Adsorption effectivity of combined adsorbent zeolite, activated charcoal, and sand in liquid waste processing of agroindustrial laboratory

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Abstract. The quality control laboratory of the department of agroindustrial technology produces a lot of liquid waste that has not been maximally treated. The study aimed to determine the effectiveness of the adsorbent in treatment wastewater by filtration and adsorption methods. Zeolite, activated charcoal, and sand, with a ratio of 1:1:1, are used as adsorbents. One liter of liquid waste was inserted into the filter and gradually repeated up to five times so that the filtrate $P_1$, $P_2$, $P_3$, $P_4$, and $P_5$ were obtained. Liquid waste before treatment and after treatment with adsorbent was analyzed include Total dissolved solids (TDS), Total suspended solids (TSS), Chemical oxygen demand (COD), and pH. The results showed that adsorbent effectively reduced up to 40%, 80%, 58%, of TDS, TSS, and COD of liquid waste, Respectively. This adsorbent is very effective as a laboratory-scale waste treatment even though it has not met regulations.

Keywords: Laboratory liquid waste, TDS, TSS, pH, COD, Adsorbent.

1. Introduction
Activities in the quality control laboratory of Dept. The agroindustrial technology of education produces hazardous liquid waste which is still a problem in the management of waste. The liquid waste comes from chemicals used in routine analysis or research. In fact, management to eliminate hazards from the liquid waste of the laboratory has not managed well [1]. Adsorption is one method that can be used to treat laboratory wastewater. Adsorption is a process that occurs when liquids (liquids or gases) are bound to solids and eventually form a thin layer on the surface of the solid so effective to reduce contamination in liquid waste [2]. The previous study reported that the adsorption method effective to reduce heavy metal levels contamination from 0.73–2.62 mg/L to concentrations around 0–0.05 mg/L and COD contained in the liquid waste laboratory [3].

The adsorption process is influenced by the type of adsorbent. The success of the adsorption process is largely determined by the type of adsorbent used. Types of adsorbents that are often used in the adsorption process include active sand, silica gel, coconut shell, activated charcoal, zeolite, and combinations of these ingredients. In this study, three types of adsorbents were used combined in one sieve container, activated charcoal, zeolite, and sand. The combination of zeolite adsorbent activated carbon and sand has been shown to reduce Fe contamination from groundwater by 47.22% [4].
addition, the use of zeolite and activated charcoal adsorbents has also been shown to be effective in reducing bacteria in the water to 87.86% [5].

Zeolite, activated charcoal, and sand are the three types of adsorbents that are often applied in reducing contamination levels in liquid waste. The process of adsorbing 50 ml of phosphate solution using 4 grams of zeolite has resulting adsorption power of 23.63% [6]. The activated charcoal adsorbent with the amount of 2 grams was able to adsorb heavy metals Cu, Pb, Fe, and Cd in 120 ml of leachate with an effective adsorption power of 55.9%, 70.4%, 68.7%, and 72.5%, respectively [7]. Moreover, 22.2 kg of active sand adsorbent was also able to adsorb 32.2 liters of liquid waste [8].

The present study aimed to determine the effectiveness of adsorbent containing zeolite, activated charcoal, and sand to reduce hazardous liquid waste from the quality control laboratory. This study can be used to treat liquid waste from the laboratory to meet standard regulations.

2. Materials and methods

2.1. Material

Liquid waste from the quality control laboratory of Dept. Agroindustrial technology of education was used for research. Zeolite, activated charcoal, sand, H₂SO₄, a standard solution of potassium dichromate (0.25 N), ferroin indicator, and 0.1 N standard solution of ammonium iron (II) sulfate (NH₄)₂Fe(SO₄)₂·6H₂O.

2.2. Preparation adsorbent and research experiment

Three different adsorbent types: sand, activated carbon, and zeolite is activated by roasting for 10 minutes on a hot griddle. Cut the bottle with a volume of 1.5 liters in two parts and installed the bottom side of the bottle upside down. Sand, activated charcoal, and zeolite as an absorbent were inserted into bottles that have been coated with a cloth with a ratio of 1:1:1.

Five liters of liquid waste were mixed evenly and then divided equally into 5 different containers. One liter of liquid waste is put in a bottle that contains the adsorbent. The waste filtrate from the adsorbent is collected in the container and coded as P₁. Then, put 1 liter of liquid waste back into the bottle so that P₂ filtrate was obtained. This step was repeated until the P₃, P₄ and P₅ filtrate was achieved.

2.3. Determination of liquid waste

All liquid wastes before treatment and the results of the adsorbent were analyzed including chemical oxygen demand (COD) according to SNI 06–6989.15–2004 [9], total dissolved solids (TDS) according to SNI 06–6989.27–2005 [10], total suspended solids (TSS) according to SNI 06–6989.3–2004 [11], and pH according SNI 06–6989.11–2004 [12].

2.4. Statistical analysis

All data study was analyzed by using one-way ANOVA at a significance level of 95% followed by Duncan's Multiple Range Test (DMRT). All data analysis was performed using XLSTAT 2014.

3. Results and discussions

3.1. Changes of total dissolved solids (TDS) of liquid waste

Filtration and adsorption can reduce the level of Total Dissolved Solid contained in the waste. The decrease in TDS levels in the waste in each variation of the filtrating treatment is shown in figure 1.
Figure 1. Total dissolved solid of liquid waste treated with adsorbent containing Zeolite, activated charcoal, and sand with ratio 1:1:1.

The first filtering (P1) using 1 liter of liquid waste, TDS in liquid waste drops to 59% from 35000 to 20000 mg/L. The second filtration until fifth filtration (P2, P3, P4, P5) average TDS is 65–66% were compared with untreated waste. The high rate of TDS is due to the high total mineral content in water. Examples of mineral elements in water are lime, iron, tin, magnesium, copper, sodium, chloride, chlorine and others [13]. The filtration process can be influenced by filtration discharge, depth, size, and type of media, and the quality of filtered liquid waste [14].

3.2. Changes of total suspended solids (TSS) of liquid waste

The higher TSS levels in liquid waste indicate that the greater the barrier to the formation of organic substances in it such as carbohydrates, proteins, and lipids. So, before being discharged into the environment must be ensured that liquid waste does not contain TSS levels in exceed limit. It will endanger the ecosystem and the environment [15,16].

Figure 2 showed that TSS levels of liquid waste decreased after filtering with adsorbent containing zeolite, activated charcoal, and sand. The TSS level of waste decreased due to the levels of contamination adsorbed by the adsorbent. In the first step filtering (P1), TSS drops to 24% and then the second filtering (P2) until fifth filtering TTS contains is average 25-to 26%. This result shows that adsorbent contains zeolite, activated charcoal, and sand has the effectiveness to reduce suspended solid in liquid waste from quality control laboratory.

Figure 2. Changes of total suspended solid of liquid waste treated with adsorbent containing Zeolite, activated charcoal, and sand with ratio 1:1:1.
3.3. Changes in chemical oxygen demand (COD) of liquid waste
COD is the amount of oxygen needed to oxidized organic waste through chemical reactions [17]. The COD value is a measure of the level of pollution of liquid waste by organic matter. The higher the COD level, the higher the organic matter contained in the waste. COD value of waste decreased after the waste filtered with adsorbent media. Figure 3 showed that absorbent from zeolite, activated charcoal, and sand effectively reduced chemical oxygen demand (COD) until 58%. Further use of adsorbent (P4 and P5) surprisingly increased COD of the liquid waste filtrate.

![Graph showing COD values for different treatments](image)

**Figure 3.** Changes of chemical oxygen demand of liquid waste treated with adsorbent containing Zeolite, activated charcoal, and sand with ratio 1:1:1.

3.4. Changes in pH of liquid waste
Figure 4 shows that the filtration process can increase the pH of waste. According to Rahayu et al [18] filtration is a suitable method to increase pH of liquid waste. The zeolite adsorbent is the most influential adsorbent due to pores filled with K, Na, Ca, Mg and H2O ions, thus allowing an alternating ion and alternating water release. Liquid waste is very acidic or very basic will damage property (corrosive) and disrupt organisms [3].

![Graph showing pH values for different treatments](image)

**Figure 4.** Changes pH of liquid waste treated with adsorbent containing Zeolite, activated charcoal, and sand with ratio 1:1:1.

This study proves that the filtration and adsorption process can reduce TDS, TSS and COD levels of liquid waste, even though it is no met regulation standard. The minimum standard TDS, TSS and COD content are 2,000 mg/L, 400 mg/L, 100 mg/L respectively [19]. The pH of the waste after processed by the extraction process ranges from pH 2, which means that the pH of the waste does not meet the
standards that should range from 6–9. Therefore, to reduce contamination levels of liquid waste to be in accordance with the standards, further processing or combination of processing must be carried out.

4. Conclusion
Adsorbent made from zeolite, activated charcoal, and sand with ratio 1:1:1 was effective to reduce total dissolved solids, total suspended solids, and chemical oxygen demand of laboratory liquid waste. This adsorbent is also effective to increase pH of liquid waste until the fifth filtration. This adsorbent is very effective and simple as a laboratory-scale waste treatment even though it has not met regulations.

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