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Study on Traditional Plants Utilized for the Treatment of Effluent with Special Reference to Palm Oil Mill Industry

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Abstract:
Palm oil is one of the most important vegetable oil. The extraction and purification process create a lot of waste and is known as palm oil mill effluent or POME. This research paper reviews the efficiency natural coagulants for the treatment of POME with cacti species and zeamaize. Temperature, initial pH, mixing time, mixing speed and coagulant dose were the constant parameters throughout the experiment. Further treatment efficiency was determined by pH, conductivity, alkalinity, Turbidity, hardness, TDS, TSS, oil and grease, BOD and COD of the sample are estimated by standard method. The result of this work indicates that both these traditional plants may contribute the treatment efficiency with respect to their potential characteristics. The significance of the study was also carried out by the correlation analysis.

Keywords: POME, cacti species, zeamaize, coagulant dose, parameters, correlation, jar test apparatus

1.0 Introduction
The effluent from industries have great toxic influence on the pollution of water body as they can alter the physical , chemical and biological nature of receiving water body. The initial effect of waste is to degrade the physical quality of water. Later biological degradation becomes evident in term of number, variety and organization of the living organism in water (Akanmu2011).Oil palm is one of the most versatile crops in tropical countries. Among the waste generated, palm oil mill effluent is considered the most harmful waste for environment if discharged untreated. Several conventional treatment methods were reported to be used in treating palm oil mill effluent which involved the use of aerobic, anaerobic and facultative ponds zero discharge technology, land application, ultra filtration as well as membrane technology (Saatci.et.al 2001).In both traditional and modern milling settings, these solid waste products are all put to economically useful purposes such as fuel material and mulch in agriculture nitrogenous dissolved solids, lipids and minerals which may be converted respectively. These solids are commonly in to useful materials using microbial activity.

Coagulation and flocculation constitute the backbone process in most water and waste water treatment plants. Their purpose is to improve the separation of particulate species in down stream processes such as sedimentation and filtration. The palm oil mill effluent can be treated using natural coagulants (Tan.J 2006). . The advent of strict environment regulations has made the palm oil proprietor to realize the eco-concern and learnt to treat the waste into an environmental friendly waste. The main advantages of using natural plant-based coagulants as water treatment material are apparent; they are cost-effective, unlikely to produce treated water with extreme pH and highly biodegradable. These advantages are especially augmented if the plant from which the coagulant is extracted is indigenous to a rural community. In the age of climate change environmental degradation, application of these coagulants is a vital effort in line with the global sustainable development initiatives. Application of cacti species and maize seeds for water treatment is rather recent compared to other natural coagulant such as nirmali or M.oleifera. The most commonly studied cactus genus for water treatment is Opuntia which is colloquially known as 'nopal' in Mexico or 'prickly pear' in North America and the maize varieties are sugar maize and red maize respectively. This cactus type has long been associated with its medicinal properties and dietary food sources. Besides Opuntia, other cactus species including *Cactus latifaria* have also been successfully used as natural coagulants. The high coagulation capability of Opuntia is most likely attributed to the presence of mucilage which is a viscous and complex carbohydrate stored in cactus inner and outer pads that has great water retention capacity. The study indicated that removal of contamination from the treated palm oil effluent and to make study on the efficiency of natural coagulants on the effluent treatment and also to focused to determine the effect of dosage of coagulants needed for the treatment of the effluent.Special attention to manage the waste water with natural coagulants in terms of sustainable management.

2.0 Materials and Methods:

Samples of untreated POME were collected from a palm oil mill in Yeroor, Kollam, Kerala. The natural coagulants such as cactus and zeamays were collected from the local areas and are used as in powdered form .The coagulant solution was prepared as different concentrations such as 200mg, 400mg, 600mg, 800mg and 1gm respectively. Each concentrated solutions were agitated at approximately 100 rpm with a magnetic stirrer until the solution was completely dissolved. For consistency, the solutions were prepared fresh before each set of experiments. A conventional jar test apparatus (Phipps and Bird stirrer, USA) was used in the experiments to coagulate POME with the coagulants. It was carried out as a batch test, accommodating a series of six beakers together with six-spindle steel paddles. The POME samples were mix homogeneously before fractionated into beakers containing 500 mL of suspension each. Prior to the test, the samples were measured for pH, alkalinity, turbidity, TSS, TDS, Hardness, oil & greace and COD for representing an initial concentration. After the desired amount of coagulant was added to the suspension, the beakers were agitated at various speeds, which consist of rapid mixing (250 rpm) for 3 minutes and slow mixing (30 rpm) for 30 minutes. After the agitation stopped, the suspension was allowed to settle for 30 minutes. A sample was withdrawn using a pipette from the top inch of supernatant for pH,conductivity,alkalinity turbidity,TDS, TSS,Hardness,oil &grease,BOD and COD measurements, representing the final concentration. For the analytical analysis, pH, conductivity, alkalinity, Turbidity, hardness, TDS, TSS, oil and grease, BOD and COD of the sample are estimated by standard method.

Fig.1: Palm Oil processing Industry, Yerror, Kollam, Kerala

3.0 Result and Discussion:

Temperature, initial pH, mixing time, mixing speed and coagulant dose were the constant parameters through out the experiment.

Table 1: Showing Different Parameters of untreated and Pre- Treated Effluent

Parameters	Untreared effluent	Pre-treated effluent with coagulants									
		Cactus					Zeamaize				
		200	400	600	800	1	200	400	600	800	1
pH	4.62	5.95	6.08	6.29	6.36	6.43	6.14	6.18	6.25	6.31	6.36
Conductivity µ S	526.32	530.8	548.9	567.2	578.6	589.4	529.9	535.8	550.2	563.3	570.6
Alkalinity	40	36	28	24	20	16	32	24	20	16	8
Turbidity	233.2	231.2	222.8	211.2	203.6	192.8	224.4	202.4	188	180.4	174
Hardness	425	390	380	370	360	350	380	360	350	345	325
TDS	6200	6000	5800	5600	5200	4800	5800	5700	5300	4600	4400
TSS	1000	1000	800	600	400	200	600	500	300	200	100
Oil &Grease	26	16	10	12	8	7.5	23	20	17	14	13
BOD	4750	2220	2002	1875	1530	1000	4099	4100	3872	3610	3200
COD	5100	2050	1180	640	310	85	4600	4010	3860	3740	2872

All values in mg/l except pH and EC

Statistical Analysis-Correlation Study

Table: (2) pH

Concentration	Cactus	Zeamaize	Correlation
200 mg	5.95	6.14	0.978856
400 mg	6.08	6.18	0.978856
600 mg	6.29	6.25	0.973403
800 mg	6.36	6.31	0.998625
1g	6.43	6.36	1

Table : (3) Conductivity

Concentration	Cactus	Zeamaize	Correlation
200	530.8	529.9	0.983081
400	548.9	535.8	0.983081
600	567.2	550.2	0.996357
800	578.6	563.3	0.989201
1g	589.4	570.6	1

Table: (4) Alkalinity

Concentration	Cactus	Zeamaize	Correlation
200 mg	36	32	0.988105
400 mg	28	24	0.988105
600 mg	24	20	0.982708
800 mg	20	16	0.981981
1g	16	8	1

Table: (5) Turbidity

Concentration	Cactus	Zeamaize	Correlation
200 mg	231.2	224.4	0.963594
400 mg	222.8	202.4	0.963594
600 mg	211.2	188	0.985188
800 mg	203.6	180.4	0.988843
1g	192.8	174	0.999835

Table : (6) Hardness

Concentration	Cactus	Zeamaize	Correlation
200 mg	390	380	0.979076
400 mg	380	360	0.979076
600 mg	370	350	0.964764
800 mg	360	345	0.944911
1g	350	325	0.999999

Table: (7) Tds

Concentration	Cactus	Zeamaize	Correlation
200 mg	6000	5800	0.977855
400 mg	5800	5700	0.977855
600 mg	5600	5300	0.968216
800 mg	5200	4600	0.952217
1g	4800	4400	1

Table: (8) Tss

Concentration	Cactus	Zeamaize	Correlation
200	1000	600	0.991241
400	800	500	0.991241
600	600	300	0.982708
800	400	200	1
1	200	100	1

Table: (10) BOD

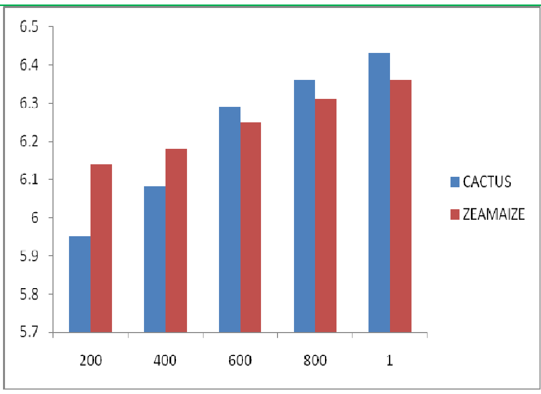
Concentration	Cactus	Zeamaize	Correlation
200 mg	2220	4099	0.985760493
400 mg	2002	4100	0.985760493
600 mg	1875	3872	0.990924817
800 mg	1530	3610	0.999987458
1 g	1000	3200	1

Table: (9) Oil & Grease

Concentration	Cactus	Zeamaize	Correlation
200 mg	16	23	0.879799
400 mg	10	20	0.879799
600 mg	12	17	0.691967
800 mg	8	14	0.990072
1 g	7.5	13	1

Table: (11) COD

Concentration	Cactus	Zeamaize	Correlation
200 mg	2050	4600	0.899056701
400 mg	1150	4010	0.899056701
600 mg	640	3860	0.810242921
800 mg	310	3740	0.86738433
1 g	85	2872	1



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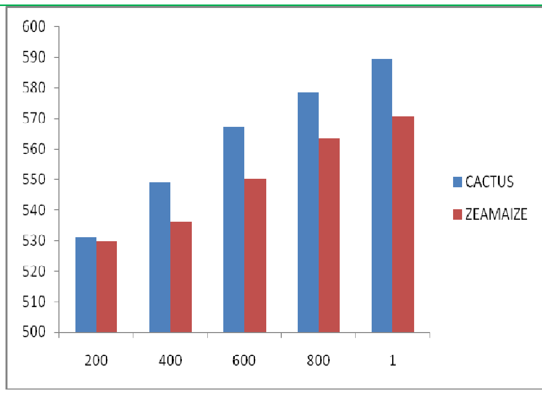

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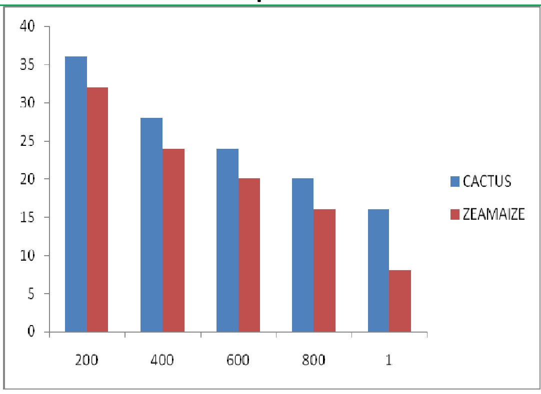

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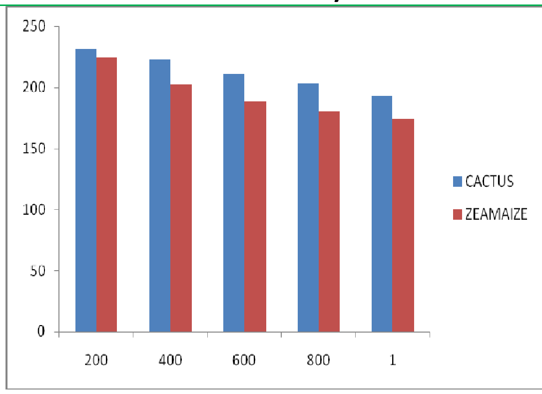

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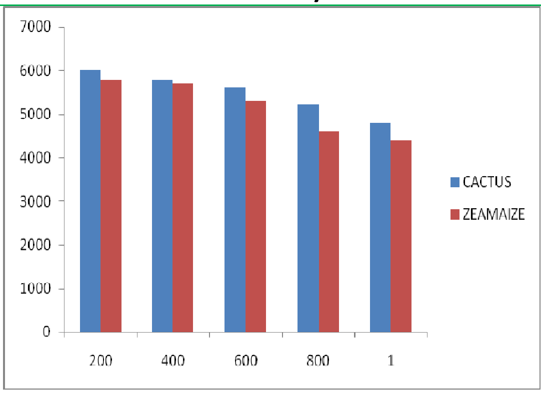

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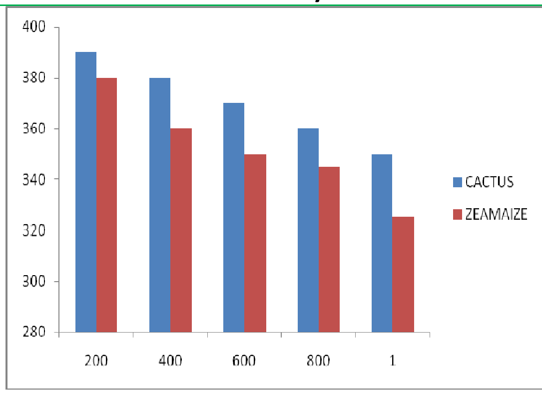

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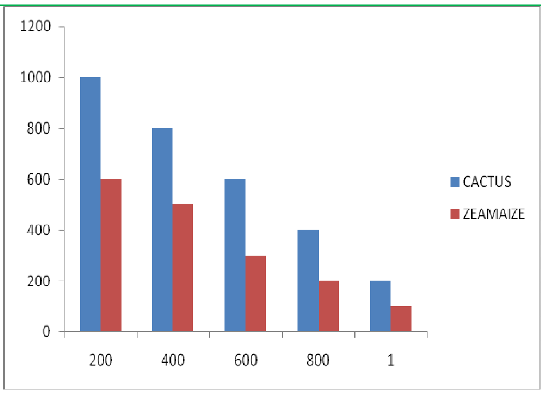

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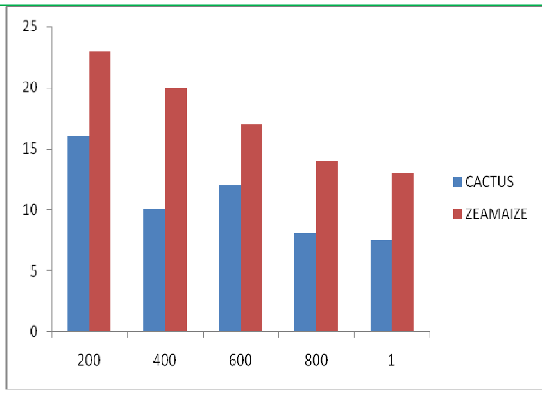
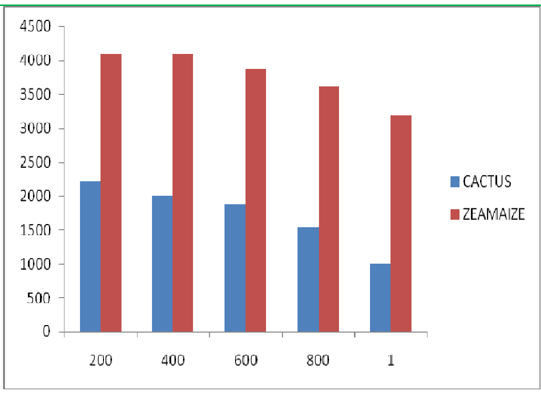
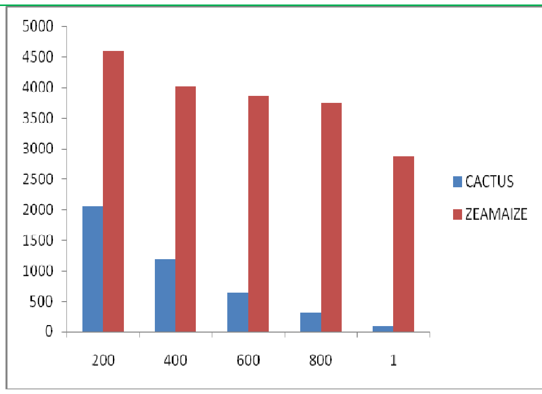


Oil & Grease



BOD



COD

3.1 Variation of pH after coagulation

The change in pH after the addition of coagulant may be due to the several hydrolic reactions , which are taking place during coagulation , forming multivalent charged hydrous oxide species and generating H_3O^+ ion during each step, thus neutralise the pH value. The graph (1) &Table (1) indicates that compairing cactus dose and zeamaize dose shows that zeamaize is more effective than cactus. The values of cactus treatment on concentrations 200,400,600,800 & 1 were 5.95, 6.08, 6.29, 6.36 & 6.43 respectively. The values of zeamaize treatment on such concentrations were 6.14, 6.18, 6.25, 6.31 & 6.36 respectively. These values (0.978856) were positively correlated (Table -2). By the addition of coagulant the pH starting to attain its neutral state.After the process of coagulation with natural coagulants such as cactus and Zeamaize shows that pH reaches the neutral state .But zeamaize have more ability to attain the neutral state than cactus.

3.2 Variation of conductivity after coagulation

The conductivity increased in a small rate when POME is pre- treated with cactus and zeamaize .The values were obtained when treated with cactus are 530.8, 548.9,567.2,578.6 and 589.4 Scm^{-1} for different concentrations and in zeamaize 529.9,535.8,550.2,563.3and 570.6 Scm^{-1} . The graph (2)& Table (1) shows that cactus more effective than zeamaize . The conductance was increases due to the action of cactus than zeamaize. The mixing and dosage of coagulants and providing settling time allow the effluent conductivity become increasing slightly. . The correlation between the cactus and zeamaize treated effluent gives a positive correlated (Table -3) value (0.983081).

3.3 Variation of alkalinity after coagulation

The effluents before pre-treatment have 40ml/l of alkanity. After pretreatment of the effluent alkalinity were redused. The value for cactus treatment were 36, 28, 24, 20,16 and zeamays were 32, 24, 20,16, & 8 for concentrations 200, 400, 600, 800& 1 respectively. The graph(3) and Table (1) shows that zeamaize is more effective than cactus and both of them were positively correlated (Table -4) to each other (0.988105).Alkalinity values provide guidance in applying proper doses of chemicals in water and waste water treatment process, particularly in coagulation, softenning and operational control or anaerobic digestion.

3.4 Variation of Turbidity after coagulation

The turbidity of effluent before pre- treatment was 233.2 high turbidity value. The treatment of effluent with cactus and zeamays cause changes in turbidity value. The turbidity value (Table 1) for effluent treated with cactus were231.2, 222.8, 211.2, 203. 6 & 192.8 for different concentration (200, 400, 600, 800, 1 respectively).Similarly values for zeamaize treatment were 224.4, 202.4, 188,180.4 &174 .From these values found that zeamaize (Graph-4) have more ability than cactus to reduse turbidity. This turbidity reduction may result from coagulation and flocculation process of palm oil mill effluent. The correlation of turbidity of effluent treated with cactus and zeamays shows (Table -5) that values were positively correlated (0.963594) .Turbidity is measured to evaluate the performance of water treatment plants

3.5 Variation of hardness after coagulation

Hardness of water is not a specific constituent but is variable and complex mixture of cations and anions.It is caused by dissolved polyvalent metalic ions.Hardness is imparted by bicarbonates, chlorides and sulphates of Ca, Mg present in sample. The effluent before pre –treatment have hardness 425mg/L. Due to the addition coagulants such as cactus and zeamaize the hardness tend to reduce because of the action of coagulants on bicarbonates and sulphates of Ca or Mg .From the graph(5) obtained that zeamaize is effective than cactus and they are positively correlated (Table-6) . When the concentration of coagulants increases hardness of effluent decreases.The hardness values obtained for cactus treatment were 390, 380, 370, 360, 350mg/L and values obtained for zeamaize were 380, 360, 350, 345, 325mg/L. The correlation obtained for these values are positively correlated (0.979076).

3.7 Variation of Total dissolved solids after coagulation

Some organic substances which contribute the dissolved solids were also present in effluent. Total dissolved solids are determined as the residue left after evpouration of the filtered sample. The high value of TDS (6200) of effluent decresed by pre treatment. The values obtained from cactus treatment were 6000, 5800, 5600, 5200, 4800 mg/L, and that for zeamaize were 5800, 5700, 5300, 4600, 4400mg/L. The graph (6) table (1) shown that zeamaize is more effective than cactus to reduse total soilds. The correlation (Table-7) is positive (0.977855).

3.8 Variation of Total suspended solids after coagulation

Great difference occurs between the actions of coagulants on effluent. Zeamays is more effective than cactus. The values for cactus treatment were 1000, 800, 600, 400, 200mg/L and zeamaize were 600, 500, 300, 200, 100mg/L. the graph (7) table (1) shown that zeamays have capability greater than cactus to reduce total suspended solids.The values were(Table-8) positiveley correlated (0.991241) .

3.9 Variation of Oil and Grease after coagulation

The palm oil mill effluents having the main contaminants are residuel oil.So the removal of these impurities make special attention. The removal of oil and grease were also obtained during coagulation and flocculation. For each concentration of coagulants the oil and grease content is decreased. The values obtained for cactus treatment were16, 10, 12, 8, 7.5, and for zeamaize is 23, 20, 17, 14, &13. The graph (8) & table (1) were shown that cactus have more efficiency than zeamays for reducing contamination. Both these coagulant treatment were positively correlated (0.879799, Table 9).

3.10 Variation of Biochemical oxygen demand after coagulation

The effluent from the palm oil mills is highly polluting with a high load of BOD, much of which is associated with finely divided colloidal or dissolved organic matter. However, in terms of meeting the BOD discharge standards, it is essential that a high proportion of these solids are removed before attempts are made to remove soluble BOD. After the coagulation process with natural coagulants,graph(9)& table(1) were shows that cactus have more efficiency than zeamaize for reducing BOD .Both these coagulant treatment were positively correlated (0.985760493,Table 10).The values obtained for cactus treatment were 2220,2002,1875,1530,1000mg/L and for zeamaize 4099,4100,3872,3610,3200mg/L.The reduction in BOD value greatly depends upon the initial value of untreated effluent.

3.11 Variation of Chemical oxygen demand after coagulation

The coagulation treatment with natural coagulants shows high COD reduction. The result from the Table 1 and Graph 10 shows that cactus is highly effective than zeamays. These shows that the increases of coagulant dosage for both coagulants lead to better coagulation performances. The trends for all values are almost identical. The values obtained for cactus treatment were 2050, 1180, 640, 310,and 85mg/L, and for zeamaize is 4600,4010, 3860,3740 and 2872mg/L The graph(10)& table(1) were shown that cactus have more efficiency than zeamaize for reducing contamination .Both these coagulant treatment were positively correlated (0.899056701,Table 11)

The estimated value for pH, conductivity, alkalinity, turbidity, hardness,TDS, TSS, oil & grease, BOD, COD, and were treated with natural coagulants showing the coagulation property is more or less identical toeach other. However,one of the natural coagulant such as cactus or zeamaize indicates the variations in physico-chemical parameters.In certain extent,the efficiency of both of the coagulants much more increses than other.After the coagulation shows that,pH become attains to neutral state,the conductivity will be decreases because of the dissolution of salts coagulation. The alkalinity, turbidity, hardness, TDS, TSS, oil and grease, BOD and COD were reduced by the action of plant based coagulants.From this research work emphasis on cactus is most effective increasing conductance and removal of BOD and COD whereas zeamaize pH,alkalinity,turbidity,hardness ,TSS and TDS respectively.

4.0 Conclusion:

Water bodies have an inherent capability to dilute the pollutants, which enter the system. However, indiscriminate dumping of untreated sewage and chemical wastes directly into rivers, lakes, and drains have made these water bodies unable to cope up with the pollutant load. The steady increase in the amount of water used and wastewater produced by urban communities and industries throughout the world also poses potential health and environmental problems. The study demonstrates that cactus and zeamays were environment friendly natural coagulant for palm oil mill effluent treatment. The result of the study showed that coagulation and flocculation were able to reduce turbidity COD, Hardness, BOD, Alkalinity, Conductivity, TDS, TSS, and Oil & Grease. This pre treatment method for palm oil mill effluent can significanty reduces the total pollution strength of the effluent. It could be concluded from obtained result that the coagulation, flocculation process become more efficient and cost effective. It improves water clarity and produces water can be recycled or safely discharged to water streams.

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