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THE ABILITY OF ALUMINIUM SULFATE ($Al_2(SO_4)_3.18H_2O$) FOR REDUCTION OF COLOR, IRON (Fe) AND ORGANIC SUBSTANCES CONTAINED IN THE PEAT WATER

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ABSTRACT

Peat water can be utilized by people as a source of clean water. Quality of peat water can be improved by eliminating the various parameters likes the colour of peat, organic matter contents, pH and iron (Fe). The purpose of this study was to determine the ability and effect of Aluminium sulfate [$Al_2(SO_4)_3.18H_2O$] in improving the peat water quality. Water samples were taken in the area of peat bog peat Kuala Tungkal in Jambi Province. Peat water into aluminium sulfate and then added a number of stirring and coagulations after being filtered, peat water parameters were measured using Ultra Violet and Atomic Absorption Spectrometry (AAS). The results showed that the addition 1gr L^{-1} of aluminium sulfate lowered the colour of peat water to 33.59%, iron content to 53.8% and organic matters to 26.8%, while the pH and Total Dissolve Solid did not change significantl. Therefore it can be concluded that the treatment with single aluminium sulfate cannot able to improve water quality with optimal path.

Keywords: Aluminium sulfate, color, organic substances, iron (Fe), peat water

INTRODUCTION

Peat water is surface water and which is brownish yellow in color, has a clear content and it contains Fe, Mn & organic substances in a large proportion. Peat water can be used for the needs of the community as a source of clean water. Peat water treatment that has not been done generally dark brown to black with a TDS content of 60-120 mg^{-1}, colour 124-850 mg^{-1} PtCo, organic substances 138-1560 mg^{-1}, and the acidic pH of 3.7 to 5.3 [1 & 2]. Some researchers reported that the River water having a pH of 5.2, Fe^{+3}; 1.623 mgL^{-1} and Cu^{+2}; 0.67 mgL^{-1}, while the peat water in the River Siantan Kalimantan has clear content ranges from 624 mg L^{-1}PtCo (3-5). Quality of Peat water in Jambi is not good and its need treatment before being used as a source of water for the domestic purposes [3 & 4]. Several methods have been conducted by experts for peat water treatment by the use of Poly Aluminium Chloride (PAC) to decrease water colour of peat in the area of Siantan Hulu Pontianak and they used the PAC at a dose of 110 mg L^{-1} and which was capable the lowering of the colours of 624 mg L^{-1}PtCo to 15 mg L^{-1}PtCo [5]. "One Stage Coagulation" method was able to reduce the turbidity of 97.18% to 96.79% and the colour of organic substances to 98.2% [6]. Then in the processing of peat water into clean water can be done by using a combination of process of Upflow Anaerobic Filter (UAF) and the Slow Sand Filter (SSF) and which was capable to lowering the water colour of peat from 804 mg L^{-1} PtCo to 118.04 mg L^{-1} PtCo, but the results had not fulfilled clean water standards in accordance Regulation of Health [1]. Sometimes peat water treatment is performed with the addition of a compound like aluminium sulfate. Aluminium sulfate is a chemical compound made of molecules of water and two kinds of salt, one of which is usually $Al_2(SO_4)_3$, the compound is known as flocculator which serves to agglomerate the impurities in the water purification process. Aluminium sulfate is used as a coagulant in water treatment and sewage. Alum sulphate used as a coagulant and it is very effective to precipitate particles floating in the form of colloid or suspension. Aluminium sulfate compound dissolves in water to form a compound of $Al(OH)_3$ at neutral pH, and in water treatment processes peat aluminium sulfate compounds react with the material contained in the peat water to form a white precipitate and which was preceded by the formation of floc-floc. According to the some researcher [7], the flow-flock will be formed quickly with the help of stirring for 1-2 minutes, and the flock will be formed within 15-20 minutes.

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This reaction occurs at the liberation of H^+ ion and that's why the pH of the solution is reduced, and for that reason the flocculation process cannot take place perfectly, because to from the $Al(OH)_3$ its required to maintain the pH 6 to 8 [8]. The main purpose of this study was to find out the ability of single aluminium sulfate to lowering the colour, organic matter and content of iron (Fe) in the peat water.

MATERIAL AND METHODS

The equipment used in this study were a set of tools like laboratory glassware, digital scales, stirrer, flask, beaker, filter paper and instruments like UV-Vis and Atomic Absorption Spectrometry. Peat water samples were taken from the low-lying areas of Tanjung Jabur Barat province of Jambi Indonesian. So many other materials were also used to carry out this study and which were distilled water, concentrated H_2SO_4, Aluminium sulfate, concentrated HNO_3, and concentrated HCl etc. So many other equipments were also used to carry out this study, primarily laboratory glassware everyday like; Erlenmeyer, flask, stop watch, electric heating, measuring cups, measuring pipette, pipette mumps, goblet, burette, analytical balance, Nessler tube and pH Meter.

Various concentrations of standard solutions were prepared for pH, colour, iron, manganese and organic matter, by referring to the Indonesia National Standard. Organic substances were measured by using the permanganometry methods. Degree of acidity were measured by using the potentiometric method, with a pH meter, by using Standard Test Method, as a normative reference ASTM D 1293-95 [9]. Colours were measured by using Spectrophotometric technique. Concentrations of iron (Fe) were determined with the help of Atomic Absorption Spectrophotometer (ISO 6989.5: 2009) [10].

RESULTS AND DISCUSSION

The peat water were treated with various concentration of aluminium sulfate and the results of various measurement parameters like pH, TDS, colour, organic matter and iron (Fe) were portrayed in Table 1.

Table 1: Results of various measurements parameters of peat water after the addition of Aluminium sulfate

No	Amount of Aluminium sulfate (g)	Parameters of peat water				
		pH	Organic matter (mg L^{-1})	color (mg L^{-1} PtCo)	TDS (mg L^{-1})	Fe (mg L^{-1})
1	0	4.04	169	437	25	1.089
2	1	3.54	124	278	537	0.503
3	2	3.48	130	371	883	0.716
4	3	3.43	148	280	122	0.835
5	4	3.39	160	346	165	0.892
6	5	3.35	157	368	197	1.003

From the data of Table 1, it has been clearly confirmed that the pH of peat water (after the addition of aluminium sulfate) was reduced from 4.04 to 3.35, but the organic matter and iron contents were changed slightly, and the values of TDS was increased correspondingly with the increase the amount of aluminium sulfate. At the same time the effect of the addition of aluminium sulfate on changes of various parameters of peat water can be seen in Figures 1 and 2.

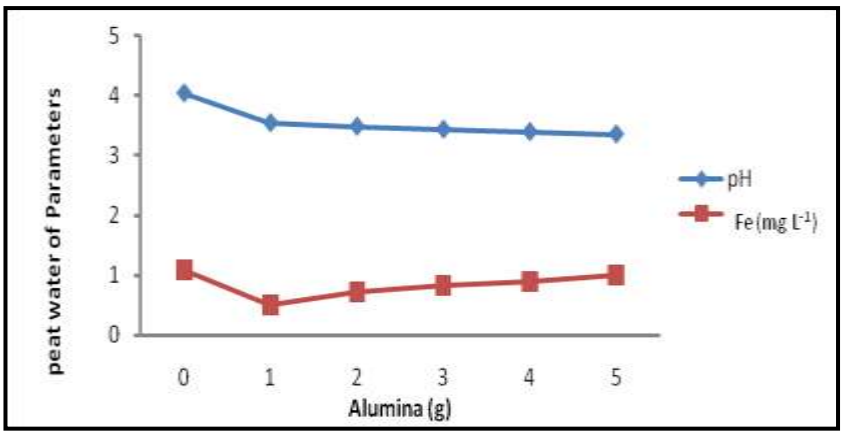

Figure 1: The effect of the addition of Aluminium sulfate on changes of pH and the content of iron (Fe) of peat water

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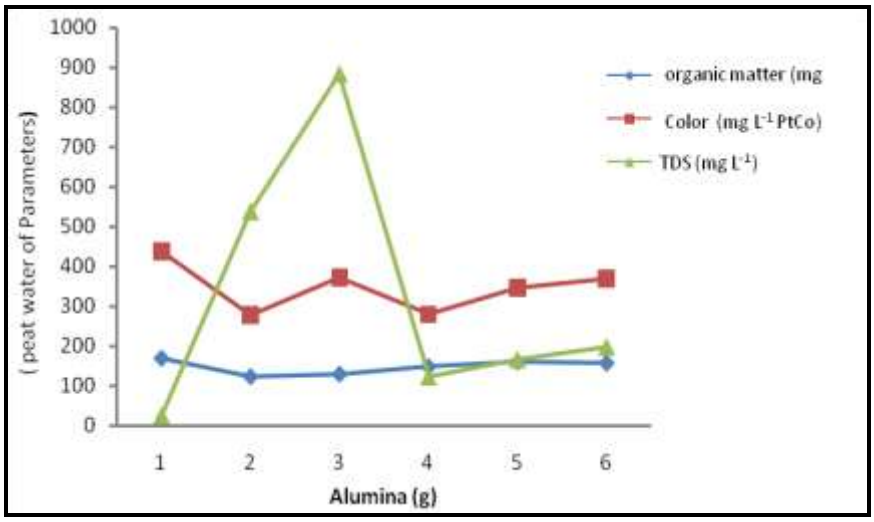

Figure 2: Effect of the addition of Aluminium sulfate on color, TDS and organic matter of peat water

Figure 1 show that the addition of aluminium sulfate into the peat water is not able to neutralize acidity and lower TDS content, even water can lower the pH of peat and improve the TDS content. This is likely due to a colloidal solution formed from the reaction of aluminium sulfate with acidic water in the peat while floks and koagluasi formation can occur with a maximum at neutral pH (pH> 7.0)

Alunium sulfate compound can form a coagulant to size with a smaller particle size and can easily form an unstable nature, prior to the formation of the first coagulant as a floc floc. Floc formation process is influenced by pH, stirring, and chemical reagents. The flock will be formed with either at neutral pH, Stirring is done repeatedly can cause the flow formed broke back [11]. The process of coagulation and flocculation process is preceded by the formation of flow maximum occurs at neutral pH (pH 6 to 8). The colloidal particles in nature usually carry a charge on its surface, which leads to the stabilization of the suspension. With the addition of some chemicals, such as the surface area of the colloidal particles can be altered or dissolved materials can be deposited, so as to facilitate the separation of solids by gravity or filtration.

The change of state of a stable dispersion into an unstable state called destabilization and destabilization process is a form of coagulation and flocculation. The term coagulation and flocculation have subtle differences, if destabilization induced by neutralization by the addition of inorganic chemicals called coagulation, on the other hand, the process of the formation of clots that are larger than the particles in suspension or agglomerates of the minor has been formed as a result of coagulation via high molecular weight materials polymer called flocculation [12].

Coagulation and flocculation are closely related to the destabilization of negatively charged particles by the positive charge of the coagulant, the collision of particles and adsorption. In addition to the collisions between the particles destabilization (microflok), which may converted the aluminium sulfate to form a flock with a relatively large size (macroflok). Alum is used of peat for water treatment has been carried out using membrane Ultra Filtration (UF) obtained results at Alum doses 50 mgL^{-1}, lime 30 mgL^{-1} and 3 bar operating pressure, yielding 37.88 flocks lm^2 $hour^{-1}$, decreased colour 96.94% and 97.33% organic decline. The adsorption process is carried out by the flocculation mechanism of aluminium hydroxide [$Al(OH)_3$]. These compounds have the nature of absorbing surface (adsorption). If the ionic strength in the water is large enough, then the presence of colloids in the water will be in the form destabilization. Destabilization caused by monovalent ions (valence 1) and divalent (valence 2) situated in the water coagulation electrostatic, while coagulation chemistry is a process by which chemicals such as salts Fe and Al are added to the water to change the form transformation substances dirt or substances. These substances react with the hydrolysis of salts Fe or Al into flow with big size that can be easily removed through sedimentation and filtration [8 & 12].

Coagulation process is then followed by a slow stirring process (flocculation), with the aim of providing an opportunity for floc core to touch each other to form a larger flock that is ready to be precipitated. The next process is the deposition (sedimentation), which aims to precipitate floc is formed. Coagulants commonly used are aluminium sulfate and ferric sulphate. These compounds interact with the alkalinity of chemical substances present in water to form a compound of aluminium or ferric hydroxide [13 & 14].

Coagulation and flocculation process is closely related to turbidity. Turbidity caused by small particles and colloidal size of 10 nm to 10 µm, which can be derived from quartz, clay, crop residues, algae and so forth. Turbidity can be removed by the flocculation process is the formation of floc-floc by adding flocculants such as alum and Fe^{+3} or organic polyelectrolyte compounds. Flock-flock formation process requires stirring. Flock-flock collects small particles and colloids that (collide) and finally together to settle [15 &16].

This colloidal stability will be disrupted by the addition of flocculants. Flocculant can be attached to the colloid surface and can change electrician charge. Most molecules of flocculant Al positively charged, while the negatively charged colloids (at pH 6 to 8, the process of formation of floc-floc). Most alum insoluble will precipitate as a flock of $Al(OH)_3$ colloid bound together [15] .

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Aluminium sulfate compound after dissolved in water will form compounds Al $(OH)_3$ at neutral pH, and will form a white precipitate. Floc-flow will form quickly with the help of stirring for 1-2 minutes, and perfectly within 15-20 minutes [7].

In the reaction of aluminium sulphate with water occurs exemption $6H^+$, so that the pH of the solution is reduced, that's why the flocculation process cannot take place is perfect, because to form $Al(OH)_3$ required pH 6 to 8 [8]. To overcome this problem, some researcher was used the compound calcite (CaO) made from seashells. This compound serves to neutralize the solution and increase the pH of the solution, so that the flocculation process can take place properly. The principle of the reaction to decrease the acidity of peat water with the addition of calcium shells can be explained be explained that one molecule of $Al_2(SO4)_3$ reacts with 3 molecules of $Ca(OH)_2$ produced 2 molecules $2Al(OH)_3$ and 3 molecules CaSO4, because the compound $Al(OH)_3$ is alkaline, it can cause a neutralization reaction [8 & 15].
In this reaction occurs liberation of H^+, so that the pH drops and flocculation process cannot take place perfectly. This is due to form $Al(OH)_3$ required pH 6 to 8. To resolve this problem, some researcher was used a compound calcite (CaO) are made from seashells. This compound serves to neutralize the solution and increase the pH value of the solution, so that the flocculation process can occur with either. The reaction of alum in general with an alkaline reagent as follows [8].

$$Al_2(SO_4)_3 + 3Ca(HCO_3)_3 \longrightarrow 2Al(OH)_3 + 3CaSO4 + 6CO2$$
$$Al_2(SO_4)_3 + 3Na_2CO_3 + 3H_2O \longrightarrow 2Al(OH)_3 + 6CO2$$
$$Al_2(SO_4)_3 + 3Ca(OH)_2 \longrightarrow 2Al(OH)_3 + 3CaSO_4$$

A single molecule of $Al_2(SO_4)_3$ reacts with three molecules of $Ca(OH)_2$ produces two molecules of $Al(OH)_3$ and $CaSO_4$ three molecules. Therefore, the compound $Al(OH)_3$ are alkaline and acidic peat water neutralization reaction will occur. Many organic matter and acidity of peat water is a picture of the rich content of organic acids in water peat, the humic acid and fulvic acid. Humic acid is formed from the decomposition of organic materials by aerobic organisms. This acid has a molecular weight of 10,000 to 100,000 g Mol^{-1} [17]. Humic acid is an organic compound that is a very complex aromatic macro molecule, have a colour ranging from dark brown to grey. This compound has a long aromatic bond and non biodegradable (can not be degraded by microorganisms), which is the result of oxidation of lignin compounds (phenolic groups). Humic substances have the ability to transfer the metals to and from metalloproteins in vivo [18].

Humic substances are negatively charged (legends) to form complexes with metal compounds. There are a number of sites where metal ions can bind the hydroxyl group of aromatic and aliphatic carboxyl and phenolic in humic acid complex. This allows the humic substances to act as ion exchangers, releasing metal ions with low atomic mass and binding heavy metals [19 & 20]. Model structure of humic acid and fulvic acid are shown in Figures 3 & 4 respectively.

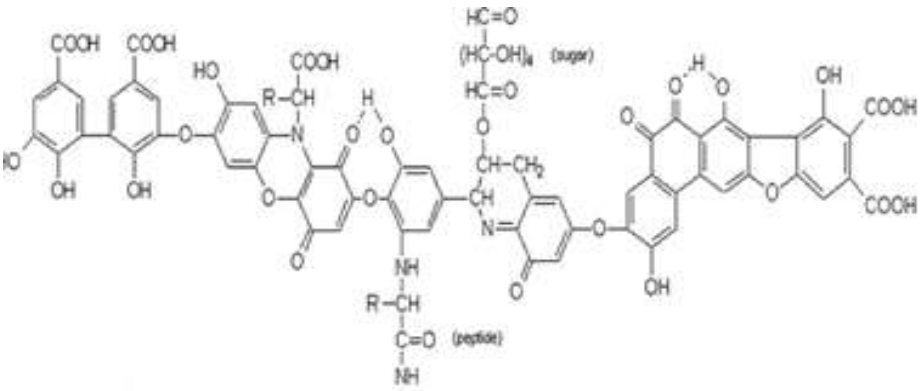

Figure 3: Structure Model of humic acid

Fulvic acid generally contains more oxygen-rich and carbon poorer than humic acids. This is reflected in the number of carboxyl groups and phenolic functional groups. Fulvic acids contain more reactive functional groups, including carboxyl, carbonyl, hydroxyl, phenol, quinine and semiquinones [21].

The molecular weight fulvic acid is considered lower than that of humic acid. Fulvic acid is an organic acid naturally occurring compound derived from humus, soluble in water, often found in surface water with low molecular weight that is between the ranges of 1000 to 10,000g mol^{-1} [22]. Fulvic acid is soluble in water at all pH conditions and will be in the solution after the separation process of humic acid through acidification process. The color of humic and fulvic acids in peat water varies from yellow to brownish yellow and brown. Model structure of Fulvic acid [22] is shown in figure 4.

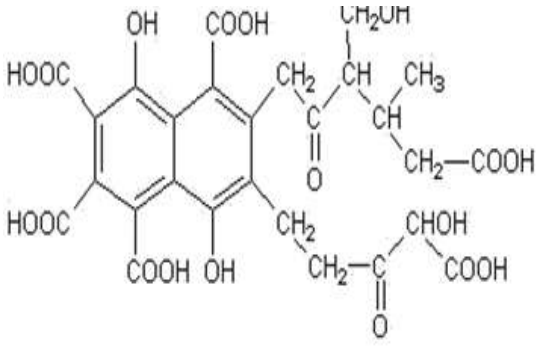

Figure 4: The model structure of fulvic acid

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Fulvic acid is formed in water environment of carbon dioxide derived from the degradation of organic compounds by bacteria and algae. The Carbon dioxide produced from photosynthesis with the help of sunlight. Humic acid and fulvic acid peat into the water through rain water flowing into the pores and peat [23].

CONCLUSION AND RECOMMENDATIONS

Aluminium sulfate have limited ability to reduce the content of peat water parameters. Aluminium sulfate in doses of 1 g/L can reduce the concentration of colour of peat water to 33.59%, iron content of 53.8% and 26.8% of organic substances and have not been able to reduce the TDS and lower the levels of water acidity of peat. Aluminium sulfate having some ability to reduce the peat water nature due to the process of flocculation and coagulation. Lack of ability aluminium sulfate in lowering the water parameters peat caused by peat water in acidic with pH<5.0, while the process of flocculation and coagulation can occur optimally at a neutral pH> 7.5. It is suggested to other researchers to continue research by combining a compound of aluminium sulfate with an alkaline substance which can increase the pH of the peat water, such as calcium hydroxide or potassium oxide so that the process of flocculation and coagulation can occur with optimal, decrease parameter peat water can occur with the maximum so that clean water produced more quality.

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