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COMPARISON OF THE EFFECTIVENESS OF SILICA SAND AND RESIN FILTER MEDIA ON REDUCING PHOSPHATE LEVELS OF WASTEWATER OF PKU MUHAMMADIYAH HOSPITAL SURAKARTA

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ABSTRACT

Liquid waste containing phosphates affect the human health. Therefore, each facility must ensure the phosphate content on their effluent are not exceeding the allowable limit. Inability of wastewater treatment plant to reach allowable phosphate content was experienced by Hospital PKU Muhammadiyah Surakarta. The phosphate content of their effluent was 5.7 mg/L, which exceeded the wastewater quality standards. There are several methods that could be applied, such as coagulation and filtration. In this research, filtration method was applied to reduce phosphate levels due to its ease operation and without any residual by-product. Silica sand and resin filter were chosen as the filtration media, due their readily available in the commercial market. Column height of the filter medium were varied, namely 60 cm, 80 cm, and 100 cm. The effectivity of the filtration treatment was evaluated based on the phosphate concentration of the produced filtrate. Higher filter column led to higher percentage of phosphate removal. About 85% and 70,32 % of total phosphate were removed from the wastewater, after filtration using silica and resin filter media at 100 cm bed height, respectively. The results have shown the silica sand has better performance in removing phosphate compare to resin filter. Thus, confirming the feasibility of the filtration application for phosphate removal of hospital wastewater.

INTRODUCTION

All living creatures need water, because water is the source of life. Without water, living creatures cannot maintain their survival, including humans. The increasing need for water causes an increase in the use and use of water, which will certainly produce waste water in the form of waste. Wastewater that is discharged into water bodies in large volumes and for long periods of time can cause environmental pollution [1].

Waste water pollution can come from industrial waste, household waste, or waste from hospitals. Hospital activities produced high amount of liquid waste, which can cause pollution if were not properly managed. Hospital liquid may come from the kitchen and laundry sections, inpatient room, laboratory services or operating room. They may contain microorganisms, toxic chemicals, or radioactivity that were dangerous to health [2].

PKU Muhammadiyah Surakarta Hospital is a non-profit hospital owned by Persyarikatan Muhammadiyah. Wastewater produced by the hospital were treated in the treatment facility, before released into the environment. However, after the treatment took place, the phosphate level still exceeded the allowable limit as stated by the local government regulation [2].
Therefore, the researchers would suggest to apply filtration method to improve the quality of waste water, by lowering the phosphate content in water. Filtration, or filtering, is a solid-liquid separation process where solid particles suspended in a liquid are physically removed by passing them through a filtering medium [3]. The filter media is capable to filter impurities, thus producing cleaner water output. Filter media that are often used include silica sand, zeolite, palm fibre, resin and activated carbon [3,4]. Silica sand is very effective in filtering mud and other impurities [3]. Apart from silica sand, resin has a certain level of absorption capacity for dissolved organic matter, colour, odor, taste, and other substances. In this research, filtration method will be applied using silica sand and resin. To evaluate the performance of filtration method, the removal effectivity of phosphate will be evaluated.

RESEARCH METHODOLOGY

Materials

The materials used in this research included silica sand, resin, latex gloves, wastewater sample from PKU Muhammadiyah Surakarta Hospital treatement plant. Whereas for The tools used in this research included 6 1L jerry cans, plastic measuring cups, buckets, scoops, and 1 set of biofilter tools.

Procedures

The silica sand material was placed in a plastic container and backwashed using tap water for several times, until clean water was obtained. Similar preparation procedure also carried out for resin filter. Whereas wastewater sample was taken from the final settling tank which commonly contain high levels of phosphate. The waste samples were used without any prior treatment. Filtration column was built using PVC pipe with setup as shown in Figure 1. Prior used, resin media was also washed to remove any impurities. Filter media bed height were varied at 60 cm, 80 cm, and 100 cm.

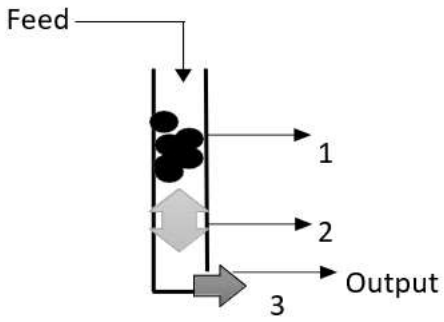

Figure 1. Schematic diagram of filtration column (1) Filter media, (2) Mold strainer, (3) Outlet pipe

The phosphate level examination was carried out at the Environmental Laboratory of Perum Jasa Tirta I, Surakarta. Testing for phosphate levels according to SNI 06-6989.31-2005 uses the spectrophotometer method using ascorbic acid in the range of 0.0–1.0 mg/L.
Data from tests on the phosphate content of silica sand filter media and hospital liquid waste resin were processed using *Microsoft Excel* to be analyzed into tables and graphs. The effectiveness (*Eff*)

of the percentage reduction in phosphate levels between silica sand and resin in hospital liquid waste is calculated using the formula as shown in Equation (1) [5].

$$Eff = \frac{inf - efl}{inf} \times 100\% \quad (1)$$

RESULTS AND DISCUSSIONS

The amount of waste produced by PKU Hospital is 70–80 m^3 /day. All liquid waste produced in the hospital is collected into one existing storage tank and pumped to the aeration reactor tank and then to the clarifier reactor. The aeration process uses two blowers that work continuously and are turned on alternately automatically. After passing through the existing holding tank, it is channelled to the filtration tank, where the filtration tank uses activated sludge, gravel, and sand as filters for the liquid waste. The waste water then flows into the effluent holding tank and flows again into the disinfection tank. After disinfection took place, the treated wastewater would be disposed into the water stream. Based on the preliminary investigation, the phosphate level was detected at 6.45 mg/l, which was higher than the allowable limit [2]. Previously, the hospital has applied the coagulation method using PAC and alum, to reduce the phosphate level. However, this is less effective in reducing levels of phosphate at PKU Muhammadiyah Hospital, Surakarta

The quality of waste water at PKU Muhammadiyah Surakarta Hospital, which is treated using resin and silica sand filtration media, shows an increase in effectiveness as seen from a decrease in levels of phosphate with variations in column heights of 60 cm, 80 cm, and 100 cm. The result was presented in Table 1.

Table 1. Test results for phosphate hospital liquid waste

Column Height Variations	Media Filter	Concentration Phosphate (mg/L)	
		Before Filtration	After Filtration
0 cm	Without filter media (control)	7.23	7.23
60 cm	Silica sand		5.75
	Resin		2.46
80 cm	Silica sand		2.02
	Resin		2.35
100 cm	Silica sand		1.02
	Resin		2.15

Analysis of the reduction in phosphate levels in the table above shows that the results without filter media are higher than using filter media. This resulted in a decrease in phosphate levels before and after treatment.

The results of the phosphate content test on the effectiveness of the filter media between silica sand and resin were presented in Table 2. Higher effectivities were observed at higher bed height, for both silica sand and filter media. Phosphate is a form of phosphorus compound that can be used as a determining factor in water quality. Phosphates are found in wastewater as polyphosphate compounds, organic phosphates, and orthophosphates. This element is one of several pollutant elements that are essential for excessive algae growth in water, which will cause a decrease in the quality of the water. The high level of foam contained in waste processing does not only arise from surface *active agents* in detergent [6].

Table 2. Results: effectiveness analysis of silica sand filter media

Column Height Variations	Filter Media	Effectiveness (%)
60 cm	Silica sand	20,42
80 cm	Silica sand	72
100 cm	Silica sand	85,85
60 cm	Resin	65,97
80 cm	Resin	67,46
100 cm	Resin	70,32

Disposal of waste containing lots of phosphate into water can cause the growth of moss and microorganisms, which is also referred to as excessive eutrophication, so that the water becomes cloudy and smells due to the decay of dead moss. Many methods have been used in the process of reducing phosphate levels in water. However, the most effective method for reducing phosphate levels is the filtration method using silica sand and resin filter media [7].

According to SNI 6774 (2008), filtration is the process of separating solids from the supernatant through filter media. Filtration is the separation of solids, or colloids, from liquids. The water filtration process involves flowing water through granular media. Water filtration can remove bacteria, color, turbidity, and metal content such as iron. Water filtration uses silica sand, resin, zeolite, and activated charcoal. In the filtration process, quite large particles will be filtered through the sand media. The resin has a certain level of absorption capacity for dissolved organic matter, color, odor, taste, and other substances. Meanwhile, zeolite and activated charcoal media function to filter bacteria and metal content in water. The space between grains functions as a place for the sedimentation of impurities in water.

The ability of this filter medium is that the filter consists of two processing components, each of which has a different function. First, silica sand filter media has the ability to act as a filter that can separate solid and liquid chemical compounds. Silica sand media as a filtration medium can separate solids and liquids using the principle of gravity so that suspended solids are resolved. Second, softener resin is a cation resin that can reduce high water hardness, one of which is the phosphate content of hospital wastewater.

Therefore, based on this research, wastewater filtration using silica sand and resin filter, were capable to reduce the phosphate level to the allowable limit. Hence this method can be chosen by the hospital to replace the coagulation method, in order to reduce the phosphate content.

CONCLUSIONS

From the research that has been carried out, the following conclusions can be drawn based on Central Java Provincial Regulation Number 5 of 2012: the quality of raw water with phosphate levels above the quality standard of 2 mg/L; and the effectiveness of reducing phosphate levels produced by filter reactors using two media. Silica, sand, and resin filters include: Resin filter media with column height variations of 60 cm, 80 cm, and 100 cm, respectively, have an effectiveness value of 65.97%, 67.46%, and 70.32%. Silica sand filter media with varying column heights of 60 cm, 80 cm, and 100 cm, respectively, has an effectiveness value of 20.42%, 72%, and 85.85%. A more effective

filter media for improving water quality is resin filter media. Because the increase in effectiveness in resin filter media is more significant than the increase in effectiveness in silica sand media, the range of effectiveness values for resin filter media on column height is between 60% and 70%. Meanwhile, the range of effectiveness values for the silica sand filter media on column height is between 20% and 86%.

In comparing the effectiveness of silica sand and resin filter media in reducing wastewater phosphate levels, it is not completely accurate, so further research needs to be carried out. Apart from that, ensure that the waste water samples that will be used for research are free from impurities that can affect the research results.

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