The Effectiveness of Greywater Treatment Using Coconut Husks and Sugarcane Bagasse With Limestone as Filter Media for Non-potable Uses

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Research Article

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Abstract

The vertical flow filtration method has been used for this research based on four distinct circumstances of filtration through coconut husks, filtration through raw sugarcane bagasse, filtration through combination of coconut husks with limestone and filtration through sugarcane bagasse combined with limestone. Coconut husks is one of the biodegradable materials that high in water absorption. For sugarcane bagasse, it is one of the most abundant lignocellulosic agro-industrial residues remaining after the crushing and extraction of juice from sugarcane stalks. Both of materials can be used as filtration at home for domestic purpose. Before the filtration are carried out, coconut husks and sugarcane bagasse have been washed with distilled water to make sure the materials were completely free of any other substances. They will be dried in the oven for 24 hours at 100°C to ensure that the materials were completely dry and that the filtered water did not cause foreign smell or taste. Coconut husks and sugarcane bagasse have been compacted to a height of up to 3cm along particles of these materials were sufficiently dense to ensure filtering process efficiency. The test on the physical properties and heavy metals of greywater before and after filtration process have been carried out. The tests have been measured parameter of physical properties of pH, turbidity and colour as well as heavy metals namely Copper, Zinc and Iron defined as being among essential heavy metals usually found in greywater. The results of these tests are recorded and compared with standard to know the effectiveness of coconut husks and sugarcane bagasse for treatment of greywater.

I. Introduction

Sustainable water resources are vital for socio-economic growth, yet in today's culture, water also gets misused and wasted (Assayed A. 2003). Sustainable water resource management is important for arid and semi-arid regions. Water conservation and reuse in arid and semi-arid areas are problems that receive much government attention. Responsible water uses and reuse is essential for the sustainability of water supply and hence for the future. Treatment and reuse of sewage is one of the best alternatives to water conservation available to people in arid regions. Many large-scale reuse attempts, for example, watering golf courses and irrigating municipal effluent treated landscapes. The capacity for wastewater reuse is not limited to large-scale projects provided by wastewater treatment plants in the city but is also accessible to individual homeowners (Asano T. 1998). Greywater recycling provides a way for individuals to save and reuse in their homes the wastewater produced.

Domestic wastewater or sewage can be split into two classifications which are black water that comes from toilets and kitchens is contaminated by gross fecal coli and usually has elevated levels of organic matter and grey water that originates from bathrooms and laundries and is biggest wastewater flow (Emmerson G. 1998). The word “greywater” relates to untreated wastewater from household that was not contaminated with toilet waste. It involves clean toilets, showers, hand basins, laundry tubs, washing machines and waste from the surface. It does not include waste from sinks, waste disposal units or dishwashing machines (Nolde E. 1999).
It is called greywater because the water often clouds and turns grey in colour if it is stored for even short periods of time (Emmerson G. 1998). The precise greywater sources differ by country and organization. Some definitions include kitchen water and dishwater. The quantity of wastewater produced by any household will differ significantly depending on the dynamics of the family and will be affected by variables such as the number of occupants, the age distribution of the occupants, their lifestyle features, water consumption habits, water costs and climate (NSW Department of Health. 2000).

Much of the wastewater generated every day is acknowledge as greywater. The complete amount of greywater produced daily from the average household (in distinct nations) is 356 litres, this represents approximately 60% of the total sewage produced (Beaver P. Greywater, 1995). Greywater can be used for various reasons, such as watering the garden, decorative use in fountains and waterfalls, landscaping, irrigation of the lawn, car washing and toilet washing (Al-Jayyousi OR. 2002). Reuse of greywater uses a resource on-site that would otherwise be wasted. Fresh drinking water supplies are preserved because of reuse, which in turn allows water to stay in natural ecosystems.

Greywater reuse is successful in saving water authorities’ cash, reducing sewage flows and reducing government demand for supplies of drinking water. By recycling of greywater, the load on wastewater disposal system is decreased, thus prolonging the lifetime of the wastewater disposal scheme and delaying the capital expenditure needed to upgrade and expand the facilities. For instance, the sewerage system in most significant towns in Australia is old and overloaded in many fields (Davis C. 1993). This issue will worsen as the population of the country expands. It is therefore necessary to investigate solutions to the traditional scheme, such as the recycle of greywater (Emmerson G. 1998).

II. Experimental Program

A. Filtration Setup

In order to achieve this research objectives, the experimental works have been conducted at the laboratory to create the vertical flow filtration to filtrate greywater. The equipment’s used to conduct this experiment was 35 cm x 25 cm rectangular plastic container. Several holes are created at the bottom of the rectangular to enable the greywater flow through every layers of the vertical flow filtration until the outlet layers to be collected. So, the greywater was filtered at every layer by each type of materials used at every layer.

This research has been applied by using four different vertical flow filtration conditions. First, the vertical flow filtration through raw coconut husks with limestone, second, vertical flow filtration through raw coconut husks, third, vertical flow filtration through raw sugarcane bagasse with limestone and lastly vertical flow filtration through raw sugarcane bagasse as shown in Figure 1.

B. Test on Turbidity
The turbidity analysis was used the turbidimeter as shown in Figure 2 to assess the cloudiness and haziness of the water samples. The Nephelometric Turbidity Unit (NTU) was calibrated. The lower turbidity of water samples suggests the higher level of contaminant present in the water to be checked.

Apparatus used for test on turbidity was turbidimeter, beakers and a cell. The sample of 150 mL were prepared in the beaker that has been cleaned with distilled water. A cell was filled with the sample until it reached the mark at the cell. Then the cell was putted into the turbidimeter after it cleaned by tissue. Press the “SIGNAL AVERAGE” key and then press the “AUTO RANGE” key until the word “AUTO RANGE” displayed on the screen. Next, press the “READ” key and wait until the value stable. After that, record the stable value in NTU unit. The measurement was taken three times and the average value was obtained. Lastly, remove the cell, press the “I/O/EXIT” and clean all the apparatus.

C. Test on pH

pH was tested to assess water sample acidity and alkalinity. pH meter was the device used for calculated pH as shown in Figure 3. This was also was used to assess whether the water was saved enough in term of pH value.

Apparatus of pH meter consisting of potentiometer, a glass electrode, reference electrode and temperature compensating device, beakers and distilled water. The sample of 150mL was filled in the clean beaker. Three beakers were needed for each sample. The electrode was cleaned with the distilled water to make sure that the reading is relatively accurate. By following the instruction of pH meter, pH was tested immediately after sample is taken because change in temperature will affect the pH value. After the “beeps” sound appeared, the reading will be recorded. There is no unit associated with it.

D. Test on Colour

Colour is a secondary or aesthetic water quality variable and is also not marked as harmful. The colour unit will be calibrated in the Platinum Cobalt Standard (PtCo). Spectrophotometer DR 2800 as shown in Figure 4 to be the equipment used to determine the colour of the specimen. It was easy to operate and manage this machinery.

Procedure test on colour using spectrophotometer use at 455 nm with matched silica cells with program number for colour which are 120. The distilled water was putted into 10 mL silica cell that label as a blank. Then another cell with same label as distilled water were filled with sample and put into the Spectrophotometer and closed the shield. The instrument was zero at 455 nm. For a few minutes the display will show the unit pt-co (platinum cobalt) for colour. The value is then recorded.

E. Test on Heavy Metals

It is important to determine the concentration of heavy metals, namely Copper (Cu), Zinc (Zn) and Iron (Fe), in order to determine the quantity of these pollutants removed by this research. The
Spectrophotometer was used as shown in Figure 4. The concentration of these metals can be measured even in small quantities.

Procedure test on heavy metals using spectrophotometer use with matched silica cells with program number for heavy metals. The distilled water was putted into 10 mL silica cell that label as a blank. Then another cell with same label as distilled water was filled with sample and put into the Spectrophotometer and will be closed the shield. The instrument was zero for blank sample. Put the silica cell of sample and for a few minutes the display will show the unit mg/L for heavy metals. The value is then recorded.

### iii. Results And Discussions

A sample of greywater for this research were collected from the sump located at the Dataran Cendekia Cafeteria UiTM Shah Alam sum. This sump covers catchment from the Dataran Cendekia Cafeteria UiTM Shah Alam. Sample were collected and stored in the cylindrical container. A sample were collected twice in two weeks. So, the results of this research for each parameter and conditions were tabulated in Table 1 and Table 2.

#### A. Turbidity

Turbidity is measurement of a liquid 's relative visibility. It is an optical water characteristic and is a measurement of the amount of light that is dispersed in the water when a light is shined through the water sample. The higher the disseminated light intensity, the greater the turbidity. Including clay, silt, very small inorganic and organic matter, algae, dissolved organic compounds and plankton and other microscopic organisms are materials that cause water to become turbid.

For the first parameter which are turbidity, all the raw before treated value with after treated value for all conditions have been tabulated in the Table 3. The raw sample of greywater acted as references for the result of other four filter conditions and its value of turbidity was 426.0NTU for the first raw sample. The result of turbidity for the raw coconut husks with limestone condition was 61.4NTU and had 86% removal of turbidity from raw sample. For the raw coconut husks condition the value was 73.2NTU and had 83% removal from raw sample.

Another two filter conditions which are raw sugarcane bagasse with limestone and raw sugarcane bagasse condition were tested using second raw sample for turbidity and its value was 320.0NTU. So, for the raw sugarcane bagasse with limestone condition the results show that the value decrease to 68.4NTU and 77% removal from raw sample of greywater. Raw sugarcane bagasse condition also decreases from raw sample of greywater to 81.4NTU and had 75% of removal.

This research showed that all the filter conditions of raw coconut husks with limestone, raw coconut husks, raw sugarcane bagasse with limestone and raw sugarcane bagasse condition decrease from its raw sample and have good percentage removal after treated. So, the percentage removal for all filter
conditions have been summarized in the Figure 4 and raw coconut husks with limestone condition was the highest removal compared to the other three conditions after treated.

So, from the results in the Table 3 and Figure 4 showing that raw coconut husks with limestone condition had the higher decreasing value of turbidity after treated using vertical flow filtration method. From the result analysis, the graph of turbidity showed that drastically improvement when the turbidity of samples was reduced after treatment. Every filter condition was showed the efficiency to remove the turbidity.

In general, turbidity is particles that are generally invisible to the naked eye, like smoke in the air. Turbidity was measured of the light-transmitting properties of water to indicate the quality of waste respect to colloidal and residual suspended matter. The results showed that the highest removed of turbidity at the filter condition of raw coconut husks with limestone that contained limestone that capabilities to remove the turbidity. According to Clarke et al., (1996), a roughing filtration very effective method for removing turbidity, coliform bacteria and suspended solid.

Lastly, during filtration time, solids will settle on top of the filter medium surface and grow to small loads of loose aggregates. A sample was moved very slowly through the limestone compared to others filter. So, it showed that the gravel as one of the roughing filters was very efficient to remove the turbidity. According to (Wegelin, 1996), Roughing filters make natural purification processes and no chemicals are necessary. Besides these filters could be built from local materials and manpower. These filters will work a long time without maintenance.

B. Colour

Colour is organic material that has dissolved into a solution, while turbidity consists of small particles that are suspended in the column of water. If a glass of water were left overnight on the counter, the turbidity-causing material would have settled to the bottom of the glass in the morning while the colour would remain as it was before.

For the parameter of colour all the value has been tabulated in the Table 4 with raw before treated value and after treated value for all conditions. The raw sample of greywater act as references for the result and the value of colour for first raw sample was 1847 PtCo and second raw sample was 1445 PtCo. For the filter condition of raw coconut husks with limestone and raw coconut husks have been tested using first raw sample. The result of colour for raw coconut husks condition with limestone after treated was 879 PtCo and had 52% of removal from first raw sample of greywater. For filter condition of coconut husks only, the value of colour decrease to 959 PtCo and percentage removal of 48% from first raw sample of greywater as shown in Figure 5.

The other two conditions of sugarcane bagasse with limestone and sugarcane bagasse have been tested using second raw sample of greywater. Both of conditions showing decreasing value of colour as for sugarcane bagasse with limestone condition decrease to 755 PtCo and had 48% of removal from its raw
sample of greywater. For the sugarcane bagasse condition also showing decreasing value of colour to 891 PtCo and had 38% of removal from its raw sample of greywater as shown in Figure 5.

So, from the Table 4 and Figure 5 showing that raw coconut husks with limestone filter condition had the higher decreasing value of colour after treated using vertical flow filtration method. The colour after treatment was an improvement when the colour was reduced by each filter condition. That shows the effectiveness of the combination raw coconut husks with limestone as filter media to reduce the contamination in greywater same as the other three filter conditions. Basically, the colour in the greywater was influenced by suspended solid and turbidity. By using spectrophotometer, the samples were measured by the light that has passed through and comparing light transmitted through the colour standard by using the blank sample as references.

Furthermore, the summarize of all filter condition of raw coconut husks with limestone, raw coconut husks, raw sugarcane bagasse with limestone and raw sugarcane bagasse condition shown in the Figure 5. it shows that all conditions have good percentage removal to reduce the of colour in the greywater from raw sample value after been treated. The highest percentage removal for colour is raw coconut husks with limestone condition with 52% of removal.

The sample contains more particulate matter from the waste of food, washing dishes and another source around the Dataran Cendekia and college area. So, colour was effectively reduced by using the combination filter. According to Ncibi et al., (2008), the natural availability and the high degree of dye or colour removal of plant waste products like sugarcane bagasse and coconut husks were increased over the last few decades. The nature of the water that affected by coloured make it unable to use by a human. Predominantly, dyes are non-biodegradable, very toxic and their metabolites have teratogenic, mutagenic and carcinogenic which cause problem to human health and aquatic life and difficult to treat by the conventional and biological process (Gunasekar and Ponnusami, 2012). So, one of the solutions to treat this problem is by adsorption. According to A. Dąbrowski (2001), the most well-known method is adsorption. Adsorption phenomena are called the aggregation of adsorbents at the gas-solid or liquid-solid interface.

C. pH

pH stands for the “power of hydrogen”. pH is a determined value, like temperature, based on a defined scale. It means that the pH of water is not a measurable parameter that can be determined in a quantity or as a concentration. The smaller the number, the more acidic the water will be. The higher the number, the more basic it is. A pH of 7 is considered neutral. The logarithmic scale means that, when counting down, every number below 7 is 10 times more acidic than the number before. Likewise, any number is 10 times basic than the previous number when counting above 7.

For the pH value, it has been tested in the laboratory and the result have been tabulated in the Table 5. The value of pH for the first sample was 4.59 and the sample have been tested for raw coconut husk with limestone and raw coconut husks condition. So, after having treated by the coconut husks condition the
pH value increases to 5.77 from its original value. As for the raw coconut husks condition the pH value also increases to 5.57 from the value of raw before treated.

For the second sample of raw greywater it's have been treated by using raw sugarcane bagasse with limestone condition and raw sugarcane bagasse condition. As shown in the table, the value of raw sample before treated was 4.67. So, after been treated by raw sugarcane bagasse with limestone condition the pH value increase to 5.38 and for the raw sugarcane bagasse condition the pH value also increase to 5.33.

The result of pH every sample show that tried to approach the neutral reading. Actually, pH is potential of hydrogen that has scale of acidity from 0 to 14. More acidic solutions have lower pH value and more alkaline solutions have higher pH value. Substance that are not acidic or alkaline have a pH level of 7 and called as neutral solutions. Besides, the sample from domestic waste that came from Dataran Cendekia and college's area where a lot of chemical contaminant from detergent, shampoo and from food waste. According to Wegelin (1996), limestone as a media in the filter can partly reduce the bacteriological water quality and to minor extent, change some other water quality parameters such as colour, pH or amount of dissolved organic matter.

It showed that the limestone can neutralise the hydrogen or pH in the filter that has a combination with gravel. In fact, limestone is a calcite which can inexpensively be used to neutralise acidic or low pH waters to a neutral, less corrosive effluent. So, limestone is a very suitable material as a media in a filtration process to neutralise the pH range.

D. Copper

Copper is a stable transition metal in its metallic state. It forms monovalent cations (cuprous) it divalent (cupric). Sometimes dissolved copper can give the drinking water a light blue or blue green colour, and an unpleasant metallic, bitter taste. Metallic copper is malleable, ductile and a strong conductor, both thermal and electric. Despite of its versatility it has many industrial applications. Copper is used for the manufacture of electrical cables, pipes, valves, fittings, coins, utensils for cooking, and materials for building.

Table 6 shows the value of two raw sample of greywater and the value of sample after been treated using raw coconut husks with limestone, raw coconut husks, raw sugarcane bagasse with limestone and raw sugarcane bagasse condition with percentage removal for copper contamination. The first raw sample have been collected and the value of copper for the first greywater sample was 3.72mg/L. The raw coconut husks with limestone decrease to 1.27mg/L from its raw before treated and have 66% removal. As for the raw coconut husks condition the value of copper decrease to 1.39mg/L after been treated and have 63% of removal.

For the second raw sample of greywater the value was 3.67mg/L and have been tested for raw sugarcane bagasse with limestone and raw sugarcane bagasse condition. Raw sugarcane bagasse with
limestone condition decrease to 1.34mg/L from its raw sample and have 63% of removal. As for the raw sugarcane bagasse condition it also decrease to 1.42mg/L from its raw sample and have 61% of removal.

The overall percentage removal for heavy metals of Copper (Cu) shown in the Figure 6. The bar chart showed each of the percentage removal of raw coconut husks with limestone, raw coconut husks, raw sugarcane bagasse with limestone and raw sugarcane bagasse condition. The highest percentage removal is raw coconut husks with limestone which is 66% compare to the other conditions.

Generally, the sources of heavy metals come from direct or indirect human activities such as urbanisation, industrialisation and anthropogenic. According to Jerm (2006), non-biodegradable and toxicity nature is the endurance of heavy metals in wastewater or greywater. In wastewater or greywater, major source of heavy metals are textile industries. Heavy metals such as copper, chromium, nickel and lead are compounds used for these industries in dyeing process (coloration). In domestic wastewater, the sources of copper occur from water pipes, copper water heaters, copper cooking pots and pesticides.

Furthermore, there are a lot of effect of copper towards human health such as liver failure, genetic predisposition and hepatic. A lot of health effect by exposure to high levels of Copper (Cu) such as genetic predisposition or disease (Stem et al., 2007). According to Argun (2007), Copper (Cu) may effect on severe mucosal irritation and corrosion, widespread capillary damage, hepatic and renal damage and central nervous irritation followed by depression. The resulting analysis of copper showed that the efficiency of the system to treat the copper contamination very effectively.

E. Zinc

Zinc occurs in almost all the igneous rocks in small amounts. Zinc imparts water with an unwanted astringent taste. Zinc is used in the manufacture of alloys and brass resistant to corrosion, and for galvanizing steel and iron products. For example, zinc oxide, which is used as a white pigment in rubber, is the most commonly used zinc compound. Occasionally, peroral zinc is used to treat human zinc deficiencies.

The overall data of the parameter of heavy metals of Zinc (Zn) contaminant for its raw sample before treated and value of zinc after been treated for all conditions have been tabulated in the Table 7. So, for the first raw sample of greywater have been treated by raw coconut husks with limestone and raw coconut husks condition with the value of 1.25mg/L. The value of zinc after been treated by raw coconut husks with limestone condition is 0.38mg/L and has 70% of removal from its raw sample before treated. For the raw coconut husks condition the value also decrease to 0.44mg/L after been treated and has 65% of removal.

The second raw sample of greywater have been treated using raw sugarcane bagasse with limestone and raw sugarcane bagasse condition with value of 1.10 mg/L. The value of zinc after been treated using raw
sugarcane with limestone condition is 0.35mg/L and has 68% of removal. As for the raw sugarcane bagasse condition the zinc value also decrease to 0.48mg/L and has 56% of removal.

For the overall percentage removal of all conditions shown in the Figure 7 with conditions of raw coconut husks with limestone, raw coconut husks, raw sugarcane bagasse with limestone and raw sugarcane bagasse. The bar chart shows that the highest percentage removal for zinc is treated by using raw coconut husks with limestone condition with 70% compare to the other conditions.

In this study identifying that the zinc contaminant in greywater was treated effectively by using this system. The consistently decreasing was showed that the zinc removal by using this treatment. Zinc occurred from corrosion and leaching of plumbing, waterproofing product, deodorants, cosmetics, colouring agent and medicine (Carbonell-Barrachina et al., 2004). In this case, the sample was taken from sump at Dataran Cendekia that contain waste can contribute to form the zinc contaminant such as deodorants, leaching of plumbing etc.

*Furthermore, the highest amount of Zinc (Zn) can cause system dysfunction such as impairment of growth and reproduction. According to Duruibe et al., (2007), the effect of Zinc (Zn) are vomiting, diarrhoea, icterus (yellow mucus membrane), liver failure, kidney failure, anaemia and bloody urine. Therefore, heavy metals should be treated as well to prevent the natural environment from polluted (Meena et al., 2008). According to Panayotova and Velikov (2003), there are few conventional methods to reduce or treat the heavy metal such as coagulation, ion exchange, solvent extraction, chemical precipitation and filtration. From the Figure 7, showing the results of zinc every filter was consistently decreased. Therefore, it showed that the system was effective to reduce the zinc in greywater sample. Erne et al., 2016 was proved in their researched that more that 90% of Copper (Cu), Lead (Pb) and Zinc (Zn) and 75.40% of Arsenic (As) was remove by using coconut husks as an adsorbent.*

F. Iron

Iron is a metal element which is common in most areas. It is a typical naturally occurring contaminant in water supply but may also be obtained from man-made sources such as corrosion in iron pipes or fittings, or its use as a solvent for water treatment, uncommon in private water systems. Iron is an important parameter in water supply because of its potential to impede treatment process efficiency and impact the water's aesthetic acceptability. High iron concentrations can impart a metallic taste and decolor the water significantly, making it undrinkable.

All the data of all condition of raw coconut husks with limestone, raw coconut husks, raw sugarcane bagasse with limestone and raw sugarcane bagasse have been tabulated in the Table 8. The raw sample of greywater acted as references for the result of other four filter conditions and its value of Iron (Fe) contaminant was 2.65mg/L for the first raw sample. The result of iron contaminant for the raw coconut husks with limestone condition was 0.42mg/L and had 84% removal of iron contaminant from raw sample of greywater. For the raw coconut husks condition the value of iron contaminant was 0.73mg/L and had 72% removal from raw sample of greywater.
Another two filter conditions which are raw sugarcane bagasse with limestone and raw sugarcane bagasse condition were treated using second raw sample for iron contaminant and its value was 2.63mg/L. So, for the raw sugarcane bagasse with limestone condition the results show that the value decrease to 0.51mg/L and 81% removal from raw sample of greywater. Raw sugarcane bagasse condition also decreases from raw sample to 0.92mg/L and had 65% of removal of greywater.

This research showed that all the filter conditions of raw coconut husks with limestone, raw coconut husks, raw sugarcane bagasse with limestone and raw sugarcane bagasse condition decrease from its raw sample and have good percentage removal of iron contaminant after treated. So, the percentage removal for all filter conditions have been summarized in the Figure 8 and raw coconut husks with limestone condition was the highest removal compared to the other three conditions after treated.

In general, iron does not present a danger to human health or the environment, but it brings unpleasantness of an aesthetic and organoleptic nature. Indeed, iron gives a rust colour to water, which can stain linen, sanitary facilities or even food industry products. Most important to metabolic process in the human body is required iron but too little iron may experience fatigue, decreased immunity or iron-deficiency anaemia, which can be serious if not treated very well (Rachel and Regina, 2000).

The occurrence of iron in water can also have an industrial origin, mining, iron and steel industry and metals corrosion. In wastewater or greywater, the iron occurs from metals corrosion in the pipeline, water heater from student’s college and medicine. The iron contaminant was effectively reduced from raw material. It shows that the iron contaminant is decreasing after treated by each condition of filter. This is because of composition of the agro-product that has been used in the system such as sugarcane bagasse and coconut husks.

The composition of the agro-product likes lignin, cellulose and hemicellulose can be as absorbent to absorb the heavy metal contamination. Besides, this composition also high in water absorption that are soluble and more easily extracted. According to Erne et al., (2016), more than 90% of Copper (Cu), Iron (Fe) and Zinc (Zn) and 75.40% Arsenic (As) was removed by using the banana trunk as an absorbent. Therefore, banana trunk is one of the agro-product same as the material used for this research which are coconut husks and sugarcane bagasse. So, the combination of the filter media for this research are effective to remove the iron contamination in greywater.

Iv. Conclusions

Coconut husks and sugarcane bagasse are waste substances that can extract heavy metals from greywater including copper (Cu), zinc (Zn), and iron (Fe). Modification of these residues with limestone wastes provided an effective method for extracting physical pollutants such as colour, turbidity and stabilizes the hydrogen or pH potential in greywater. At the same time, the goals of this research were successfully achieved where the method was able to treat the greywater pollution due to limitations considered in this research.
According to Maryam et al., (2013), removal of dyes and other pollutants from aqueous solutions is very effective by using adsorption process. The concept of the system that has been used is adsorption such as coconut husks and sugarcane bagasse as an adsorbent to remove contamination in greywater. Bashir et al., (2014) concluded in their research that sugarcane bagasse can be effectively used as an adsorbent for the removal of textile dyes. Furthermore, an adsorbent like coconut husks also one of the materials are potential to remove heavy metals contamination such as Copper (Cu), Zinc (Zn) and Iron (Fe).

Besides, limestone or roughing filter give more effect toward turbidity of the greywater when it can reduce the turbidity in the greywater. it was concluded by Clarke et al., (1996), a roughing filtration very effective method for removing turbidity, coliform bacteria and suspended solid. So, the selection of limestone for this filtration system improve the outcome of this research and meet the objectives.

Therefore, the effect of this contamination can be reduced such as soil pollution, human health and aquatic environment. One of the major sources of soil pollution is heavy metals. Various metals, such as Cu, Fe, Cd, Zn, Cr and Pb can cause heavy metals pollution of the soil (Karaca et al., 2010). Another researcher has been made by Ashraf and Ali, (2017) was concluded that the change of the population size, the diversity and overall activity of the soil microbial communities were exerted by toxic effects on soil microorganism of heavy metals. The most important are the system can reduce heavy metal that can give impact to the human health. Undesirable impacts on human and the associated harmful impacts become noticeable only after several years of exposure when digestion chronic level of heavy metals (Khan, 2008).

Lastly, the effectiveness viability mix of coconut husks and sugarcane bagasse with combination of limestone as an adsorbent to reduce heavy metals such as Copper (Cu), Zinc (Zn) and Iron (Fe) in greywater were achieved and implemented the economic method for the greywater treatment. In origin, heavy metals sources can be natural or anthropogenic. In removing heavy metals from water, several treatments commonly use which include reverse osmosis, electrocoagulation, nanofiltration and precipitation exchange (Kumari et al., 2006; Mondal et al., 2008 and Rahman et al., 2008). Nevertheless, these methods are limited because high in operational cost (Murugesan et al., 2006). However, the material like coconut husks and sugarcane bagasse can easily find and cheap. So, the combination coconut husks and sugarcane bagasse with limestone treated greywater are very effective.

**V. Recommendations**

A lot of consideration is needed to study in order to make sure this system is more effective in greywater treatment because a combination coconut husks and sugarcane bagasse with limestone as a filter media is a new combination system where a lot of consideration is needed. Besides, the scope of this study is limited due to the limitation of this study before. To improve this system must take a lot of ways for the future consideration. Some of that ways are:

1. Change the solution of the sample from greywater to the aqueous solution.
An aqueous solution is a solution in which the solvent is water. It is usually shown in chemical equations by appending to the relevant chemical formula. It can determine by whether the substances can match or exceed the strong attractive forces that water molecules generate between themselves.

2. Study more types and various condition of the sample.

In this research, it only focused on the domestic greywater as sample to be tested but a lot of samples with the highest concentration contaminant can be as samples to be testing such as from industrialized effluent.

3. Identify the suitable types and size of the filtration tank.

In this study, it used a plastic container as filtration tank that can affect to the sample or not. Besides, it should take the best size of the tank to run the system and can control the capacity of the samples.

4. Increase the parameters to be testing using this system.

In this study, it only focused on the limitation parameters such as turbidity, colour, pH and heavy metals namely copper (Cu), zinc (Zn), and iron (Fe). So, the parameters can be enhanced such as BOD, COD, phosphorus, total coliform, lead, chromium and cadmium. It can determine the best parameters are an efficiency to be treated by this system.

5. Modification of coconut husks and sugarcane bagasse can be enhanced using chemicals.

The chemicals that can be used include tartaric acid, hydrochloric acid, sodium hydroxide and others. These chemicals can improve the absorbance efficiencies of the plant wastes.

Declarations

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References


Department of Chemical and Environment Engineering, University Putra Malaysia.


Tables

Tables 4.0 to 4.7 are available in the Supplementary Files section

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Figure 3

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Figure 4

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Figure 5

Figure 4.4: Bar chart of percentage removal of turbidity for every filter condition.

Figure 6

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Figure 7

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Figure 8

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Figure 9

Figure 4.8: Bar chart of percentage removal of Iron for every filter condition.

Supplementary Files

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- Tables.docx