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Laboratory effluent Treatment by Using Coagulant Alum sulphate and Poly Aluminium Chloride (PAC)

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Abstract

It has been investigated of the laboratory effluent treatment using coagulant Alum sulphate (AS) and Poly Aluminum Chloride (PAC). This research purposes to get the best doses of coagulant in waste water treatment. Parameter focuses are Total Dissolved Solid (TDS), Fe, Mn, Cr, and Ammoniac (NH_3). The result shows the Alum sulphate was more effective. The effectiveness of pollutant decrease is 58,80% of TDS, 99,14% of Fe, 98% of Cr, 77,24% of Mn, and 23,18% of Ammoniac, respectively.

Keywords: Laboratory wastewater, Alum sulphate, Poly Aluminum Chloride, Heavy metals, Coagulation

Abstrak (Indonesian)

Telah dilakukan penelitian tentang pengolahan air limbah laboratorium dengan menggunakan koagulan Aluminium sulfat (AS) dan Poli Aluminium Klorida (PAC). Penelitian ini bertujuan untuk mendapatkan jenis dan dosis koagulan yang tepat dalam proses pengolahan air limbah. Parameter uji yang diamati adalah Zat padat terlarut (TDS), Logam besi (Fe), Mangan (Mn), Kromium (Cr), dan Amoniak (NH_3). Hasil penelitian menunjukkan bahwa penggunaan zat Aluminium sulfat adalah lebih efektif. Efektivitas penurunan polutan dengan proses koagulasi mampu menurunkan zat padat terlarut 58,80%, Fe 99,14%, Cr 98%, Mn 77,24%, Amoniak 23,18%,masing-masing.

Kata kunci: pasang surut, kualitas air, pencemaran

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INTRODUCTION

Laboratory is where done some testing activities to obtain data of test results are accurate and valid. Data obtained from the test results in laboratory testing both qualitative and quantitative basis is the data that can be traced, and then can also be used as a legal process. Various activities can be done in the laboratory, from sample preparation to test until the testing activities. Some common tests performed in the laboratory, among others testing of physics, chemistry and microbiology.

Flow testing activities in the laboratory starting from sample preparation to implementation testing, need major chemicals and supporters. Common types of chemicals that had been used among other chemicals are acids, bases, organic and inorganic. Type the strong acids used such as Hydrochloric Acid (HCl), Nitrite acid (HNO_3), sulfuric acid (H_2SO_4) and others.

Some weak acid is used among other things Acid Phosphate (H_3PO_4), Carboxylic Acid (HCOOH) and so on. Types of strong base commonly used such as Sodium hydroxide (NaOH) and Potassium Hydroxide (KOH). Group of inorganic chemicals include various types of salts such as Sodium chloride (NaCl), Magnesium Chloride ($MgCl_2$), Potassium Chloride (KCl), Mercury Sulphate (MgSO4), Potassium chromate (KcrO4), Potassium dichromate (K_2CrO_7), Ferro Ammonium Sulphate ($Fe(NH_4SO_4)_2$ and various types of other salts. Organic chemicals are often used as the type of alcohol, aldehyde, acetone, amine compounds, amides and the like. The type of support used chemicals such as detergents as cleaning agents. Chemicals mentioned above are generally disposed of resulting waste is then known as laboratory waste.

Activity testing laboratory dense enough so that is certainly the volume of wastewater produced quite a

lot. Characteristics of wastewater laboratory can be categorized as dangerous wastes and toxic (B3). Most of the harmful elements contained in waste water lab are a heavy metal such as iron (Fe), Manganese (Mn), Chromium (Cr), and Mercury (Hg). In addition, there are also dissolved solids (TDS), Ammoniac (NH3) and Nitrile (NO_2). Based on the Indonesian Government Regulation No.85 of 1999 [1], that the elements above is a compound which is classified hazardous and toxic materials. Thus the necessary waste water treatment laboratories seriously so as not to pollute the environment.

There are currently no wastewater treatment plants (WWTP) that feared the next few years there will be environmental degradation as the effect of environmental pollution from waste water laboratory. It required an integrated design of the processing waste. This study is intended as a preliminary study to obtain preliminary data wastewater laboratory.

THEORY

Water Pollution

Water pollution can reduce the amount of clean water for daily use. The waste products will be overhauled by the bacteria into nutrients or other substances that are not harmful anymore for animals, plants and other living creatures. But unfortunately, this bacterium's ability to have limitations. This is called the carrying capacity of water. What- if the amount of waste in a body of water exceeds the capacity or ability of dissociation, then not all of the waste can be decomposed and the rest is what will be the contaminants in these waters.

Chemical Treatment

The treatment of chemical wastewater normally was done to remove particles that are not easy to precipitate. The particle types among other things: colloid, heavy metals, phosphorus compounds, and toxic organic compounds. Processing done by affixing certain chemicals that can produce larger particles. The deposition of suspended material which is not easy by pouring a substance soluble electrolyte is charged opposite to its coloid- substances. When the electrolyte substance met with colloidal substances charge neutralization reaction will occur in colloidal form a larger compound that deposition can occur [2].

Coagulation-Flocculation

Coagulation is the process of adding and mixing a coagulant dilaknjutkan with destabization colloidal substances suspended and terminated by the formation of large-sized particles (floc). Coagulant commonly used are salts such as Aluminium Sulphate (AS) and Poly Aluminum Chloride (PAC) [3].

In the coagulation process, the sediment occured characterized by rapid stirring (60-100 rpm) with a pH varied while on stage flocculation occurs merging the cores of sediment becomes large molecules (Flocs). Flocculation is done with slow stirring (40-50 rpm). Floc which came into being separated from the liquid by means of sedimented or floated.

Reactions that commonly occur in the coagulation process:

$$Al_2(SO_4)_3 \cdot 18H_2O + 3Ca(HCO_3)_2 \rightarrow 2AL(OH)_3 + 3CaSO_4 + 18H_2O + 6CO_2$$

$$Al_2(SO_4)_3 \cdot 18H_2O + 3Ca(OH)_2 \rightarrow 2AL(OH)_3 + 3CaSO_4 + 18H_2O$$

In this study, we will add two types of coagulant, Aluminium sulphate and Poly aluminium Chloride, to determine the effectiveness of each coagulant to remove the TDS, heavy metal and Ammoniac.

EXPERIMENTAL SECTION

Materials

The materials needed in the study consisted of two groups: materials for analysis and research activities. Materials analysis consists of chemicals that Qualification proanalysis (pa) such as Sulfuric Acid, Acid Nitrate, Hydrochloric Acid, NaOH, and salts of potassium bichromate, Manganese Sulphate, Nessler, Brucin Sulphate, AS and Sulfuric Ferro and metals such as Iron, Manganese and Krom. While the materials used for the study consisted of laboratory waste, AS, and PAC.

Methods

The research was carried out in two stages, namely a preliminary test and the test continued. Test prelude an initial test of the wastewater laboratory which aims to study the properties and characteristics of the wastewater laboratory while further tests to find the optimum concentrations of substances used coagulant. In this test, the concentration of coagulants used range between 0.5-10 g/L with a variety of rapid stirring and stirring slowly. Below are the SNI procedure for analysis TDS, Fe, Mn, Cr and NH_3 [4].

- Analysis of Total Dissolved Solids (TDS)

Analysis method used potentiometric or electrometric by using a TDS meter. This measurement refers to SNI. 06-6989.27-2004.

- Analysis of Iron (Fe)

Testing based on SNI. 06.6989.4-2004. Testing this would be a measurement of ferrous metals in the waste water by AAS method on Range of Fe content from 0.3 to 6.0 mg/L and a wavelength of 248.3 nm.

- Analysis Manganese (Mn), Manganese levels Testing based on the ISO 06-6989.5.2004 Mn metal Measurement ranges from 0.1 to 4.0 mg/L at a wavelength of 279.5 nm.

- Analysis of total chromium (Cr) Testing based on the total chrome content SNI 06-699.17-2004. The measurement of metal chromium ranged from 0.2 to 5.0 mg/L pda wavelength of 357.9 nm

- Analysis Levels of Ammonia (NH_3) Ammonia levels based on the test SNI. 06-2478-1991. Ammonia concentration measurements using spectrometer at a wavelength of 400-425 nm.

RESULT AND DISCUSSION

Reduction of Total Dissolved Solids (TDS)

Effect of substance use AS and PAC happened toward pollutants TDS can be seen in Figure 1.

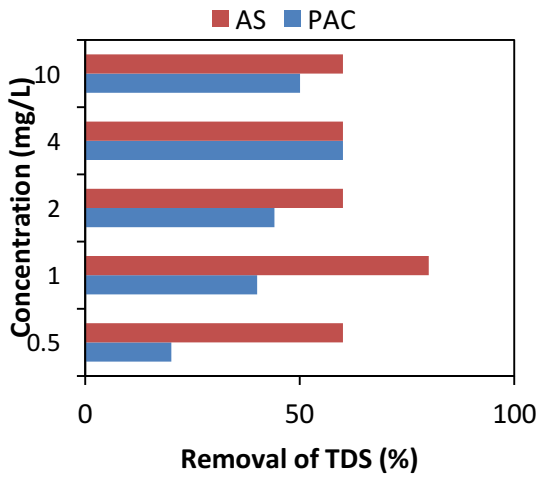

Figure 1. Effect of AS and PAC on the removal of TDS

From Figure 1 shows that a decrease in TDS in the wastewater laboratory by using a coagulant AS average above 60%. Decrease optimal dissolved solids contained in AS concentration of 1 g/L reaching 80%. This indicates that the coagulation process was very good. After concentration of 1 g/L, the effectiveness of AS having a little decrease with the lowest conditions at a concentration of 10 g/L is 61%.

PAC substance use in the coagulation process ranges between 20-60%. PAC effectiveness is still far below AS. The decline in the dissolved solids contained in the optimal concentration of 4 g/L is 60.5%. While the decline in some low dissolved solids at a concentration of 0.5 g/L of 20%.

In Figure 1 shows the change of form of the graph is almost the same percent decline continued to increase until it reaches the optimum value. This shows that the longer the time caused the chance of active substances of coagulate to collide and interact with the colloidal particles in the waste will be even greater. Of interactions that occur resulting colloidal stability decreases because the charge neutralized and will tend to unite to form colloidal mikroflok and later settles [5].

Having reached the optimum contact time of ammonia concentrations greater than optimum conditions. This is because the neutralization process atan colloidal mouth no longer exist while a lift not continue to happen, so it is possible collision happened next is a collision among colloidal particle. A type of particle collisions will increase repulse force and formed restabilitation condition and resulting colloidal particles of waste does not bind with the coagulant.

Reduction of Metal Iron (Fe)

Ferrous metals in the periodic system of elements included in Group VIII. This element group with Cobalt (Co) and Nickel (Ni). The existence of Fe in possible because some test samples using either Fe as an element or combine with other elements. Effect of coagulant AS and PAC can be seen in Figure 2.

Overall effectiveness AS to the decline of Fe in wastewater laboratories ranged from 40-100%. The highest decrease effectiveness Fe at a concentration of 0.5 g / L is almost 90%. This shows good binding reaction occurs between AS with metal Fe. Trace elements Fe in wastewater usually having positive charge. Equivalent to AS resulting in a good ion exchange between Fe and Al [6].

Increasing concentration of adding PAC make the Fe metal removal is quite good, ranging between 20-80%. Although still less than the percentage decline in ASbut stable Fe metal (approximately 80%), unlike AS is steadily declining. The highest effectiveness is achieved when the concentration of 4 g/L is 82%.

Reduction of Chromium (Cr)

The use of metallic element chromium in the Lab. Basic Chemistry quite a lot. Cr used in the form of a salt compound that is Potassium chromate ($KCrO_4$) and Potassium bichromate (K_2CrO_7). Most of Cr type in the wastewater laboratory is Cr with valency sixth (Cr_{6+}). Effect of coagulant AS and PAC can be seen in Figure 3.

The ability of AS in removal of Cr in waste water laboratories face down compared with the PAC. In the initial state AS reacts well but after the concentration more than 1 g/L, the effectiveness of AS. This means the use of excessive coagulant alum sulphate is ineffective [7]. Opposite is the case with PAC coagulant which continued to rise in the mean percentage uptake reaction Cr run effectively. Nevertheless, overall AS is still better than the PAC because with just a little use of Alum sulphate (1 g/L) in the absorption of Cr will be walked up to (98%).

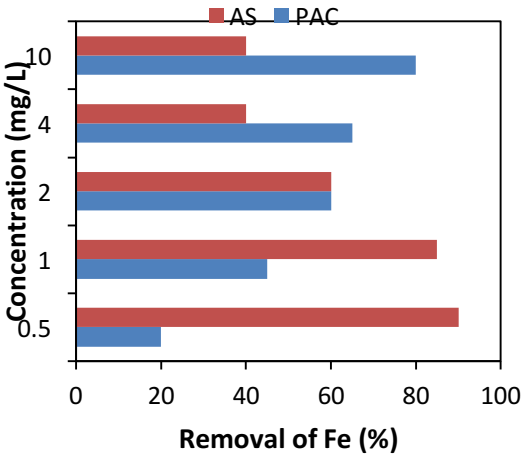

Figure 2. Effect of AS and PAC on the removal of Fe

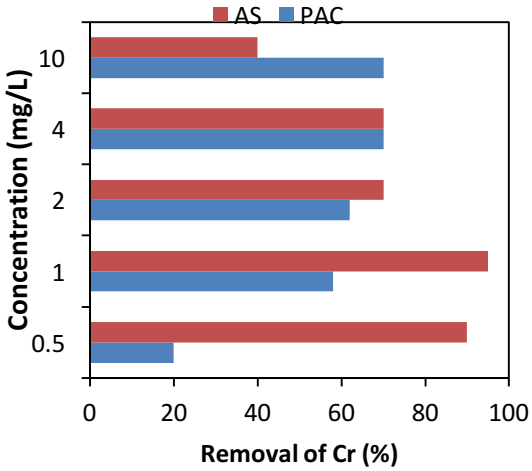

Figure 3. Effect of AS and PAC on the removal of Cr

Reduction of Metal Manganese (Mn)

The use of Mn metal element in the analysis work in the lab pretty much so that in the initial analysis of Mn metal content above 15 mg/L. The effectiveness of coagulants AS and PAC in the show in Figure 4.

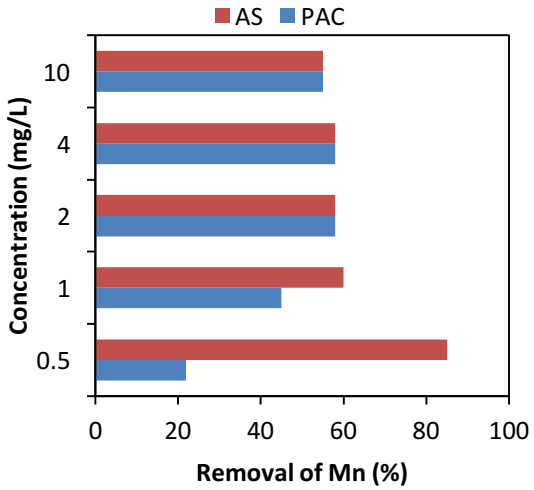

Figure 4. Effect of AS and PAC on the removal of Mn

Effectiveness of decreasing the concentration of Mn metal in the waste water laboratory with the use of AS ranged between 44-58%. The biggest effectiveness was obtained at AS optimum concentration of 1 g/L with a percentage decrease reached 60% and the lowest at a concentration of 0.5 g/L of 42%. Similarly, PAC coagulant, the highest percentage decline at a concentration of 2 g/L of 58% and the lowest at a concentration of 0.5 g/L of 22%. This shows that the effectiveness of the second coagulant equally well only at low concentrations (0.5 and 1 g/L), coagulant ASbetter. In the initial concentration of the chemical bonds between coagulant with waste water has not gone well so that the percentage of decline is still small and decrease in metal content Mangan effective.

Reduction of Ammoniac (NH_3)

The decline in the element nitrogen in the wastewater laboratory test parameters are represented with ammonia (NH_3) in the form of ammonium compounds. These types of compounds used in the process significantly testing in the laboratory. This element is generally use as basis form of a compound of Ammonium sulphate ferries (FAS). FAS compounds used as Titrant in the testing process parameter COD.

The effectiveness of the coagulant substance AS and PAC happened toward the decline of Ammonia in laboratory wastewater can be seen in Figure 5. Alum ability to lower Sulphate concen-trations Ammonia in waste water ranged laboratory 0,3-25%. Effectiveness highest in AS concentration of 1 g/L. After that the effectiveness of AS continue to decline. While the PAC capabilities ranged from 0-62%. The reciprocal of AS, PAC effectiveness is constantly increasing. This indicates that the PAC coagulant is more effective for

lowering agents compared with Alum Ammonia Sulphate.

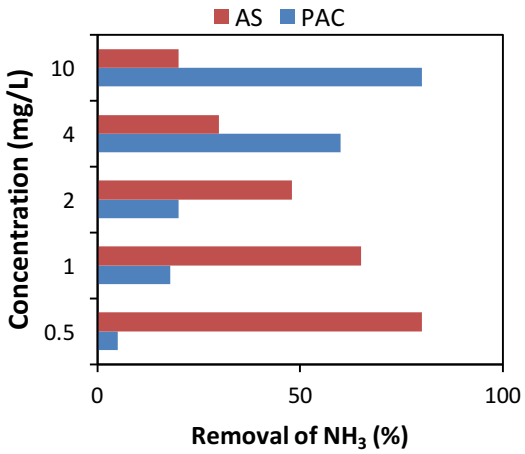

Figure 5. Effect of AS and PAC on the removal of Ammoniac

The explanation of this is as follows: Characteristics of Ammonia in water was ammonium (NH_4OH). When the compound is an excess of the hydrogen atom (H), then this compound turned into a positively charged ionic compound. When Ammonium in PAC reacts with ions of the polymer will be binding compound PAC positive H^+ and it will turn into short-chain monomers. Meanwhile, when the Alum Ammonium sulphate reacts with fat, the two compounds will have difficulty to react [10].

CONCLUSION

From the description of the results and discussion it can be concluded:

1. The more effective coagulant substance was Aluminium sulphate.
2. The percentage of TDS, Fe, Cr, Mn, NH_3 removals were 80%, 99.80% , 98% 60% and 25%, respectively.

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