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Colour and COD Removal from Food and Beverages Industrial Wastewater by using Spent Alkalis Carbide Lime (SACL)

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ABSTRACT

The abundant amount of water used in the food & beverages (F&B) industry has caused the wastewater from this industry to be one of the major sources of water pollution, due to its high content of colour and chemical oxygen demand (COD). In this study, spent alkalis carbide lime (SACL) was used in treating the colour and COD simultaneously from the F&B industrial wastewater. SACL was used to reduce the amount of landfill waste and because of its similar characteristic to lime. The SACL was characterized using X-ray Diffractometer (XRD) X-ray Fluorescence (XRF), Scanning Electron Microscope (SEM), and Fourier-Transform Infrared Spectroscopy (FTIR) while the F&B industrial wastewater was characterized by using HACH DR6000 and UV-Vis Spectrophotometers. Several series of chemical precipitation experiments were conducted through jar tests to evaluate the effects of SACL dosing, pH value, and contact time on the percentage removal of colour and COD. The optimum conditions obtained from this study are pH 7 and 20 minutes, with percentage removal of 99.5% and 89.8% for colour and COD. However, the percentage removal of colour and COD decreased as contact time increased. With the same value of pH and contact time, SACL managed to remove more colours compared to lime, which is 93.6% compared to 88.54%, respectively. According to the analyses of FTIR and UV-Vis, the wastewater sample was cleaner when using SACL compared to using lime during the treatment. Thus, the study proves that SACL is a reliable alternative to treat colour and COD from F&B industrial wastewater.

Keywords:
Spent Alkalis Carbide Lime (SACL); leachate; Ammoniacal Nitrogen (AN); colour

1. Introduction

In comparison with other industrial sectors, the F&B industry is a part of many industries that use a colossal amount of water for every ton of product made. This industry produces wastewater containing high colour and turbidity since most of the food manufacturers include the use of dye and printing activities in their production cycles [1]. Other than that, wastewater coming from the food industry also contains high contaminants like biological oxygen demand (BOD), suspended solids (SS) as well as colloidal particles [2]. To make it worse, wastewater with high colour and turbidity would

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reduce the penetration of light radiation from reaching into the water. The photosynthetic activity would eventually be disrupted, leading to the changes in the natural balance of flora and fauna [2].

The colours, especially the synthetic ones, are found to be harmful to human health as well as to the environment. The effluent is a serious environmental matter, as it could substantially drop the concentration of oxygen as a result of the hydrosulphide presence [1]. Meticulous studies have deduced that coloured allergens are possible to encounter the assimilation of chemical and biological, promote eutrophication, deplete dissolved oxygen, prohibit the re-oxygenation in receiving streams, and prone to sequester metal ions that speeds up the genotoxicity and micro toxicity [3].

In compliance with the Sustainable Development Goals, the treatment of wastewater is very important to ensure the sustainability of water sources in this generation. In line with the principle of the Environmental Management Plan (EMP), the impacts of human activities on the environment can also be controlled. In this case, the colour of wastewater coming from food industries can be treated or reduced by using several treatment methods like adsorption, electrocoagulation and chemical precipitation [4,5].

Adsorption offers the benefits of simplicity in terms of operation and equipment, efficiency, and low in terms of cost [6]. Activated carbon is the most used adsorbent as it is remarkably effective [7]. However, it is expensive because the commonly activated carbon in the market is made from coal, lignite, peat, petroleum residue and wood which are very expensive and exhaustible [8]. Electrocoagulation is widely used in wastewater treatment because of its low requirement of chemicals, flexibility, safety, precision, simplicity of control, and automation [9]. Aluminium (Al) and ferum (Fe) are the most common types of electrodes used in this process. Other than that, the efficiency of contaminant removal in the chemical precipitation process is generally influenced by the pH and concentration of chemical agents used [10].

Since Malaysia has quite limited space for landfills and the cost of disposal methods is increasing, the government of Malaysia has started to enhance solid waste management in the country. In order to resolve the issue of waste management, some wastes coming from industrial activities have started to be reused and recycled for wastewater treatment which can also help in reducing the consequences to the environment [11].

In this study, we have found that spent alkalis carbide lime (SACL), which is mineral sludges including calcium hydroxides sludges one of the scheduled wastes from acetylene production gas, has the potential to be a good precipitant in wastewater treatment. This is because it contains a high composition of calcium hydroxide ($Ca(OH)_2$), which is usually more than 90% of the whole SACL composition on a dry weight basis [2]. The compositions Ca^{2+} and OH^- ions from $Ca(OH)_2$ in SACL contribute to trapping colloidal particles contained in the wastewater [12].

However, instead of aiming for colour removal, SACL has been used in previous studies to remove and reduce other contaminants in the wastewater [12] such as organic compounds and total suspended solids (TSS) [13]. Hence, this study was done to determine the optimum conditions (dosing, pH, contact time) that would help in improving the effectiveness of SACL in the chemical precipitation process to remove colour, COD and other contaminants in the wastewater.

2. Methodology

2.1 Preparation of Raw Material

2.1.1 Spent Alkalis Carbide Lime (SACL)

The SACL was obtained from an acetylene gas production company located in Shah Alam, Selangor. 3 kg of SACL sample was taken through the grab sampling method and kept in a plastic container to be taken to the laboratory in UiTM.

The SACL was first spread out on a tray to be dried uniformly. The Universal Oven (FROILABO) was used to dry the sample for 24 hours at 100°C to remove the moisture content (80-85%) from the SACL. To ensure that the moisture content has been removed uniformly, the SACL was weighed before and after the drying process for determination of moisture content. The percentage of moisture content was calculated using Eq. (1).

$$\%\,Moisture\ content\ = \frac{(M_W - M_D)}{M_W} \times 100\% \tag{1}$$

where,
M_W = Total mass of wet sample (g)
M_D = Total mass of dried sample (g)

After the SACL sample had been completely dried, the sample was let to cool down at room temperature, 25°C, for about 20 minutes. Then, the dried SACL sample that was fragile enough was crushed by mortar into powder size. After the crushing process, the sample was sieved by using Sieve Shaker 200CL (OCTAGON) to ensure that the dried SACL samples used in the experiment are all in uniform powder size of 300 µm.

2.1.2 Food and beverage wastewater

The wastewater was obtained from concentrated cordial beverages manufacturing company located in Shah Alam, Selangor. The initial pH of the obtained wastewater was taken using a pH meter (Hanna HI8424). To avoid any changes to the condition of the sample throughout the time, the sample was stored in a refrigerator at 4°C before being used in the experiment.

2.2 Characterization of Raw Material

2.2.1 Spent Alkalis Carbide Lime

The powdered SACL sample was characterized by using X-ray Fluorescence (XRF), X-ray Diffractometer (XRD), and Scanning Electron Microscope (SEM) as well as Fourier-Transform Infrared Spectroscopy (FTIR). Rigaku XRD D/Max 2200V/PC was used to determine the crystallographic structure of powder [14]. The angle of the diffractogram started from 3° until 80° with the speed of 5°/min, and it was run at 40 kV. It works by irradiating the SACL sample with incident X-rays and then measuring the intensities and the scattering angles of the X-rays that leave the material. After the XRD analysis was completed, the XRD2DScan software visualized the 2D data of the SACL sample into a 1D data scan.

The Panalytical Axios XRF / HP DC7900 linked to Epsilon software, was used to determine the elemental composition in the SACL before chemical precipitation process. After running the sample, the software displayed the compositions of elements that were present in the SACL sample. The SEM, Type Leo DSM 982 Gemini, was used to visualize the structures present within the SACL or on its surface. The images resolutions observed ranges from 1.00 mm @ 15.0 kV until 5.00 µm @ 15.0 kV.

The Perkin Elmer FTIR was used to analyse the infrared spectrum of SACL, together with the peak of absorption that correlates to the vibration frequencies between the bonds of the atoms that make up the SACL. Since SACL is similar to lime and previous studies stated that it contains a high composition of $Ca(OH)_2$ [12], FTIR was used specially to determine the wavelength and the peak value of the O-H bond.

2.2.2 F&B industrial wastewater

F&B wastewater was characterized before the chemical process was conducted to determine the initial concentration of colour, COD, TSS, and turbidity. The initial concentration of these four parameters is important for comparison between the parameters' concentrations before and after the experiment has been conducted. To identify the characteristics of the F&B wastewater sample, HACH DR6000 Spectrophotometer and UV-Vis Spectroscopy were used. The final concentration of the parameters should comply with the concentration as listed in the Standard B of Environmental Quality (Industrial Effluent Regulation) 2009 provided by the Department of Environment's Malaysia [15].

HACH DR6000 Spectrophotometer is the industry's most advanced laboratory spectrophotometer for water testing. It offers high-speed wavelength scanning across the UV and Visible Spectrum and comes with over 250 pre-programmed methods including the most common water and environmental testing methods. This spectrophotometer was used to determine the concentration of colour, COD, and TSS in the solution, which in this case is the F&B wastewater sample. Its spectral range goes from 190 nm to 1100 nm, with a bandwidth of 2 nm. In this study, 10 mL of sample wastewater was measured to determine the characterization of the elements that were present in the wastewater.

The Perkin Elmer/ Lambda 750 UV-Vis Spectroscopy was used to measure the absorbance of light across the ultraviolet and visible ranges of the electromagnetic spectrum. When incident light strikes the liquid sample, it can be absorbed, reflected, or transmitted. The absorbance of radiation in the UV-Vis range causes the excitation of the atom, referring to the molecules' transition from a low-energy ground state to an excited state.

2.3 Parameter Determination

2.3.1 Colour measurement

Before determining the colour concentration of the F&B wastewater sample, a blank was prepared first. 25 mL of sample cell was rinsed with distilled water and dried with a tissue before being used. After that, 10 mL of distilled water was filled into the dried sample cell using a dropper to ensure that there would be no spilling from the sample cell. Then, the stored program number that has been displayed in the DRB6000 was selected.

Since the size of the sample cell was 10 inches and the unit of colour concentration required in this study was ADMI, therefore the setup programme used was Programs 97. The spectrophotometer then displayed the unit for the colour concentration (ADMI) and the ZERO icon. The blank of the sample cell was covered tightly with the instrument cap and placed in the cell holder. After that, press the ZERO icon, and the screen displayed 0 ADMI.

The same method was repeated by filling 10 mL of F&B wastewater samples into the sample cell by using a dropper. The sample cell was placed into the cell holder and was made sure that it was covered tightly with the instrument cap. After that, the READ icon was pressed, and the screen displays the concentration of the colour in the ADMI unit. The displayed colour concentration is recorded for further study.

2.3.2 COD measurement

The determination of COD concentration can be adapted from the Standard Method for the Examination of Water and Wastewater by following the HACH Method 8000. The COD HACH DRB200 reactor vial used in this study ranges from 20 to 1500 mg/L (HR). For the measurement of COD, the blank was prepared with 2 mL of distilled water into the COD (HR) vial by using a dropper. After that, the vial was covered with a cap, and it was inverted gently several times to ensure that the content was completely mixed. The colour of the vial changed from light clear yellow colour to milky yellow colour after it was completely mixed. Safety precautions should be considered since the bottom of the vial started to feel hot after it was being inverted due to the reaction occurring.

Next, 2 mL of filtered wastewater sample was prepared into the vial of COD (HR) by using a dropper. The vial was inverted gently to mix the content. The prepared sample was then heated in the HACH DRB200 reactor for 2 hours at 150°C. After the heating process has completed, each vial was placed in a tube rack to be cooled down at room temperature. After the vial was completely cooled, the program in DR6000 was set to read the COD concentration result with the 435 COD HR program (HACH).

The blank sample was wiped and inserted into the cell holder. Then, the cell holder lid was closed and button zero was pressed on the DR6000. The screen displayed 0.0 mg/L of COD concentration. After that, the blank sample was wiped and replaced with the F&B wastewater sample in the cell holder. The lid of the cell holder was closed, and the button read was pressed to determine the concentration of COD in the mg/L unit.

2.3.3 Turbidity measurement

To measure the turbidity of the F&B wastewater sample, the HACH Z100Q turbidity meter was used in this study. Before measuring the turbidity of the F&B wastewater, the sample bottle was inverted gently to mix the wastewater. Then, the pipette was rinsed three times with the sample wastewater. After the turbidity cell was filled, the outside of the turbidity cell was wiped to ensure that the cell was free of smudges. Then, the turbidity cell was placed in the turbidimeter. After several seconds, the value of the turbidity of the sample was displayed on the instrument screen in the unit of NTU. The averaging on the instrument increased the signal-to-noise ratio, which differentiates the signal better from the background noise of the instrument.

2.4 Chemical Precipitation

Several series of jar test were conducted to study the chemical precipitation of the powdered SACL to remove colour and COD from the F&B wastewater sample. The rotary shaker was used instead of jar test equipment. Before the test was conducted, the initial concentration of colour, COD, TSS, and turbidity was measured by using HACH DR6000 and HACH 2100Q turbidimeter.

The jar test was conducted several times with different values of SACL dosing, pH, and contact time. In each experiment, each beaker used was filled with 250 mL of F&B wastewater. In addition, the rotary shaker was set at 120 RPM by turning the jog shuttle in a second.

After each experiment was done, the remaining SACL in the beakers was filtered by using Whatman grade 42 filter paper. The final concentration of colour, COD, TSS, and turbidity of the wastewater samples from each beaker were also measured by using HACH DR6000 and HACH 2100Q turbidimeter to determine the percentage removal for all four parameters.

2.4.1 Effect of SACL dosing and pH value

In accordance to determine the optimum pH value, the dosing of the SACL was done to control the pH of the F&B wastewater. The pH values of the wastewater sample were varied from 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5 and 9.0. Hanna pH meter (HI8424) was used to measure the pH value. After the beakers were well prepared with the wastewater at different pH values, they were put onto the rotary shaker and allowed to run at 120 RPM for 20 minutes. After 20 minutes, the beakers were left to allow the flocs to settle down completely. The correlation between SACL dosing and pH value as well as the percentage removal of colour and COD versus pH value were plotted on a graph to find the optimum pH value.

2.4.2 Effect of dosing

To determine the optimum contact time for chemical precipitation of SACL towards the F&B wastewater, the optimum pH value of wastewater obtained from the first experiment was kept constant. The contact time for this experiment was varied from 20 to 40 minutes, with 10 minutes increment between the beakers. Thus, three beakers were used to study the contact time of the chemical precipitation process. All three beakers were located onto the rotary shaker then run. After the experiment was done, the percentage removal of colour and COD versus pH value of the wastewater sample was plotted on a graph to find the optimum contact time.

2.4.3 Comparison between SACL and lime

After the optimum conditions for pH value and contact time of the powdered SACL have been determined, the last experiment was conducted by using lime as the chemical agent. The conditions of pH value and contact time used for the lime were the same as the optimum conditions obtained from the experiment with SACL treatment. After the experiment was done, the percentage removal of colour and COD were plotted in a graph. The effectiveness of using powdered SACL and lime was compared.

3. Results and Discussion

3.1 Characterization of F&B Industrial Wastewater

The F&B wastewater used in this experiment was taken from concentrated cordial beverages manufacturing company located in Shah Alam, Selangor. The initial value of parameters for pH, colour, COD, TSS, and turbidity was recorded in Table 1. Table 1 also shows the value of parameters for Standard B in Environmental Quality (Industrial Effluents) Regulation 2009 [15].

Based on the initial characterization of the wastewater sample, it is observed that all the parameters listed do not comply with Standard B in the fifth and seventh schedule of Environmental Quality (Industrial Effluents) Regulation 2009 [15]. Hence, the F&B wastewater from NFBI must be treated before being discharged into any water bodies.

Table 1
Initial value of parameters for F&B Industrial Wastewater

Parameters	Initial Values	Equipment Used	Standard B Values
pH	3.38	Hanna pH Meter H18424	5.5 – 9.0
Colour (ADMI)	35600	HACH DR6000 UV-Vis Spectroscopy	200
COD (mg/L)	889800	HACH DR6000 UV-Vis Spectroscopy	200
TSS (mg/L)	6000	HACH DR6000 UV-Vis Spectroscopy	100
Turbidity (NTU)	5860	HACH 2100Q Portable Turbidimeter	Not stated

3.2 Characterization of SACL

Before water treatment was done, the SACL was characterized using several types of equipment to study the element contained in SACL and the surface of the SACL that would allow chemical precipitation and adsorption to occur.

3.2.1 XRD analysis

Figure 1 shows the XRD analysis of SACL with the peaks of intensity for specific compounds present at specific angles. From Figure 1, the peak only shows the presence of calcium carbonate, $CaCO_3$ compound in the SACL. This is because the XRD equipment could not detect the H element, hence, the equipment could not detect the $Ca(OH)_2$ from the SACL. Therefore, based on a study on the composition of the carbide lime, in which its composition is very similar to SACL [16], the equipment was set to detect the second-highest composition of the compound in the SACL, which is the $CaCO_3$.

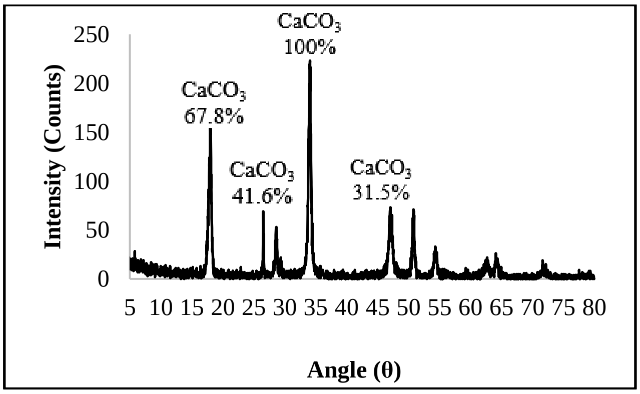


Fig. 1. Result of XRD analysis for SACL

3.2.2 XRF analysis

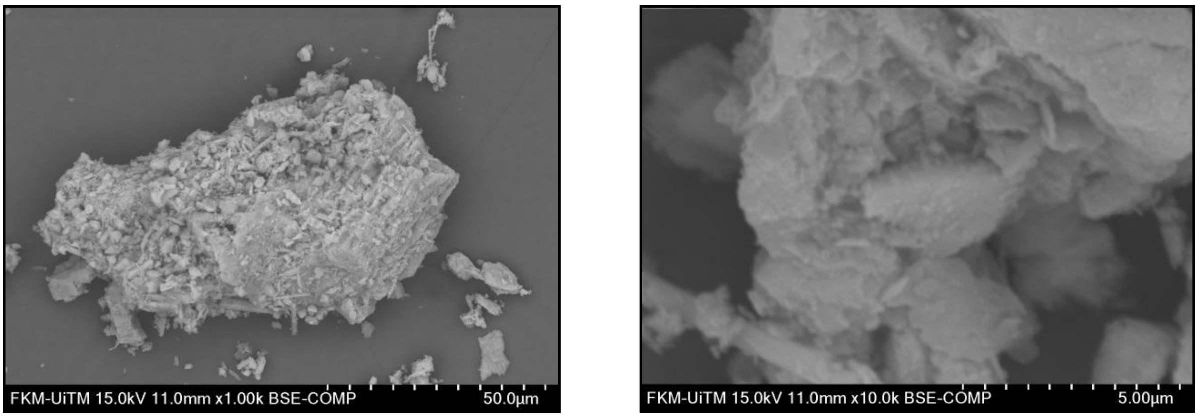
XRF analysis was done to determine and trace the major elements and compounds present in the SACL [14]. Since XRF also could not trace any compound that has the H element, hence the elements and compounds traced by the XRF in SACL are as listed in Table 2.

Table 2
Result of XRF analysis for SACL

Element	Compound	Content (%)
Ca, C, O	CO_2	13.261
	CaO	86.739

3.2.3 SEM analysis

Figure 2 shows the result for SEM analysis of SACL at (a) x1000 and (b) x10000 magnification. During the production of acetylene gas, SACL was formed in aqueous slurry and filter pressed. In addition, the SACL was also dried and crushed before being used in the experiment. Therefore, based on Figure 2, the processes mentioned have created more “closed” clusters with some porous regions [16].



(a) (b)

Fig. 2. SEM image of SACL at (a) x1000 and (b) x10000 magnification

3.2.4 FTIR analysis

Figure 3 shows the comparison for sludge between the FTIR analysis on SACL and lime after the chemical precipitation process. Figure 3 clearly shows that the trend of transmittance between SACL and lime is the same. Therefore, it is proven that SACL is suitable to replace the use of lime in the wastewater treatment process, especially in treating the colour of the wastewater. Other than that, according to previous studies, the O-H chemical bond is quite strong at the wavenumber range of 2500 to 3900 cm^{-1} [17]. Based on Figure 3, it can be determined that the peak at 3200 cm^{-1} was due to the presence of the O-H bond coming from the $Ca(OH)_2$ compound in the composition of the SACL and Lime. It shows that, SACL and lime are contain of similar component.

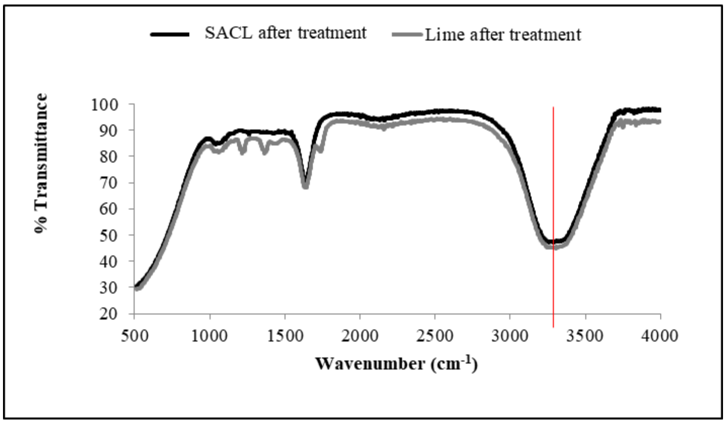


Fig. 3. Comparison FTIR analysis for sludge between SACL and lime after chemical precipitation process

3.3 UV-VIS Spectroscopy Analysis of F&B Wastewater

According to Figure 4, the light absorbance for the F&B wastewater after being treated is lower than before being treated. At the wavelength of 286 nm, the highest percentage of light absorbance for treated wastewater is only 1.49%. According to Beer-Lambert Law, the higher the molecule numbers in a sample that can absorb UV-light at a specific wavelength, the higher the extent of light absorbance of the sample. Therefore, it can be concluded that the number of molecules like the colour and COD particles in the wastewater has been reduced after being treated with SACL. Other than that, the light absorbance for the untreated wastewater falls below 0%. This may be caused by calibration error, where the blank used is contaminated during the study.

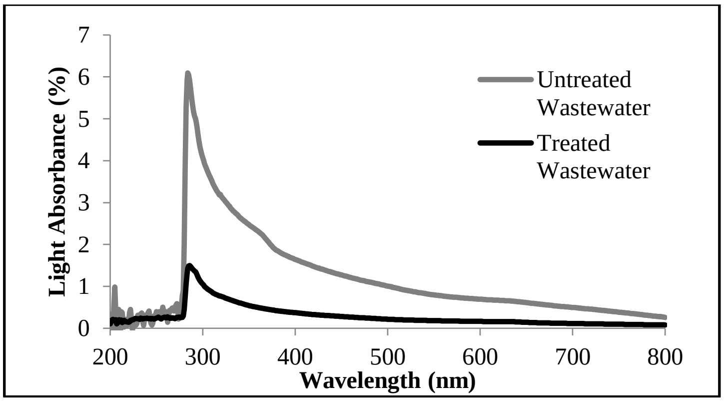


Fig. 4. Comparison of UV-Vis light absorbance of untreated and treated wastewater

In addition, Figure 5 demonstrates the comparison between the UV-Vis analysis of wastewater being treated by SACL and lime. It can be seen from Figure 5 that the trend for the percentage of light absorbance of both treatments is similar. Hence, it is proven that SACL can also be used in the industry to replace lime to treat industrial wastewater.

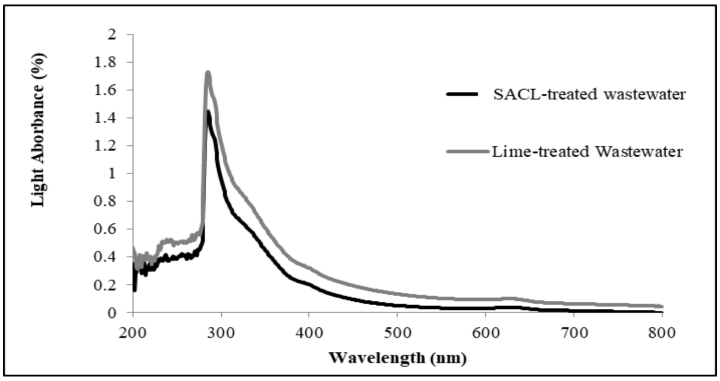


Fig. 5. Comparison of UV-Vis light absorbance of SACL-treated and lime-treated wastewater

3.4 Removal of Colour and COD from F&B Industrial Wastewater by using SACL
3.4.1 Effect of SACL dosing and pH value

To study the effect of pH on the removal of colour and COD from the wastewater, the pH of the wastewater was varied from pH 5.0 until 9.0 by dosing SACL into the wastewater. The reason for the choice of the pH value range is because the acceptable pH value for industrial wastewater discharge according to Standard B in IER 2009 ranges from 5.5 – 9.0 [15]. Apart from that, the range of the stated pH is acceptable since the wastewater will not be too acidic nor too alkaline, which will prevent the water discharge from giving harm to the ecosystem after being discharged. Figure 6 shows the changes in pH value of the wastewater after dosing in the SACL. By increasing the dosing, the hydroxyl ion amount will increase and will increase the pH value.

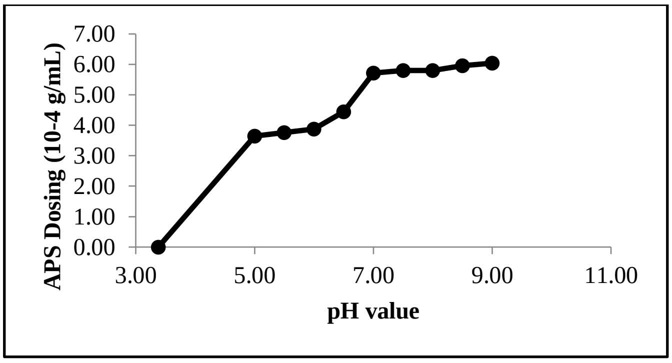


Fig. 6. Effect of SACL dosing to pH value of wastewater

Before changing the pH value of the wastewater, nine beakers of 250 mL of wastewater sample were prepared. SACL was added into the beakers until the pH reached pH 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5 and 9.0. The mixtures of the solution in the beakers were stirred for 20 minutes at 120 rpm. Based on Figure 5, to increase the pH of a solution from one value to another, the dosing of the SACL must be increased too. This means that the dosing of SACL increases the pH of a solution, especially acidic solution, due to its alkaline characteristic [18]. The increase of pH value of a solution is due to the existing [OH-] ion when the SACL powder is being added into the wastewater sample.

Since the desired range of pH value has been obtained, the study is then preceded by the effect of pH value on the removal of colour and COD removal. Figure 7 shows the colour and COD removal percentage against pH value of wastewater after SACL dosing.

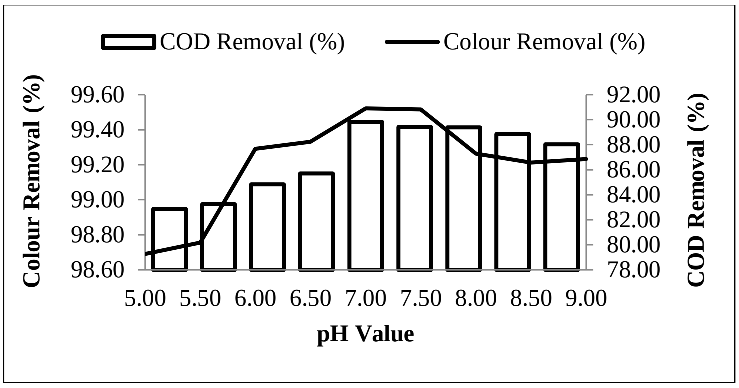


Fig. 7. Effect of different pH value on colour and COD removal

Figure 7 shows that the colour and COD removal are highly dependent on the SACL dosing and the pH value of wastewater. Based on Figure 7, the percentage removal of both colours started to increase significantly at pH 6.0. It can be observed from the graph that the peak percentage of colour was at pH 7.0 with a value of 99.52%. This means that almost 100% of the F&B industrial wastewater colour can be removed using SACL. On the other hand, the COD percentage removal increases slowly for the first four pH values: from pH 5.0 to pH 6.5. Despite the slow increment, at pH 7.0, the COD percentage removal increases drastically, making the percentage removal rise from 85.71% to 89.83%. However, both colour and COD percentage removal started to decrease at pH 7.5 to 9.0. This means that the optimum pH value of the wastewater sample to be treated with SACL is at pH 7.0 where the highest colour and the COD percentage removal has been obtained. This may be caused by the optimum value for this wastewater is at pH 7 caused by the most suitable amount of hydroxyl ion contain at dosing of APS when pH 7. The main factor involved is the amount of SACL dosing. Too low dosing will cause the low pH. Low pH shows that less amount of the hydroxyl ion and it is not enough for colour and COD removal.

Apart from studying the colour and COD of the wastewater, the changes in TSS and turbidity of the wastewater after being treated were also recorded. The percentage removal of TSS and turbidity of the wastewater is as illustrated in Figure 8. it clearly shows that the percentage removal for both TSS and turbidity were increasing slowly as the pH value of the wastewater increases from pH 5.0 to pH 7.0, where both of their peaks are at pH 7.0. The percentage removal at the optimum pH value is 99.17% and 97.34% for TSS and turbidity, respectively. However, there was a slightly decrement from pH 7.5 to pH 8.0. The percentage removal then increases again from pH 8.5 to pH 9.0. The decrement at pH 8.0 might be due to the SACL just do not work efficiently at pH 7.5 to 8.

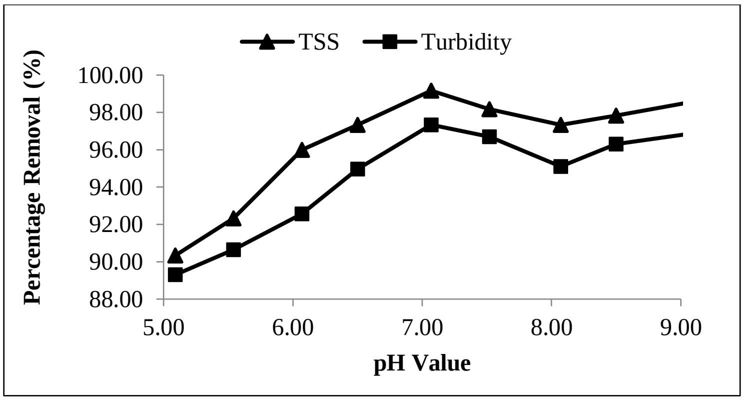


Fig. 8. Effect of pH on percentage removal of TSS and Turbidity against pH

3.4.2 Effect of contact time

The purpose of the second experiment is to determine the optimum contact time for the chemical precipitation of the wastewater to occur by dosing in the SACL powder. In this experiment, the pH value of the 250 mL wastewater in three different beakers was kept constant at pH 7.0 with the contact time for the three beakers was varied from 20 minutes, 30 minutes, and 40 minutes. Figure 9 illustrates the graph of contact time against the colour and COD percentage removal.

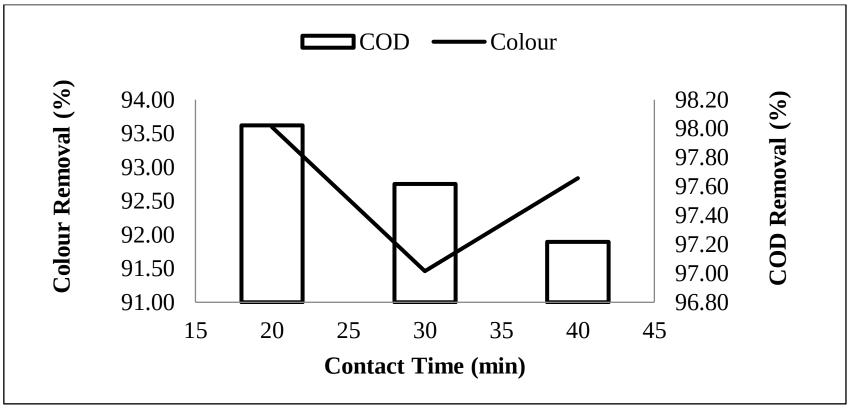


Fig. 9. Graph of percentage removal of COD and colour against contact time

Based on Figure 9, it is shown that as the contact time increases the percentage of COD removal decreases. At contact time of 20 minutes, the treatment managed to remove 98.02% of the wastewater COD, compared to the contact time 30 minutes and 40 minutes where the COD percentage removal is only 91.467% and 92.84% respectively. As for the colour percentage removal, the line graph decreases at contact time of 30 mins, then increases at contact time of 40 mins. At the equilibrium point in 20 minutes, the adsorption sites may have already saturated with the binding of colour particles [19]. Despite that, the highest percentage removal of colour valued at 93.60% is achieved at a contact time of 20 minutes. Thus, it can be said that the optimum contact time for colour and COD removal of F&B wastewater treatment by using SACL is 20 minutes.

3.4.3 Comparison between SACL and lime in wastewater treatment

The last experiment was conducted to make a comparison between the efficiency of using SACL and lime in the treatment of F&B industrial wastewater. The pH value and contact time were kept constant in optimum conditions, which are at pH 7 and the jar test was run for 20 minutes. Figure 10 shows that the colour, COD, TSS, and turbidity can all be removed significantly by using SACL in wastewater treatment. It can also be seen from Figure 10 that only COD can be removed more efficiently by lime as compared to SACL. Since the main objective of this study is to remove colour from the F&B industrial wastewater, it can be concluded that SACL works better than lime in treating the wastewater used.

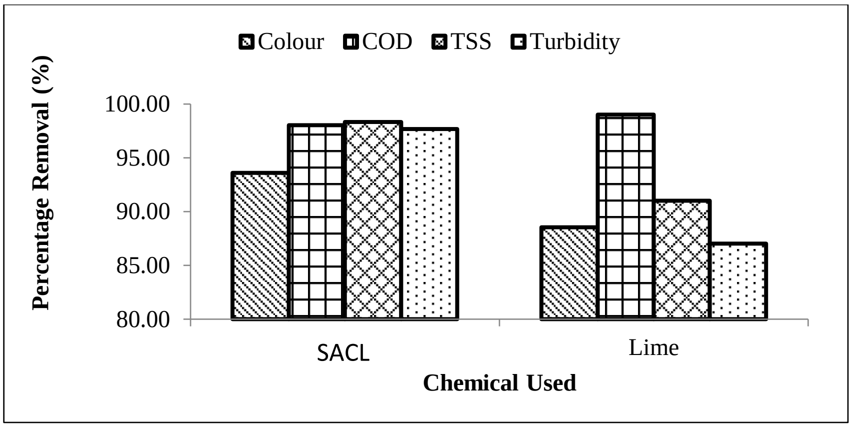


Fig. 10. Comparison of percentage removal of colour, COD, TSS and Turbidity between SACL and Lime

3.5 Comparison Between Previous and Current Studies

The result of the percentage removal of colour from this study is being compared with previous studies to validate the effectiveness of SACL to be used as a precipitant in treating the industrial wastewater before being discharged into the water bodies. Table 3 shows the summary for the treatment comparison.

Based on the summary in Table 3, it can be finalized that the use of SACL in the chemical precipitation process can be as effective as the uses of other materials in either adsorption or chemical precipitation processes that have been proposed in previous studies.

Table 3
Summary of comparison between previous and current colour treatment

Methods	Wastewater Types	Chemical Agents	Colour Percentage Removal (%)	References
Adsorption	Dye solution	Boiler ash from palm oil factory	99	[20
	Methylene blue simulated wastewater	Indian Rosewood sawdust	97.1	[21]
Chemical Precipitation	Food industry wastewater	$Al_2(SO_4)_3.18H_2O$	95	[10]
	Synthetic coralene scarlet RR	$Al_2(SO_4)_3.18H_2O$	87	[22[
Current Study	F&B industrial wastewater	Acetylene gas production sludge (SACL)	99	-

4. Conclusion

This study has proven that SACL can be an alternative precipitant in removing colour as well as chemical oxygen demand (COD), total suspended solids (TSS), and turbidity from the food and beverages (F&B) industrial wastewater. Based on the characterization of the SACL, the results coming from SEM show that SACL has the sites that may be able to bind particles onto its surface. Apart from that, the result from UV-Vis Spectroscopy analysis also shows a huge difference in light absorbance of the wastewater, before and after the treatment using SACL. The wastewater after treatment is much cleaner with less colour and COD particles compared to before being treated. The comparison between the use of SACL and lime also shows that SACL could work as efficiently as lime in treating the F&B industrial wastewater, especially in colour treatment. Despite the good result obtained for the UV-Vis analysis, there were some errors in the graph since the value of light absorbance for the untreated wastewater falls below 0%. This may be caused by contaminated blank used during the study. Therefore, the upcoming studies should consider cleaning the cuvette properly before pouring any liquids into the cuvette during experiment. As for the percentage removal, colour and COD can be removed efficiently at the optimum condition of pH 7 and 20 minutes. Almost 100% of the colour was removed, while a significant percentage removal of COD was obtained. In brief, the reuse of SACL in this F&B industrial wastewater treatment is recommended to be applied in the industry. This will also lead to the reduction of landfill waste coming from the industrial sector while making sure the F&B industrial wastewater is being treated efficiently before being discharged into the water bodies.

During the experiment, certain errors should be considered to get a better result from the study of colour removal from the F&B industrial wastewater by using SACL. For instance, the dosing of SACL into the wastewater should be done carefully since the SACL might spill off the spatula, hence, affecting the difference of SACL weight before and after being dosed. Apart from that, the pH meter in the laboratory should be calibrated first to prevent it from affecting the result of the study. Other than that, during the characterization of wastewater after being treated, it is very important to ensure that the vial being used in the HACH DR6000 spectrophotometer is always cleaned especially during the characterization of the blank. This is because the result of wastewater would be driven out of the result from the blank sample. Lastly, since the result of contact time was not too satisfactory, therefore, a wider range of contact time should be studied in the upcoming studies. It is also encouraged to run the experiment with different types of industrial wastewater to get enough experimental data on the effectiveness of SACL treatment in various wastewater, before being commercialized.

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