste streams. An adsorbent frequently used is activated carbon. Although activated carbon is used extensively in water and wastewater industries, it remains expensive. In recent years, there has been a need for economical and safe methods for heavy metal elimination from contaminated water. This need has only grown, which gave rise to research aimed toward producing low-cost alternatives to activated carbon. There is an urgent need to explore all possible sources of inexpensive agro-based adsorbents, and heavy metal removal's feasibility should be studied in great detail. This research objective is to learn how inexpensive adsorbents can remove heavy metals from wastewater. Treating Automobile battery waste efficiently remains a significant challenge due to its enormous quantity, hazardous nature, and complexity. When effective treatment technology has poor implementation, this aggravates the situation and worsens the situation further in countries with high and rising populations. This leads to more pressures of urbanisation and industrials, giving room for more industrial waste.

This research suggests the best possible options by critically reviewing the existing practices. While slow biological treatment schemes usually fail to support microbial activities in the presence of toxic components in concentrations, other physicochemical plans often need to meet strict waste disposal and discharge regulations. The approach where sludge disposal is thermally incinerated has never seen environmental justification, and this is because of dioxin release and obnoxious substances transferred directly. Newly emerging membrane-based schemes can be flexible, environmentally friendly, petite, economically self-sufficient, and easy to implement and maintain after installation.

Keywords: battery and automobile wastewater; adsorbent; carbonisation; pollution; heavy metals.

INTRODUCTION

The pollution of the environment with toxic substances has increased in recent years due to the rapid growth of industries. Most industries, such as automobile, mining, electroplating, iron-steel, and battery industries, utilise substances containing heavy metals [13]. Subsequently, these heavy metals are discharged into the environment from the effluents obtained from the industries. Although small amounts of heavy metals

are necessary for the normal development of biological cycles, most are toxic at high concentrations [14]. Heavy metals being released into the environment pose a severe health threat caused by pollution to aquatic life, plants, and humans due to their persistence, non-biodegradability, and bio-accumulation in the food chain. Ground, marine, industrial, and often treated water all have heavy metals as significant pollutants. Industrial wastewater from mining, pesticides, tanneries, organic chemicals, metal processing,

pharmaceuticals, plastics and rubber, wood products, and lumber are primary point sources of heavy metal pollutants. They are easily transported by runoff water and other water sources downstream that are polluted by industrial sites. It is necessary to remove these toxic heavy metals from waste before disposal to avoid health hazards, and proper recycling plays a vital role. Heavy metal discharged wastewater is toxic, carcinogenic, and a massive threat to the health of all living organisms [26].

Large amounts of hazardous materials being released into the natural environment have resulted in various environmental problems and climate change due to their persistence and non-biodegradability. They can keep accumulating on elements such as the food chain and already have shown signs that they pose serious health challenges to humans. Therefore, removing these metals from industrial effluents is necessary to maintain environmental quality [6]. Several techniques have been used for heavy metal removal, including solvent extraction, filtration, ion exchange, coagulation, sedimentation, oxidation, and activated carbon adsorption [19]. However, these techniques have the disadvantages of high cost, low removal efficiency, and the problem of secondary contamination. Due to this, many researchers have used low-cost, environmentally friendly, and very effective and efficient adsorbents to extract and remove the metals from the effluents. These adsorbents include biomass materials, clays, charcoal, sludge ash, microorganisms, and lateritic materials, to mention a few [8]. The automobile industry (Innoson) is located in Nnewi, Anambra State, Nigeria, and was chosen due to the reasonably high metal concentration.

Environmental protection agencies have imposed stricter regulatory prohibitions to protect the environment. This has made water treatment more expensive, and complying with the discharge quality standard is becoming a massive burden for industries. Water resource pollution, mainly due to the removal of poor-quality effluents, poses a severe threat to organisms like aquatic life and humans that depend on water for sustenance. Developing countries face these challenges more where rapid population growth and industrialisation have increased the complexity of effluents. In recent years, researchers have shifted their interests to the possible reuse and

recycling of various effluents, where dairy industries are no exception [5].

In most cases, these effluents are not treated and thrown into rivers, where they contribute to eutrophication by adding phosphorus and nitrogen compounds. Treating dairy effluents is of crucial importance not only for the environment but also for recycling water for industrial use. The physicochemical processes suffer the disadvantage that reagent costs are high and the soluble COD removal is low [9]. Moreover, chemical treatments could induce secondary pollution because chemical additives may contaminate the treated water. Dairy industry wastewater demonstrates a complicated system containing different components, including pollutants from the process-drawn materials, chemicals, and residues of technological additives used in individual operations. Regarding the food industry wastewater, treatment processes must ensure the required quality of discharged effluents.

Problem statement

Environmental pollution, mostly from minerals and heavy metals in wastewater, has become an enormous issue. Anthropogenic activities like mining, industrial operations, agricultural processes, and disposal of industrial waste materials have made the hazardous situation skyrocket to dangerous levels. Heavy metals like arsenic, chromium, nickel, lead, and cadmium are in industrial waste. So far, several methods have been set out for removing heavy metals, such as ion exchange, chemical precipitation, ultra-filtration, electro-dialysis, Nano-filtration, reverse osmosis, coagulation, flocculation, and many more.

However, each method has some disadvantages, like unpredictable metal ion removal, high reagent requirements, generation of toxic sludge, etc. Pollution is the biggest challenge facing the world today, and its impacts on the climate are expected to worsen if no remediation actions are taken. As the contamination of water increases, we will experience more scarcity, and this will lead to disputes over water resources. Pollution can be placed into three categories: water, land and air. Significant causes of water pollution are decomposed domestic wastes, industrial plants, and mining operations like petroleum and solid mining. Land pollution is mostly caused by industrialisation, waste dumping, and the constantly

rising human population. Air pollution is seen to arise mainly from economic and domestic activities of people like modern agriculture, thermal power stations, industrialisation, fossil fuel burning both legal, artisanal refineries and other means, and transportation which emit harmful pollutants like cars and the aviation industry.

Research shows that heavy metal ions cannot be degraded into harmless end products [15]. This makes it difficult to degrade biologically. Heavy metals contaminate our ecosystem mainly because of mining operations, refining ores, fly ash incinerators, metal plating, sludge disposal, radioactive material processes, paints, batteries, alloys, pesticides, and radioactive material processes, paints, batteries, alloys, pesticides, and preservatives [2]. Metals like Pb, Cd, Zn, and Cu, present in industrial wastewater, are non-biodegradable and exist in streams and receiving lakes, causing bioaccumulation in organisms, further leading to several health challenges or all life on earth and environmental degradation [20]. These metals enter our food chain and become difficult to track as they move up the trophic levels [24] due to the biomagnification and bioaccumulation in the food chain. They enter the living tissues and store up throughout the food chain. Humans receive the worst toxic impact since we remain at the top of the food chain [7]. Some symptoms of copper poisoning may include vomiting, jaundice, low blood pressure, and coma to death [25]. Several industries continuously release Zn (II) in their discharges [23]. Zinc toxicity through excessive ingestion may lead to several health issues, such as respiratory incapacitation and liver failure, as shown by increased respiratory activity, such as coughing, frequency of ventilation, breathing rate, and a decrease in oxygen uptake efficiency [4]. Cadmium occurs naturally in combination with zinc minerals [16]. Cadmium is hazardous and toxic as it bioaccumulates, and there exists no known homeostatic control in the human body for it. About 1-2% of ingested cadmium, when retained in the human body, is hazardous and a potent enzyme inhibitor. It has also been known to cause liver and kidney damage [16] in animals and humans.

Lead is one of the potentially toxic heavy metals and tends to accumulate in soft tissues, blood, and bones when adsorbed into the body [10]. Lead is widely used in mining, steel, automobile,

batteries, and paints [22]. Lead can accumulate over a lifetime and, even at low concentration levels, may cause diseases such as anaemia, encephalopathy, vertigo, anorexia, hepatitis, and nephric syndrome [21]. Likewise, phenol is a severe environmental priority pollutant since it is toxic and harmful to organisms even at low concentrations. Phenolic compounds have been classified as high-priority pollutants by the USA EPA [12]. Besides the poisonous effects, phenolic compounds create an oxygen demand in receiving waters and impart taste and odour to water with minute concentrations of their chlorinated compounds [3]. The chronic toxicity of phenols in humans results in headaches, dizziness, fatigue, nausea, vomiting, fainting, weakness, and lack of appetite at high levels. Phenol can also change blood pressure and cause liver and kidney damage [3].

Scope of study

Waste discharge in industries, agriculture and domestic in rivers and lakes causes the deposit of pollutants in sediments. These pollutants comprise heavy metals, which pose health threats when they enter the food chain.

Incidences of heavy metal accumulation in aquatic life, like oysters, fish, mussels, sediments, and other components of marine ecosystems, have been reported worldwide. Excess amounts of heavy materials are often toxic through the direct action of the metal or their inorganic salts or organic compounds through which metals are introduced into the cell or easily detached. Metal Exposure may occur in ordinary circumstances, especially in an industrial setting, and environmental accidents can lead to high-level exposure. Even at low concentrations, some metals are toxic to aquatic organisms. The issue of metal pollution in water and marine organisms needs continuous monitoring and surveillance as these elements do not degrade and can be biomagnified in man through spread in the food chain.

Aquatic organisms are majorly affected by heavy metals present in the environment, and the level of toxicity is majorly a function of the surface water systems' water chemistry and sediment composition. Metals are mineralised by microorganisms, which are taken up by plankton and aquatic organisms. Finally, the metals now, several times

biomagnified, are taken up by man when he consumes fish from the contaminated water.

Slightly elevated metal levels in natural waters may cause the following sub-lethal effects in aquatic organisms:

- change in physiology, such as suppression of growth and development, poor swimming performance;
- change in the circulation;
- change in biochemistry, such as enzyme activity and blood chemistry;
- histological or morphological change in tissues;
- behaviour change; and change in reproduction.

Industrial by-products are available free of cost and cause significant disposal problems. Some of these wastes are regenerated, while others find no utilisation and are disposed of. If solid waste is used as low-cost adsorbents, it will reduce the volume of waste materials and the pollution problem associated with its disposal. Several industrial wastes such as red mud, metal hydroxide sludge, and fly ash have been investigated with or without treatment as low-cost adsorbents for removing pollutants from wastewater. They require little processing to increase their sorption capacity. Red mud (RM), primarily produced from the alumina industry, emerges as a residue of the digestion of bauxite ores with caustic soda for alumina (Al_2O_3) production. Inside it is fine particles of iron, titanium oxides, silica, calcium and hydroxides. These are responsible for the highly reactive surface, enabling a low-cost adsorbent to be used for heavy metal adsorption and phenols from wastewater. Hence there is a great need to extract all heavy metals from aquatic ecosystems. Research and development, therefore, focus on sector-specific methods and technologies to remove these heavy metals.

Purpose of the study

1. Using the co-activation process, characterise activated carbon from corn cob by employing chemical, physical, and chemical activation.
2. Remove heavy metals by adsorption process, which has excellent economic potential for eliminating heavy metals from Industrial waste.
3. To characterise the number of heavy metals, Chromium VI, Zinc, Copper, Lead, Iron, BOD, COD, total suspended solids, total dissolved solids and

solids in most industrial waste and treatment to reduce its hazards on living things.

4. Optimising the process parameters for preparing activated carbon for effective wastewater treatment curtails environmental issues due to the discharge of untreated wastewater into water bodies and the immediate environment. It poses serious threats to both human and aquatic life.

From the study, the characterisation and treatment of industrial waste were carried out, and solid waste, BOD, heavy metals, COD, and others were eradicated from water content, thereby reducing its hazardous effects on living organisms. Besides, it can be a valuable guideline to researchers, industrial owners, and practitioners interested in improving society's health.

METHODS

Three effluent samples each were collected from Ibeto Battery industry Nnewi and Innoson Automobile company Nnewi using standard methods. Samples were collected at the point of discharge of the effluents (P1), at 20 m away from the point of effluent discharge (P2), and at 40 m away from the point of effluent discharge (P3) in a sterile bottle, labelled and preserved using standard methods.

Characterisation of wastewater. The individual and composites samples were analysed for suspended solids, total dissolved solids, Biochemical Oxygen Demand, Chemical Oxygen Demand, total solids, as well as heavy metals such as Cr (VI), Zn (II), Cu (II), Pb (II) and Fe (III) using standard methods.

Adsorbent preparation & chemical activation. Corn cobs were collected from the "Isi gate" market in Umuahia Abia State, Nigeria, and were washed with distilled water. The samples were broken into smaller sizes and then oven-dried to reduce the sample size so they could dry quickly. After oven drying and grinding, the ground sample was sieved with a 2 mm mesh size sieve at the laboratory, Civil Engineering department, MOUUAU. The model was activated chemically by soaking for 2 hours in 0.5 M Hydrochloric acid. It was washed repeatedly with de-ionised water until a pH value of 7 was obtained, indicating no acid was left on the sample. The sample was air-dried for two days at room temperature.



Figure 1 – Samples soaked in 0.5 M hydrochloric acid



Figure 2 – Samples air-dried for two days

Physical activation. The ground sample was sieved with a 2 mm mesh sieve. This was followed by carbonisation in the absence of air in a muffle furnace at a temperature of 400-600 °C for 60 minutes. The corn cob ash was washed with de-ionised water until no further impurities, such as dust or residues, were found. The corn cob ash was then air-dried for two days.



Figure 3 – Adsorbent undergoing carbonisation

Physicochemical activation. The ground sample was sieved with a 2 mm mesh size sieve. After which, it was carbonised in the absence of air in a muffle furnace at a temperature of 400–600 °C for 60 minutes. The carbonised sample was mixed with an aqueous phosphoric acid (H_3PO_4) and soaked for 2 hours. The mixture was washed thoroughly with de-ionised water until a PH value of 7 was obtained to ensure that the acid had been thoroughly washed away. The sample was air-dried for two days.



Figure 4 – Carbonised corn cob

Characterisation of the adsorbent. The chemical compositions, including the rare earth metals for chemically, physically, and physically/chemically activated corn cobs, will be determined using standard methods.

Adsorption experiment. The chemically activated, physically activated, and physically/chemically activated corn cobs were used for the adsorption experiment. A total of three dosages, 5, 10 and 20 mg, were used.

Batch mode adsorption studies for individual metal compounds were conducted to investigate the effect of different parameters such as adsorbent particle size, contact time, temperature, initial concentration, and adsorbent dosage. The solution containing adsorbate and adsorbents was taken in 250 ml capacity conical flasks and agitated at 180 rpm in a mechanical shaker at predetermined time intervals [18]. The adsorbate was decanted and separated from the adsorbent using filter paper (Whatman No-1).

Heavy metals analysis. The final residual metal concentration after adsorption was measured using Atomic Absorption Spectrophotometer.

The following equation was used to estimate the percentage removal of heavy metals from its aqueous solution.

$$\% \text{Rem.} = \frac{C_o - C}{C_o} \times 100 \quad (1)$$

where C_o and C are the initial and final concentrations in the solution (mg/l), V is a known volume of wastewater (l), and m is a known mass of dry adsorbent (g).

Coagulation preparation. A stock solution of Alum was prepared before starting the experiment. The answer was prepared by dissolving 10 g of Alum in distilled water, and the solution volume will increase to 1 litre. Every 1 ml of these stock solutions was equivalent to 20 mg/l when added to 500 ml of wastewater. They were prepared in distillation water in three different concentrations (10, 20, and 30 mg/l).

Jar Test. The jar test was used to evaluate the coagulation efficiency (Alum). Jar testing is an essential tool for determining the best chemical dosing regimen and the efficiency of the treatment system [17]. A conventional jar test apparatus was used in the experiments to coagulate the industrial wastewater using Alum. This was executed as a batch test to provide a series of six beakers with six spindle steel paddles. The pH of the solution was controlled by adding H_2SO_4 and then fractionated into the beaker containing 500 ml of suspension; the wastewater sample was mixed homogeneously. The samples were analysed for initial concentration to measure pH, TSS, COD, BOD, TS, TDS, and turbidity. After the desired amount of Alum was added to the suspension, the beakers were agitated at various mixing times and speeds, which consisted of rapid mixing (rpm) for 1 minute and slow mixing (30 rpm) for ten minutes to coagulate. After the agitation was stopped, the suspension was allowed to settle for 20 minutes. Finally, a sample was withdrawn using a pipette from the top inch of supernatant for turbidity, COD, BOD, TS, and TDS measurement, representing the final concentration. All tests were performed at an ambient temperature range of 20 to 23 °C. In the experiment, the study by varying a few experimental parameters, Alum dosage (10-30 mg/l) and pH (5.5-8.0), to know their effect on coagulation and obtain the optimum condition for each parameter.

Analytical Analysis. The COD test was performed by the wet chemical oxidation method. It was used to measure the oxygen demand for the oxidation of organic matter by strong chemical oxidation, which was equivalent to the amount of organic matter in the sample. The sample was filtered through a weighed standard glass fibre filter with 0.2 µm diameter when determining TSS. The residue on the filter was dried at 100 °C. The filter's weight increases and represents the wastewater's TSS and pH.

The removal efficiency (% Removal) was calculated from (1), where C_o and C = COD, TSS and colour control of wastewater (mg/l) before and after coagulation treatment, respectively.

Matrix spiking. A Spike sample was developed, a known amount of analysis was added (a spike) to a model, and the spiked sample was tested and determined since the amount added was recovered. Two portions of the sample were prepared for testing. In the matrix spike portion, a known standard amount was added (to increase the concentration) by a known amount. The matrix spike result was higher by that amount added. A spiking solution was the standard for preparing a matrix spike. The analysed spiking solution's concentration is usually 50 to 100 times higher than that of the unspiked sample.

The spike level was chosen so that it doubled the sample concentration. The concentration of the spiking solution to use was determined. A spiking solution about 50-100 times higher than the chosen spiking level was preferred. The amount of spiking solution added was determined. The calculated volume of the spiking solution was added. Test the spiking sample using the same analytical procedure as the unspiked sample.

RESULTS AND DISCUSSION

The test results are presented in Tables 1–13 and Figures 1–10.

The selected heavy metals analysis (Tables 1–2) showed that the Lead, Chromium VI, Zinc, and Copper fall within WHO permissible limits, while iron at point 3 exceeded the allowable limits set by WHO for both battery and automobile wastewater. In the present study, Iron values ranged from 0.174 to 2.510 mg/l. These values exceeded WHO standards of 0.1 mg/l.

Table 1 – Battery wastewater heavy metals, mg/l

Selected metals	P1	P2	P3	WHO	Heavy metals to be treated
Pb	0.0081	0.0092	0.0088	0.01	-
Cr	0.015	0.007	0.003	0.05	-
Fe	0.083	0.128	0.174	0.1	P3
Zn	0.033	0.002	0.012	5	-
Cu	0.245	0.043	0.039	0.5	-

Table 2 – Automobile wastewater heavy metals, mg/l

Selected metals	P1	P2	P3	WHO	Heavy metals to be treated
Pb	0.0090	0.0077	0.0096	0.01	-
Cr	0.008	0.019	0.006	0.05	-
Fe	2.060	0.680	2.510	0.1	P3
Zn	0.006	0.034	0.016	5	-
Cu	0.074	0.168	0.102	0.5	-

Table 3 – Battery wastewater physicochemical parameters, mg/l

Parameters of interest	P1	P2	P3	WHO	Parameters to be treated
Ts	3050.00	3100.00	2970.00	500	P2
COD	83.06	1.660	1.860	255	-
BOD	12.80	6.80	3.20	10	P1
TSS	443.10	973.40	1258.30	10	P3
TDS	195.80	185.60	796.00	1000	-
Ph	0.60	0.63	0.58	6.5-8.0	P3
Turbidity (NTU)	8.158	5.816	0.745	5	P1

Table 4 – Automobile wastewater physicochemical parameters, mg/l

Parameters of interest	P1	P2	P3	WHO	Parameters to be treated
Ts	1050.00	510.00	560.00	500	P1
COD	9.09	344.50	3.00	255	P2
BOD	8.10	11.70	5.00	10	P2
TSS	256.30	275.80	314.60	10	P3
TDS	58.80	180.70	64.90	1000	-
pH	3.30	5.30	6.0	6.5-8.0	-
Turbidity(NTU)	0.750	7.183	2.263	5	P2

Table 5 – Battery wastewater (Spiked)

Selected	P3, mg/l	WHO
Pb	5.0088	0.01
Cr	5.003	0.05
Fe	5.174	0.1
Zn	5.012	5
Cu	5.039	0.5

Table 6 – Automobile wastewater (Spiked)

Selected metals	P1, mg/l	WHO
Pb	5.009	0.01
Cr	5.008	0.05
Fe	7.060	0.1
Zn	5.006	5
Cu	5.074	0.5

Table 7 – Changes in heavy metals from Battery Wastewater after adsorption using Physicochemical (Ph) and Chemical (Ch) activation from corn cob, mg/l

Heavy metals	5 mg		10 mg		20 mg		WHO
	Ph	Ch	Ph	Ch	Ph	Ch	
Pb	0.165	0.08	0.160	0.084	0.162	0.084	0.01
Zn	0.200	0.09	0.203	0.092	0.204	0.094	0.05
Fe	1.050	0.155	1.053	0.158	1.105	0.155	0.1
Cr	0.314	0.249	0.313	0.246	0.311	0.247	5
Cu	0.108	0.071	0.109	0.072	0.110	0.073	0.5

Table 8 – Changes in heavy metals from Automobile Wastewater after adsorption using Physicochemical (Ph) and Chemical (Ch) activation from corn cob, mg/l

Heavy metals	5 mg		10 mg		20 mg		WHO
	Ph	Ch	Ph	Ch	Ph	Ch	
Pb	0.105	0.055	0.109	0.058	0.108	0.052	0.01
Zn	0.150	0.315	0.153	0.318	0.154	0.319	0.05
Fe	2.218	0.100	2.220	0.103	2.224	0.104	0.1
Cr	0.052	0.059	0.0524	0.062	0.063	0.060	5
Cu	0.029	0.092	0.031	0.094	0.032	0.094	0.5

Table 9 – Changes in Battery Wastewater physicochemical parameters of interest after coagulation with Alum

Dosage	Turbidity, NTU	TSS, mg/l	TS, mg/l	pH	DO, mg/l	BOD, mg/l	COD, mg/l
5 mg	3.03	5.28	720	6.33	0.472	0.96	175
10 mg	3.64	3.51	792	6.20	0.266	0.54	149
20 mg	4.22	1.67	807	6.14	0.144	0.29	57
WHO	5	10	500	6.5-8	5	10	255

Table 10 – Changes in Automobile wastewater physicochemical parameters after coagulation with Alum

Dosage	Turbidity, NTU	TSS, mg/l	TS, mg/l	pH	DO, mg/l	BOD, mg/l	COD, mg/l
5 mg/l	2.49	9.00	352	6.17	0.472	3.80	185
10 mg/l	3.93	5.89	435	6.15	0.157	0.32	153
20 mg/l	4.11	4.71	487	6.15	0.122	2.50	91
WHO	5	10	500	6.5-8	5	10	255

Table 11 – Element Lead (Pb), %

Dosage	5 mg	10 mg	20 mg
Physicochemical (Automobile)	97.94	97.82	97.84
Chemical (Automobile)	98.40	98.84	98.96
Physicochemical (Battery)	96.70	96.80	96.76
Chemical (Battery)	98.90	98.32	98.32

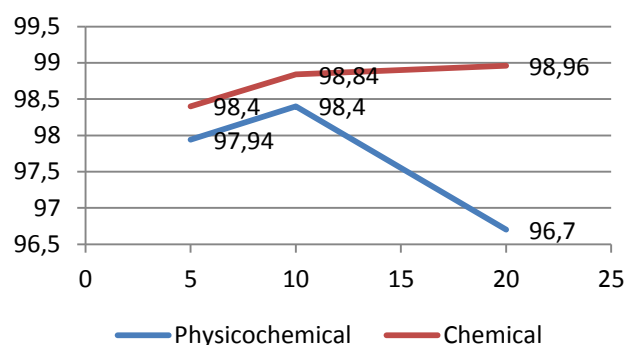


Figure 5 – A graph of percentage removal against adsorbent dosage – Physicochemical & Chemical properties for Element Lead (Pb) Automobile

Table 12 – Element Chromium VI, %

Dosage	5 mg	10 mg	20 mg
Physicochemical (Automobile)	98.96	98.85	98.74
Chemical (Automobile)	98.82	98.76	98.80
Physicochemical (Battery)	93.72	93.74	93.78
Chemical (Battery)	95.02	95.10	95.06

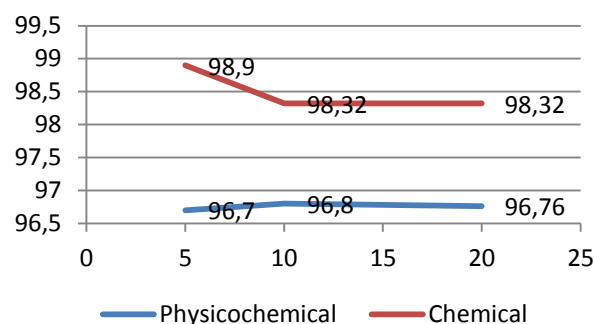


Figure 6 – A graph of percentage removal against adsorbent dosage – Physicochemical & Chemical properties for Lead (Pb) battery

Table 13 – Element Iron (Fe), %

Dosage	5 mg	10 mg	20 mg
Physicochemical (Automobile)	85.12	68.85	65.50
Chemical (Automobile)	97.80	98.54	98.53
Physicochemical (Battery)	57.91	79.34	78.64
Chemical (Battery)	98.07	96.94	97.004

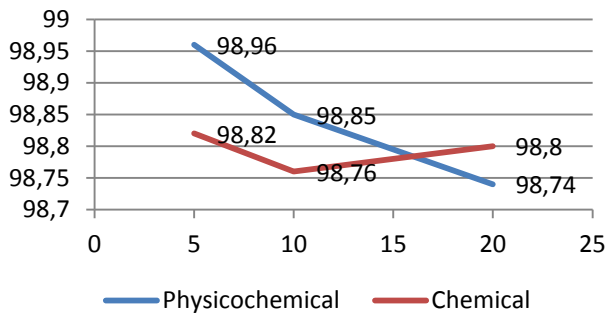


Figure 7 – A graph of percentage removal against adsorbent dosage – Physicochemical & Chemical properties for Chromium VI Automobile

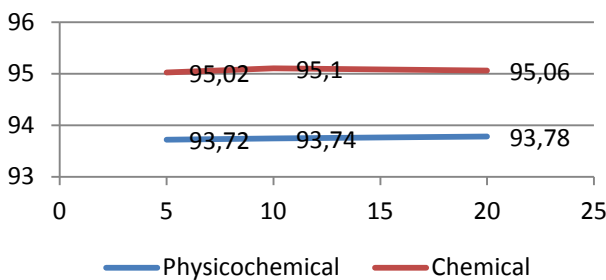


Figure 8 – A graph of percentage removal against adsorbent dosage – Physicochemical & Chemical properties for Chromium VI Battery

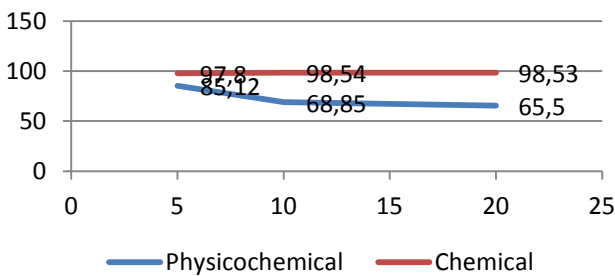


Figure 9 – A graph of percentage removal against adsorbent dosage –Physicochemical & Chemical properties for Iron (Fe) Automobile

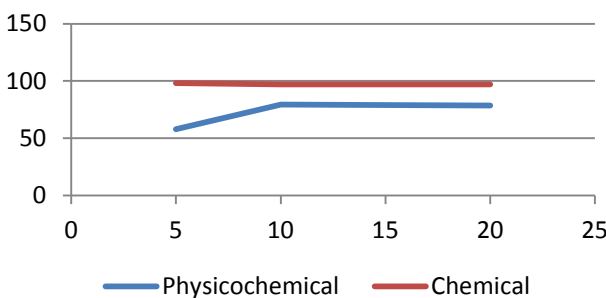


Figure 10 – A graph of percentage removal against adsorbent dosage – Physicochemical & Chemical properties for Iron (Fe) Battery

Physicochemical analysis. The physicochemical parameters result, as shown in Tables 3–4, shows that chemical oxygen demand and total dissolved solids fall within the WHO permissible limit while Total solids, Biochemical oxygen demand at point 1, total suspended solids, pH, and turbidity at point 1 and 2 exceeded the WHO permissible limit for battery wastewater sample. Total suspended solids fall within the Who permissible limit. In contrast, total solids at points 1, 2 and 3, Chemical oxygen demand at point 2, Biochemical oxygen demand at point 2, total suspended solids, pH, and turbidity at point 2 exceeded the permissible limit for Automobile wastewater.

pH Values. pH values ranged from 0.58 to 0.63 for battery wastewater and 3.30 to 6.0 for automobile wastewater which is acidic and indicated the presence of metals at a toxic level. pH is an indicator of the existence of biological life, as most thrive in a relatively narrow and critical pH range [11]. The pH of the water sample collected at points 1, 2, and 3 for the battery and automobile was below the WHO minimum allowable pH concentration for human consumption. The pH of water affects the solubility of many toxic and nutritive chemicals.

Total Suspended Solids. These are organic and inorganic solid materials which are suspended in water. It is an indicator of water pollution. Total suspended solids in the samples ranged from 443.10 to 1258.30 mg/l for battery wastewater and 256.30 to 314.60 mg/l for automobile wastewater. The values exceeded the permissible limits for WHO. The high value of total suspended solids could be due to the direct discharge of effluents into the River, which increased the River's pollution load.

Biochemical oxygen demand. BOD is the oxygen amount a bacterium requires to stabilise decomposable organic matter. A high BOD signifies the presence of a large amount of organic pollution [1]. In the present study, BOD in the sample ranged from 3.20 to 12.80 mg/l for the battery wastewater sample and 5.00 to 11.70 mg/l for the automobile wastewater sample. Points 1 and 2 for the battery and automobile wastewater samples exceed the WHO permissible limits.

Chemical oxygen demand. COD is the amount of oxygen consumed under specified conditions of organic and oxidisable inorganic matter in wastewater and water [1]. COD, ranging from 3.00 to 344.50 mg/l in an automobile

wastewater sample and 1.660 to 83.06 mg/l in a battery wastewater sample. The COD in the Battery wastewater sample is within the WHO permissible limit, while in the automobile wastewater sample at point 2, it exceeded the WHO permissible limit.

Total solids. The total solids in the wastewater sample are the residue after evaporation of the model. Ts ranged from 2970 to 3100 mg/l for battery wastewater and 510 to 1050 mg/ for automobile wastewater samples. All exceeded the WHO permissible limit.

Turbidity. Turbidity in wastewater is due to suspension, which is removable. Removal of turbidity before disinfection is essential. In the present study, turbidity ranged from 0.745 to 8.158 mg/l for the battery wastewater sample and 0.750 to 7.183 mg/l for the automobile wastewater sample. At points 1 and 2, battery wastewater exceeded the WHO permissible limit. Point 2 for automobile wastewater sample exceeded the WHO permissible limit.

Spiking. After the water analysis, the world health organisation standard was used to compare with the result obtained from the study. It was found that some heavy metals were below the average at points 1, 2, and 3. Pb, Cr, Zn, and Cu were below WHO standard, while Fe at point 3 was above WHO standard for battery and automobile wastewater.

From Tables 7–8, it was observed that Chemical Activated corn cob treat more effective as values for all the heavy metals were found to be less when added 5 mg, 10 mg, and 20 mg were in the two effluents.

CONCLUSIONS

The project illustrated how industrial wastewater, precisely automobile and battery wastewater, can be characterised and treated using coagulation and adsorption techniques. The significant parameters were heavy metals

like chromium, lead, iron, copper, zinc, etc., although minor parameters were considered, such as BOD, COD, TS, TSS, Turbidity, etc. There may be other ways to achieve the same or more significant results. The beauty of this technique is that it is both economical and efficient.

The steps taken to achieve this are interesting, stimulating, and loving. The functionality value of this project makes the knowledge vital and its use in any industry for treatment. This is to end the ongoing destruction or hazards to a biological organism. Though the techniques required to perform this project seem small for the industry, the importance and result after treatment and characterisation cannot be over-emphasised, so it saves both financial commitment and resources to achieve a great result (that is, low cost against high efficiency).

Conformity with health standards, health standards, and rules were strictly followed during this analysis. This technique is restricted to be used by engineers and environmentalists who know the importance of environmental, biological, and water conditions.

Since the project has shown that using Alum as a coagulant and corn cob as an adsorbent is suitable for wastewater treatment in industries, we recommend its use in any construction, pharmaceutical, automobile, etc. industries emit wastewater involving heavy metals. Corn cob, as an adsorbent, is very sensitive to heavy metals' adsorption, so it approves its importance.

Engineers and industries do not overlook the effect of heavy metals in wastewater regarding disposal; knowing it incurs grave hazards on all living things, its damage cannot be overemphasised. The sensitisation, strict rules, and investigations in large and small industries on wastewater and its effect by health authorities such as WHO and engineering bodies should be carried out regularly to achieve environmental and biological friendliness.

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