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CHARACTERIZATION AND REMOVAL OF CONTAMINANTS FROM ALCOHOL DISTILLERY WASTEWATER BY USING CHEMISORPTION AND BIOSORPTION PROCESSES

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Abstract

In this research, the characterization and the removal of contaminants from alcohol distillery wastewater from industrial zone in Mandalay Region was performed. Wastewater sample was collected from alcohol industry, Mandalay Region. Some physicochemical parameters such as pH, colour, total solids, total dissolved solids (TDS), total hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were determined. The contaminants from distillery wastewater were removed by using coagulants such as sugar bleaching powder, clinker, limestone and lime. The wastewater sample was treated with different dosages of coagulants. Then, the parameters such as turbidity, TDS and pH were analyzed. And then, the wastewater sample was treated with the effective dose of lime coagulant for various agitation times. Moreover, the decolourization of distillery wastewater by using coagulant such as *Strychnos nux-vomica* seeds and by applying microbial film method were performed. In microbial film method, four strains of two gram-positive *bacilli* and two gram-positive *cocci* were firstly isolated from wastewater of alcohol industry. These isolated bacteria were confirmed by standard bacteriological methods. The potential of isolated bacterial strains in treatment of wastewater were studied by applying microbial film methods. After treatment, the wastewater sample was analyzed by digital photo colorimeter (Model-312).

Keywords: *Strychnos nux-vomica*, alcohol distillery wastewater, decolourization, microbial film method

Introduction

Water pollution is the contamination of water bodies such as lakes, rivers, oceans, or ground water by human activities. All water pollution affects organisms and plants that live in these water bodies and in almost all cases either to individual species and populations but also to the natural biological communities. It occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful constituents (Agrawal *et al*., 2010).

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The purification of wastewater from various industrial processes is a worldwide problem of increasing importance due to the restricted amounts of water suitable for direct use, the high price of the purification and the necessity of utilizing the waste products. Maintaining the drinking water quality of water from a source of water, maintaining adequate water quality throughout a distribution system has never an easy task (Shivajirao, 2012).

The largest contributor of industrial pollution is the fermentation industries, particularly the alcoholic fermentation waste. Distilleries produce high strength wastewater characterized by large amounts of organic matter. Distillery wastewater is one of the most polluted waste products to dispose because of the low pH, high temperature, dark brown color and high percentage of dissolved organic and inorganic matter with high (BOD) biochemical oxygen demand and (COD) chemical oxygen demand values. Distilleries have been generating huge quantities of high toxic effluents (Kharayat, 2012).

In Myanmar, there are many alcoholic industries. Alcoholic fermentation wastewater pollutes the environment with concentrated organic matter and high suspended solids content of discharge if it is untreated. It is an acknowledgeable fact that the alcoholic fermentation wastes are known to pollute the plant sites and the surrounding environment. Therefore, it is necessary to reduce water pollution and put up a pretreatment system.

Direct disposal of untreated distillery effluents into natural waters can result in depletion of dissolved oxygen in the receiving water stream and poses a serious threat to aquatic organisms as they contain many dark brown colored recalcitrant compounds (Wandzel *et al*., 2009).

Therefore, pretreatment of distillery wastewater is required for the control of water quality to its suitability for a particular purpose such as drinking water source, recreation and health, aquatic lives and agricultural use etc. and to achieve minimal impact on the receiving ecosystems.

In the present study, distillery wastewater sample collected from alcohol industry located in industrial zone of Mandalay was selected to analyze their physicochemical parameters and to remove their contaminants by chemisorption and biosorption processes. The decolourization of distillery wastewater by using coagulant such as *Strychnos nux-vomica* seeds and by applying microbial film method were performed. *Strychnos nux-vomica* seeds (Figure 1) are used as a primary coagulant in drinking water clarification and it can reduce turbidity of the water. The coagulant activity of *Strychnos nux-vomica* seeds are applied in water treatment at household level in environment of Inlay lakes, Southern Shan State. Furthermore, coagulation by using sugar bleaching powder, clinker, limestone and lime were analyzed.

Figure 1: Fruits and Seeds of *Strychnos nux-vomica*

Materials and Methods

Collection of Sample

Wastewater sample was collected from alcohol industry located in industrial zones of Mandalay (Figure 2). The sample was collected in 20 L (~5 gallons) polyethylene containers.

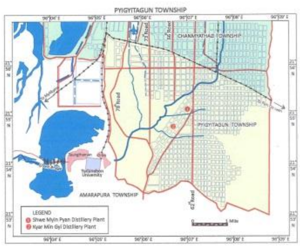

Figure 1: Map of Pyigyitagun Township, Mandalay Region

Determination of Some Physicochemical Parameters of Wastewater

The physciochemical parameters such as pH, turbidity, biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen and colour were analyzed by using pH meter, turbidity meter (Hach 2100 P), dissolved oxygen meter (Hach-Seni-ion 156) and digital photo colorimeter (Model-312). A total dissolved solid (TDS) was measured by oven method. Total hardness was determined by EDTA titration method.

Coagulation Using *Strychnos nux-vomica* Seeds

Collection and Preparation of Coagulating Materials (Ta-Paung-Lay-Win-Khar)

Strychnos nux-vomica seeds are used as a coagulating material. *Strychnos nux-vomica* (Ta-Paung-Lay-Win-Khar) seeds were collected from Naung Shwe Township, Southern Shan State. The seeds were harvested when they were fully matured which was determined by observing if there were any cracked pods on the plants. The pods were plucked and cracked to obtain the seeds which were air dried for one month. The seeds were grinded using blender and ground to obtain fine particles.

Study on the Effect of Coagulation Parameters

The coagulation parameters were studied via different coagulant doses and coagulating times.

Study on the Effect of Dose of Coagulants

0.5 g, 1.0 g, 1.5 g, 2.0 g of each coagulant was added separately into the beakers containing 1000 mL of wastewater. The mixtures in the beakers were shaken for 20 min using shaker. The suspension were left to stand without disturbance for overnight and the supernatants formed were decanted and subjected to determine the turbidity, total solid, total dissolved solid and total suspended solid.

Study on the Effect of Coagulation Times

1.5 g of *Strychnos nux-vomica* seed powder were added into four of plastic containers each containing 1000 mL of wastewater. The mixtures in the containers were shaken for 30, 60, 90 and 120 min by using shaker. The suspensions were left to stand without disturbance for overnight. The obtained supernatants were decanted and turbidity, total solid, total dissolved solid and total suspended solid were measured.

Isolation of Bacteria from the Wastewater Sample

Isolation of bacteria

To cultivate bacteria from wastewater samples, 1 mL of wastewater sample was direct cultured on the sterilized Petri dishes. It was incubated at 37 ºC for overnight. Numerous colonies with varying morphologies appeared on the agar plate and were studied microscopically by Gram's staining method.

The probable *bacilli* or *cocci* colonies were transferred onto the nutrient agar plates to obtain the pure culture. Bacteria $K_1$and K_2 are isolated from wastewater sample (Kyar- Min-Gyi alcohol industry) and bacteria $S_1$and S_2 are isolated from wastewater sample (Shwe-Min-Pyan alcohol industry) in Figure 3and 4.

Identification of Bacteria

Grams staining

Each and every types of colony from agar plates was stained with Grams stain. Staining reactions and cellular morphology was examined under oil immersion lens of the microscope.

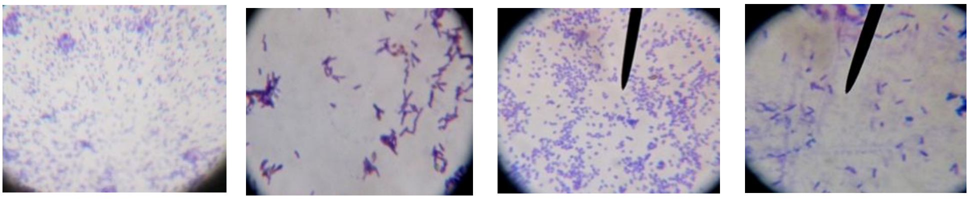

Figure 2: Microscopic morphologies of bacteria isolated (K_1, K_2, S_1 and S_2)

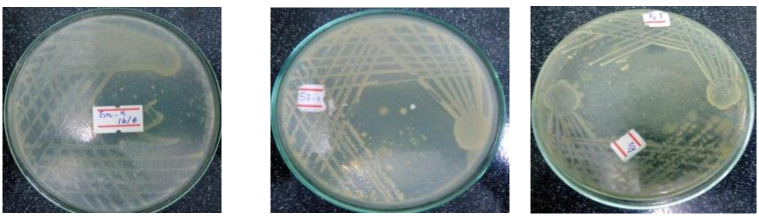

Figure 3: Screening of bacteria on nutrient agar medium

Investigation of Wastewater Treatment by Biofilm

Preparation of agar media for plate culture

Firstly, a conical flask containing an appropriate medium was stirred with a thermostatic control magnetic stirrer for a few minutes to mix the ingredients thoroughly and sterilized in an autoclave at 121˚C for 15 min under 15 psi pressure. Then, the sterile medium was poured into the sterile Petri dishes. The agar medium was allowed to solidify and drying was carried out using a microwave oven at 40 ˚C for 15 min. The selected bacterial strain was streaked on this solid medium and then incubated at 37 ˚C for its optimum incubation period.

Preparation of media for broth culture

0.13 g of nutrient broth was added into the 10 mL of distilled water in the beaker. The nutrient broth was added into the test tube. The test tube were plugged with non-absorbent cotton wool, sealed with aluminum foil, and then sterilized in an autoclave at 121˚C for 15 min under 15 psi pressure. After cooling the sterile media at room temperature, single colony of selective bacteria was added. Before use, the bacterial strain from the plate was checked by gram staining method. Then, the flask was on the shaker and shaking was done for 24 h. The resulting culture broth was used to prepare biofilm.

Preparation of biofilm

50 mL of nutrient broth and three pieces of sponges (1"x 1"x 1") were added into the conical flasks. The flasks were plugged with non-absorbent cotton wool, sealed with aluminum foil, and then sterilized in an autoclaved at 121˚C for 15 min under 15 psi pressures. Then, 5 mL of culture broth was added and shaken on shaker. The shaking was done for 48 h. After that, this mixture solution was decanted. The sponges were used as biofilm. Sponge only without bacteria adsorption was studied with microscopically (Figure 5).

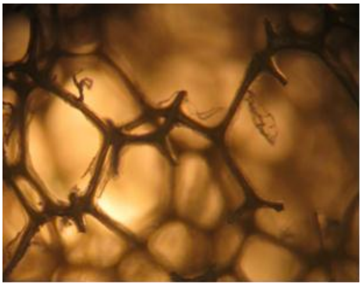

Figure 5: Sponge only by microscopic morphologies

Wastewater treatment by biofilm

150 mL of wastewater sample without nutrient was added into the biofilm. Then, the mixture was on shaker. In every 24 h, 5 mL of treated wastewater was taken and centrifuged at 10000 rpm for 15 min. After that, the supernatant was analyzed for colour intensity at 450 nm with digital photo colorimeter (Model- 312) and for total solids (suspended solid and dissolved solid). The experiment was repeated up to 5 days. Bacteria (K_1, K_2, S_1 and S_2) adsorption on sponge was studied by microscopic morphologies (Figure 6).

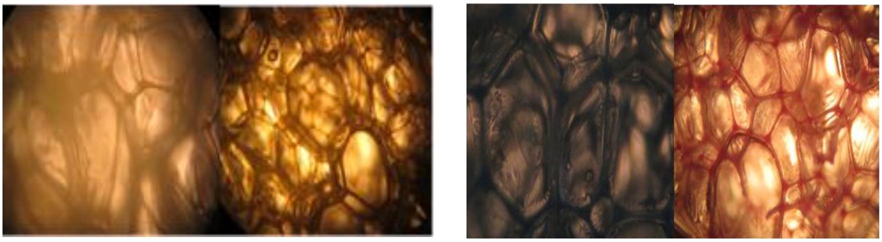

Figure 6: Bacteria (K_1, K_2, S_1 and S_2) adsorption on sponge by microscopic morphologies

Collection of Coagulating Materials

Sugar bleaching powders, clinker and limestone were used as a coagulating material in this experiment. Sugar bleaching powder was collected from Kyaukse market, Kyaukse Township, Mandalay Region. Clinker and limestone were also collected from Alpha Cement Industry, Kyaukse Township, Mandalay Region. Lime was collected from Htone-pho, Patheingyi Township, Mandalay Region.

Treatment of Collected Wastewater Samples by Coagulation

Coagulation Using Sugar Bleaching Powder

Four plastic containers each containing 1 L of wastewater sample were treated with various dosage of sugar bleaching powder such as 10 g, 20 g, 30 g, 40 g and 50 g. The mixtures in the containers were left to stand without disturbance for 30 min to 24 h. The optimum coagulation time was found to be 30 min. Therefore, all the containers were left to stand without disturbance for 30 min and the supernatants were decanted and subjected to determine pH, turbidity and total dissolved solids.

Coagulation Using Clinker

Four plastic containers each containing 1L of wastewater sample were treated with various dosages of clinker such as 20 g, 30 g, 40 g, 50 g and 60 g. The mixtures in the containers were left to stand without disturbance for 30 min to 24 h. The optimum coagulation time was found to be 24 h. Therefore, all the containers were left to stand without disturbance for 24 h and the supernatants were decanted and subjected to determine pH, turbidity and total dissolved solids.

Coagulation Using Limestone

Four of plastic containers each containing 1 L of wastewater sample were treated with various dosage of limestone such as 40 g, 50 g, 60 g and 70 g. The mixtures in the containers were left to stand without disturbance for 30 min to 24 h. The optimum coagulation time was found to be 24 h. Therefore, all the containers were left to stand without disturbance for 24 h and the supernatants were decanted and subjected to determine pH, turbidity and total dissolved solids.

Coagulation Using Lime

Four plastic containers each containing 1 L of wastewater sample were treated with various dosage of lime such as 20 g, 30 g, 40 g, 50 g and 60 g. The mixtures in the containers were shaken for 24 h using shaker. The suspensions were left to stand without disturbance and the supernatants formed were decanted and subjected to determine pH, turbidity and total dissolved solids.

Study on the Effect of Agitation Time

By studying the different doses of lime used in coagulation, the effective dosage of lime was found to be 50 g/L. According to these results, pH of wastewater sample was found to be increased and turbidity and TDS were reduced. So, the effective dosage of lime 50 g were added into five plastic containers each containing 1 L of wastewater. The mixtures in the containers were stirred for 3, 6, 9, 12 and 15 h by using magnetic stirrer. The suspensions were left to stand without disturbance for overnight. The obtained supernatants were decanted and turbidity, absorbance, total dissolved solid and pH were measured.

Results and Discussion

Analysis of Wastewater Samples

Table 1: Characteristics of Alcohol Distillery Wastewater Collected from Alcohol Industry

Parameters	Concentration	USEPA Standards
pH	5.43	6.00 – 9.00
TDS (mg/L)	3200	1200
Turbidity (NTU)	575	25
Total Hardness (mg/L)	1760	600
DO (mg/L)	0.40	> 0.5
BOD (mg/L)	14300	40
COD (mg/L)	15000	150

Table 1 shows the average characteristics of alcohol distilleries wastewater. From the determination of the physicochemical properties of the distillery wastewater, it can be observed that the major contaminants in wastewater were very high loadings of COD, BOD, total solids, TDS and TSS. Moreover, the characteristics of wastewater were observed to be highly coloured or highly turbid. In addition, there was significant acidity where pH is 5.43.

Removal of Turbidity in Wastewater Sample with Different Doses of Coagulants

Table 2: Turbidity in Wastewater Sample with Different Doses of Coagulants (*Strychnos nux-vomica*)

Doses of Coagulants (g/L)	Turbidity (NTU)
0	575
0.5	527
1.0	501
1.5	435
2.0	520

According to the results in Table 2, the effective dose of *Strychnos nux-vomica* coagulant was found to be 1.5 g/L.

Removal of Total Dissolved Solids in Wastewater Sample with Different Doses of Coagulants

In this result, the effective dose for the removal of TDS was found to be 1.5 g/L of coagulant.

Table 3: Total Dissolved Solids in Wastewater Sample with Different Doses of Coagulants

Doses of Coagulants (g/L)	Total Dissolved Solids (mg/L)
0	3200
0.5	2980
1.0	2800
1.5	2600
2.0	2600

Effect of Coagulation Time on Turbidity Removal from Wastewater Sample

Table 4: Effect of Coagulation Time on Turbidity Removal in Wastewater Sample

Coagulation Time (min)	Turbidity (NTU)
30 mins	435
60 mins	422
90 mins	438
120 mins	441

According to the results, the effective coagulation time for turbidity removal of *Strychnos nux-vomica* coagulant was found to be 60 min (Table 4).

Effect of Coagulation Time on Total Dissolved Solids Removal from Wastewater Sample

Table 5: Effect of Coagulation Time on Total Dissolved Solids Removal in Wastewater Sample

Coagulation Time (min)	Total Dissolved Solids (g/L)
30 mins	3200
60 mins	2600
90 mins	2560
120 mins	2560

According to the results, the effective coagulation time for TDS removal of *Strychnos nux-vomica* coagulant was found to be 90 min (Table 5).

Table 6: Physicochemical Characteristics of Alcohol Distillery Wastewater Sample before Treatment and after Treatment by Using *Strychnos nux-vomica* Seeds

Parameters	Before Treatment	After Treatment (1.5 g coagulant,60 mins)	Removal Efficiency (%)
pH	5.43	6.43	-
Total Dissolved Solids	3200	2560	20.00
Turbidity (NTU)	57	422	26.61
Total Hardness (mg/L)	1360	940	30.88
DO (mg/L)	0.40	0.97	-
BOD (mg/L)	14300	13900	2.79
COD (mg/L)	15000	9340	37.73

Table 6 shows physicochemical characteristics of alcohol distillery wastewater samples before treatment and after treating with effective dose of coagulants 1.5 g and optimum coagulation time of 60 min. After treatment, total hardness, BOD, COD, TDS and turbidity of wastewater samples were reduced and the value of pH and DO were increased.

After treatment for wastewater sample from alcohol industry, it was observed that the percents removal of total hardness were (30.88 %), BOD (2.79 %), COD (37.73 %), TDS (20.00 %), and turbidity (26.61 %). Before treatment, pH of wastewater sample was found to be 5.43 and DO of wastewater sample was found to be 0.40. After treatment, the values of pH and the values of DO were found to increase.

Percent Decolourization of Distillery Wastewater Using the Biofilm Method

The wastewater sample was treated by selected four bacterial strains using the biofilm method (Table 7 and Figure 7).

Table 7: Decolourization Activity of Isolated Bacterial on Distillery Wastewater for 5 Days Incubation

	Absorbance (450 nm)					
	0 day	1 day	2 days	3 days	4 days	5 days
Control	1.19	1.18	1.18	1.19	1.19	1.19
K_1	1.19	1.03	1.02	1.02	1.22	1.25
K_2	1.19	1.15	1.01	1.09	1.14	1.21
S_1	1.19	1.13	1.19	1.28	1.29	1.29
S_2	1.19	1.21	1.21	1.28	1.25	1.36

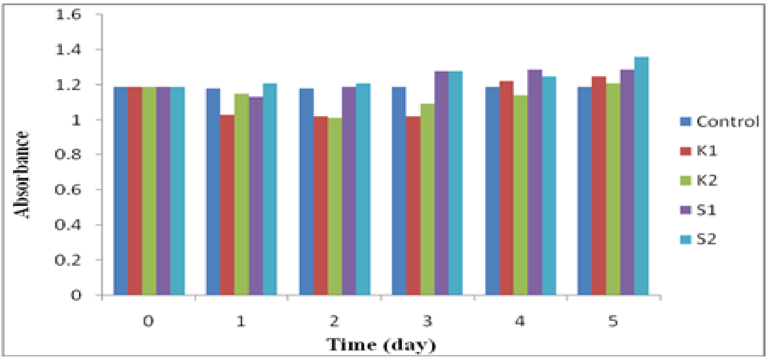

Figure 7: Decolourization activity of isolated bacterial on distillery wastewater for 5 days incubation

After two days incubation, colour removal of selective bacterial strains was found to be optimum. Among them, colour removal of bacterial K_2 was higher than other three bacteria.

According to these results, removal activity (TS, TDS and TSS) of isolated bacteria K_2 was found to be better than three other isolated bacteria and the optimum incubation time was found to be two days (Table 8).

Table 8: Removal of TS, TDS and TSS of Isolated Bacterial on Distillery Wastewater for 5 Days Incubation

Intubation Time (day)	mg/L	Control	K_1	K_2	S_1	S_2
	TS	3200	1600	1400	1600	1800
1	TDS	3000	1300	1100	1300	1500
	TSS	200	300	300	300	300
	TS	3200	1600	900	1200	1200
2	TDS	3000	1300	600	800	800
	TSS	200	300	300	400	400
	TS	3200	1100	1000	1300	1300
3	TDS	3000	800	600	900	900
	TSS	200	300	400	400	400
	TS	3200	1100	1100	1300	1300
4	TDS	3000	800	700	900	900
	TSS	200	300	400	400	400
	TS	3200	1100	1100	1300	1300
5	TDS	3000	700	700	900	900
	TSS	200	400	400	400	400

Table 9: pH Changes of Isolated Bacterial on Distillery Wastewater for 5 Days Incubation

Bacterial Strains	**pH**					
	0 day	**1 day**	**2 days**	**3 days**	**4 days**	**5 days**
K_1	4.62	5.11	5.42	5.42	5.42	5.42
K_2	4.62	5.11	5.42	5.42	5.42	5.42
S_1	4.62	5.11	5.42	5.42	5.42	5.42
S_2	4.62	5.11	5.12	5.11	5.11	5.11

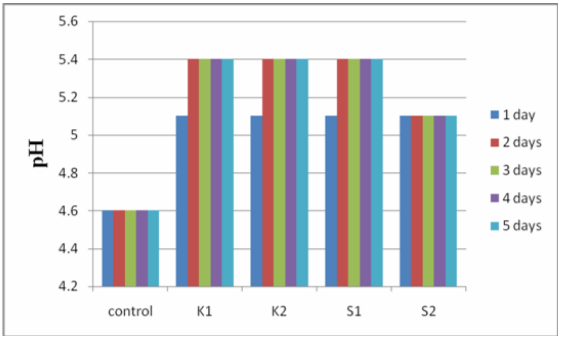

Figure 8: pH changes of isolated bacterial on distillery wastewater for 5 days incubation

Table 9 and Figure 8 show pH changes of isolated bacterial on distillery wastewater for 5 days incubation. Before treatment of wastewater sample was found to be 4.62. After treatment, the values of pH were found to increase.

Figure 9: Decolourization activity of isolated bacterial on distillery wastewater for 1 day incubation

Figure 10: Decolourization activity of isolated bacterial on distillery wastewater for 2 days incubation

Figure 11: Decolourization activity of isolated bacterial on distillery wastewater for 3 days incubation

Figure 12: Decolourization activity of isolated bacterial on distillery wastewater for 4 days incubation

Figure 13: Decolourization activity of isolated bacterial on distillery wastewater for 5 days incubation

Table 10: Physicochemical Characteristics of Wastewater Sample Before and After Treatment with Bacterium K_2 (Optimum Incubation Time 2 days)

Parameters	Before Treatment	After Treatment	Removal Efficiency (%)
pH	5.43	5.42	-
Total Dissolved Solids	3200	600	81.25
Turbidity (NTU)	575	310	46.06
Total Hardness (mg/L)	1360	720	47.06
DO (mg/L)	0.40	2.02	-
BOD (mg/L)	14300	8000	44.06
COD (mg/L)	15000	9600	36.00

Treatment of Wastewater Sample by Coagulation

Coagulation is the process by which dirt and other suspended solid particles to chemically stick together to floc. So they can easily be removed from water. Coagulants play an important role in the treatment of wastewater and disposal of sludge.

Coagulation Using Sugar Bleaching Powder

In this experiment, the dosages of sugar bleaching powder used in wastewater sample were in the range of 10 g/L to 50 g/L. After that, turbidity and TDS of wastewater samples were reduced and pH was increased.The most suitable condition of sugar bleaching powder dosage was found to be 40 g/L (Figure 14 and Table 11).

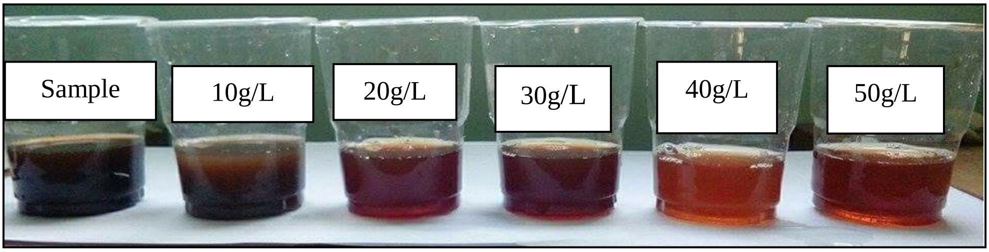

Figure 14: Wastewater sample from alcohol industry treated with different doses of sugar bleaching powder

Table 11: Removal of contaminants from wastewater sample using sugar bleaching powder

Parameters	Before Treatment	After Treatment (Bleaching powder)				
		10 g/ L	20 g/L	30g/ L	40 g/ L	50 g/ L
pH	5.43	6.31	6.42	6.42	6.42	6.42
TDS (mg/L)	3200	272	211	204	190	190
Turbidity (NTU)	575	390	389	375	310	320

Coagulation Using Clinker

In this study, the various dosages of clinker such as 20 g/L, 30 g/L, 40 g/L, 50 g/L and 60 g/L were used and the removal of contaminants (turbidity and TDS) were investigated. According to these results, the suitable and optimum dose 50 g/L was observed in Figure 15 and Table 12.

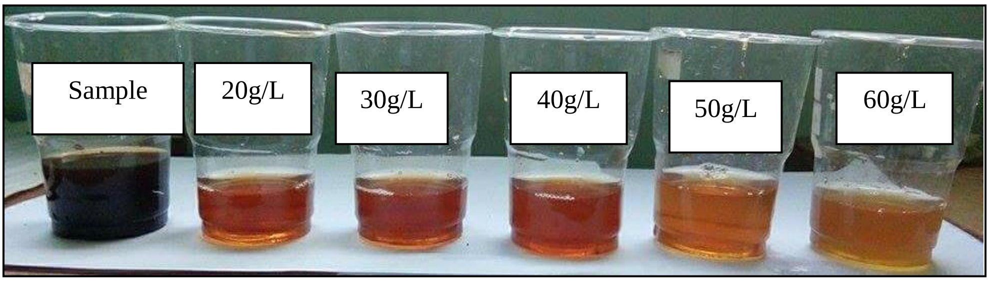

Figure 15: Wastewater sample from alcohol industry treated with various amount of clinker

Table 12: Removal of Contaminants from Wastewater Sample Using Clinker

Parameters	Before Treatment	After Treatment (Clinker)				
		20 g/ L	30 g/ L	40g/ L	50 g/ L	60 g/L
pH	5.43	8.55	9.25	9.25	9.25	9.25
TDS (mg/L)	3200	180	172	172	160	163
Turbidity (NTU)	575	250	215	200	180	180

Coagulation Using Limestone

In this research, the different doses of limestone used for coagulation. pH of wastewater sample was found to increase and turbidity and TDS were found to decrease. According to these results, the optimum dosage of limestone was found to be 60 g/L (Figure 16 and Table 13).

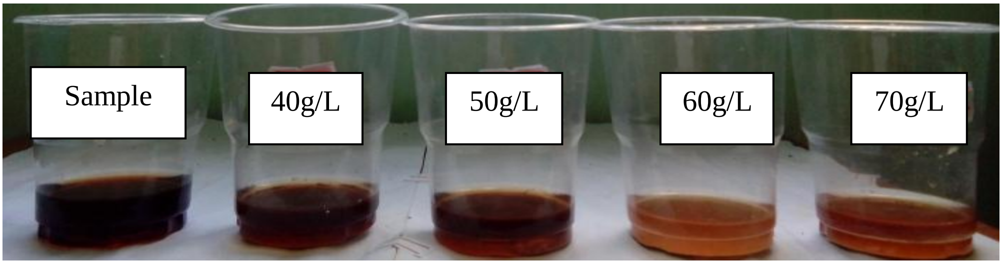

Figure 16: Wastewater sample from alcohol industry treated with various amount of limestone

Table 13: Removal of Contaminants from Wastewater Sample Using Limestone

Parameters	Before Treatment	After Treatment (Limestone)			
		40 g/ L	50 g/ L	60g/ L	70 g/ L
pH	5.43	5.43	7.51	7.51	7.51
TDS (mg/L)	3200	3200	250	230	230
Turbidity (NTU)	575	575	295	252	126

Coagulation Using Lime

In this research, the different doses of lime used for coagulation. pH of wastewater sample was found to increase and turbidity and TDS were found to decrease. According to these results, the optimum dosage of lime was found to be 50 g/L (Figure 17 and Table 14).

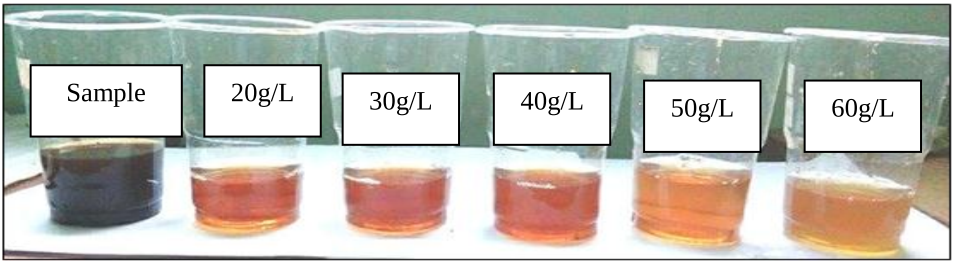

Figure 17: Treatment of wastewater sample from alcohol industry using lime

Table 14: Removal of Contaminants from Wastewater Sample Using Lime

Parameters	Before Treatment	After Treatment (Lime) 20 g/ L	30 g/ L	40 g/ L	50g/ L	60 g/ L
pH	5.4	8.00	8.00	8.93	8.93	8.93
TDS (mg/L)	3200	250	240	240	220	220
Turbidity (NTU)	575	295	185	182	120	120

Effect of Coagulant Doses on Contaminants Removal from Wastewater Sample

Table 15 shows the effective dose and the most suitable coagulant was found to be 50 g/L lime. The removal of TDS and turbidity from wastewater sample by lime coagulant was higher than other coagulants.

Table 15: Characteristic of Wastewater Sample from Alcohol Industry using Optimum Dose of the Different Coagulants

Parameter	Before Treatment	After Treatment Bleaching Powder (40 g/L)	Clinker (50 g/L)	Limestone (60 g/L)	Lime (50 g /L)
pH	5.43	6.42	9.25	7.51	8.93
TDS (mg/L)	3200	190	160	230	220
Turbidity (NTU)	575	310	180	252	120

The collected alcohol distillery wastewater contained very high COD, BOD, total dissolved solids and inorganic solids. The colour of wastewater was dark brown and it was acidic (pH 5.43).

Table 16 shows characteristics of alcohol distillery wastewater sample before and after treatment with effective dose of lime 50 g/L. After treatment, BOD, COD, TDS, hardness and turbidity of wastewater samples were reduced and the value of pH and DO were increased.

After treatment for wastewater samples from alcohol industry, it was observed that the percent removal of BOD (88.11 %), COD (33.33 %), hardness (51.36 %), TDS (93.12 %), and turbidity (79.13 %). Before treatment, pH of wastewater sample was found to be 5.43, and DO of wastewater sample was found to be 0.40. After treatment, the values of pH and the values of DO were increased.

Table 16: Characteristics of Distillery Wastewater from Alcohol Industry Before Treatment and After Treatment with Lime

Parameters	Before Treatment	After Treatment	Removal Efficiency (%)
pH	5.43	8.90	-
TDS (mg/L)	320	220	93.12
Turbidity (NTU)	575	120	79.13
Total Hardness	1360	856	51.36
DO (mg/L)	0.40	2.50	-
BOD (mg/L)	14300	1700	88.11
COD (mg/L)	15000	10000	33.33

Effect of Agitation Time on Removal of Contaminants from Wastewater Sample

In these results, the contaminants in water samples were reduced by using various doses of lime coagulants. The optimum lime dose 50 g/L was used for the removal of contaminants. The agitation times were varied at 3, 6, 9, 12 and 15 h. According to the results, optimum agitation time was found to be 9 h.

Table 17: Removal of Contaminants from Wastewater Sample After Treatment with Lime 50 g/L Using Stirrer

Parameters	Before treatment	After Treatment with Lime 50 g/L (Agitation Time)				
		3 h	**6 h**	**9 h**	**12 h**	**15 h**
pH	5.43	8.22	8.22	8.22	8.22	8.22
Turbidity	3200	110	98	57	60	60
TDS (mg/L)	575	210	210	210	210	210

The maximum percentage of turbidity removal was found to be 90.08 % for alcohol industry. After treating with the effective lime dose 50 g/L and effective agitation time 9 hours, it was found that the percent removal of BOD, COD, TDS, total hardness and turbidity were 88.11 %, 34.67 %, 93.44 %, 54.55 % and 90.08 %. Before treatment, the pH and DO of wastewater sample were 5.43 and 0.40. After treatment, the pH and DO of wastewater sample were increased (Figure 18 and Table 18).

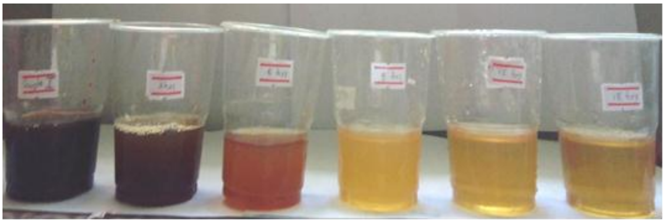

Figure 18:Wastewater sample from alcohol industry treated with lime for various stirring time

Table 18: Characteristics of Distillery Wastewater from Alcohol Industry Before Treatment and After Treatment with Lime (agitation time 9 h)

Parameters	Before Treatment	After Treatment	Removal Efficiency
pH	5.43	8.22	-
TDS (mg/L)	3200	210	93.44
Turbidity (NTU)	575	57	90.08
Total Hardness	1760	800	54.55
DO (mg/L)	0.40	3.20	-
BOD (mg/L)	14300	1700	88.11
COD (mg/L)	15000	9800	34.67

Removal Efficiency = A-B / A × 100
A = before treatment
B = after treatment

Conclusion

This research work was carried out for the characterization of alcohol distillery wastewater collected from alcohol industry. Physicochemical parameters such as pH, colour, total dissolved solids, total hardness, dissolved oxygen, biochemical oxygen demand and chemical oxygen demand were analyzed to determine the wastewater quality. From the determination of physicochemical properties of distillery wastewater, it can be observed that the major contaminants are very high loading of BOD, COD, total solids, total dissolved solids, total suspended solids, total hardness and turbidity. Moreover, the wastewater was acidic (pH 5.43).

So, pretreatment of distillery wastewater is required for the control of water quality to its suitability for a particular purpose and to achieve minimal impact on the receiving ecosystems.

The decolourization of distillery wastewater by using coagulant such as *Strychnos nux-vomica* seeds was carried out. The wastewater sample was treated with effective dose of coagulant (1.5 g) and effective coagulation time (60 min). It was found that 20.00 % of TDS, 26.61 % of turbidity, 30.88 % of total hardness, 2.79 % of BOD and 37.73 % of COD could be removed from alcohol industry.

In addition, the decolourization of distillery wastewater by applying microbial film method was studied. The wastewater samples were treated by selected four bacterial strains (K_1, K_2, S_1 and S_2). The most effective strain was found to be K_2 and the optimum incubation time was 2 days. The percent removal was found to be 81.25 % of TDS, 46.09 % of turbidity, 47.06 % of total hardness, 44.06 % of BOD, 36.00 % of COD in wastewater of alcohol industry.

Moreover, the contaminants from alcohol distillery wastewater were removed by using coagulant such as sugar bleaching powders, clinker, limestone and lime. After treatment, the removal percentages of turbidity and TDS from wastewater sample by lime were higher than those of other three coagulants. After treating with optimum dose of lime (50 g/L) and optimum agitation time (9 h), the percents removal were found to be93.12 % (TDS), 79.13 % (turbidity), 51.36 % (total hardness), 88.11 % (BOD) and 33.33 % (COD) in wastewater of alcohol industry. DO of the wastewater sample were significantly increased. The value of pH was also increased.

Locally available materials and low cost chemicals were used in this research. There was a strong indication that contaminants were significantly removed to reach the acceptable levels of United State Environmental Protection Agency (USEPA) Standards. Therefore, the suggested treatments can be used to reduce the pollution and the environmental impact for distillery wastewater.

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