EPRA International Journal of Agriculture and Rural Economic Research (ARER)- Peer-Reviewed Journal
Volume: 10 | Issue: 12| December 2022 | Journal DOI: 10.36713/epra0813| Impact Factor SJIF (2021) : 7.604| ISSN: 2321 - 7847

COMPARATIVE ANALYSES OF THE FILTRATION PERFORMANCE OF CERAMIC FILTERS PRODUCED USING CLAY-HYDROGEN PEROXIDE AND CLAY-RICE HUSK COMPOSITIONS

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ABSTRACT

This work, the filtration performance of two types of water filters for the purification of water was investigated. Rice husk was used as a pore former on one hand, while hydrogen was used on the other hand ac a pore inducer. The clay was wet sieved and then mixed thoroughly in three proportions of 15%, 30% and 50% by volume each for rice husk and clay for ceramic water filter production. The other filter made of clay and hydrogen peroxide was achieved by adding 30ml, 45ml, and 60ml each of a 40% concentration of industrial grade hydrogen peroxide into a thick clay slurry mixed with 2600grams of Edda clay for each filter sample. The mixture was then blungged using an electronic blunger. The filter pots were cast in a plaster of Paris (P.O.P) mold. The pots were made to hold 5 litres of water at a time. Both samples were allowed to dry and the fired at 900^0C in an electric kiln. The rates of filter for the rice husk filters (RHF) ranged between 0.14litres/hr. to 0.62litres/hr. while that of the Hydrogen peroxide filter (POF) showed a filter rate of between 0.4litres/hr. to 0.87litres/hr. The results obtained from the filter rate characteristics, shows that all the six filters that were used in the experiment was found to be similar to those of Wongsakoonkan, Prechthai and Tantrakarnapa (2014) in the filter rate standards, since they all had their flow rate between 0.4-0.87 liters per hour (L/h). The results showed that, the two kinds of filters did indicate a significant difference in their flow rates, indicating a more even distribution of porosity in (POF) clay-hydrogen peroxide filter. It was observed that this kind of filter could easily be tailored to have a range of porosities when using different compositions of the hydrogen peroxide. This can be useful in the removal heavy metals in water.

KEY WORDS: ***porosity, pore former, pore size, water filtration rate.***

1. INTRODUCTION

Water is very essential for the existence of all living things. The importance of water is such that life cannot be sustained beyond a few days, without water intake. Clapham (2004) have stated that the lack of adequate and quality water supply leads to the spread of disease. Furthermore, water can be a host for many ill health causing materials and organisms. These materials could be either dissolved matter or minerals from the earth crust which when ingested has been attributed to medical conditions or evening poisoning, while others are living microorganisms. Doris (2006), opined that the quality of water is mostly affected by contaminants that can be categorized into four main groups. These include; biological, chemical, aesthetic and radiological. These contaminants go a long way to affect the wholesomeness of water and make its unhealthy for consumption. Bhardwaj, & Mirlis (2001), stated that radiological contaminants, sometimes known as radioactive contaminants, are radioactive substances that find their way into water bodies.

Boller, (1993) stated that the purification of water in our modern societies is a task which must be carried out in order to always improve and sustain a good health status. To this effect, various research have been carried out in order to come up with systems where water treatment can be easily carried out. Different methods are used in the purification of water for consumption; one of which is filtration. Clay filtration is the use of porous fired clay to filter

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microbes or other contaminants from drinking water. The basic mechanism is the exclusion of particles larger than the mean pore size. The pore sizes are sometimes small enough to trap anything larger than a water molecule Erhuanga, Kashim, & Akinbogun (2014). One other method of synthesizing porous media in clay that can be used for filtration is the use of hydrogen peroxide as a pore former. It is believed that the rate of filtration is affected by the size and degree of porosity within the matrix as such, the performance of clay filters can be significantly improved by the use of a pore former or inducer which increase flow rate by creating a network of pores with different orientations. Unlike chemical or thermal disinfection, clay filters do not significantly change water taste or temperature and does reduce turbidity significantly as stated by Clasen, Brown, Collin, Suntura, & Cairncross, (2014).

Filtration technologies are adopted to remove unwanted contaminant, especially suspended solids from surface waters. Filtration has to do with the flow of water through a porous medium. The water is purified through a range of physical, chemical and biological mechanisms. Filtration is among the most effective ways of purifying water (www.schultzsoftwater.com). The use of a filter means the water being purified has to pass through a medium which traps the contaminants. Rayner et al. (2009) stated that when using the right media, filters are very effective in ridding water of the compounds which make them unsafe for drinking. Rayner, further stated that filtration uses physical processes to purify water and makes it safe for human consumption. Fulton, (2000) has equally stated that filtration eliminates both large compounds and small dangerous contaminants that cause diseases with a simple and quick filtration process. Kinetico water systems (2021) stated that since filtration does not deplete all the mineral salts in water, filtered water is considered healthier compared to water purified using other methods. With various research carried out on ceramic water filters, this work aims at comparing the performances of water filters made with clay and an organic burn out materials like rice husk and water filters made from clay hydrogen peroxide.

2.RAW MATERIAL SELECTION AND EQUIPMENT

The basic raw materials used to make the ceramic water filters include clay, rice husk and hydrogen peroxide. Clay forms the main base material of the ceramic water filter. It was preferred because it exhibits very high plasticity and it has the capacity to be made porous when fired. Rice husk is used as a pore forming material. Rice husk was preferred because it does not cause bloating and results in a uniform pore size distribution. Industrial grade Hydrogen peroxide was used because of its ability to form a wide range of pore sizes which are predominantly closed pores when mixed with clays. The equipment include; a blunger, a drying cabinet, a gas fired kiln, a stop watch, plastic bucket and hydraulic press and P.O.P mold.

3. METHOD

The clay material was soaked to remove impurities. The clay and rice husk was subjected to drying, crushing, grinding and sieving before using the clay for the ceramic filter preparation.

For the production of clay filter with saw dust, the sieved clay was weighed out and mixed in various ratios on the basis of volume by volume with rice husk and some amount of water added to produce a homogenous paste that was then pressed into a pot filter. It was allowed to dry for 2 weeks and then fired in a gas kiln at 1000 ^{0}C Table 1 shows the composition proportions of the filter pots produced.

The second part involved the mixing of the clay, water and hydrogen peroxide in different proportions as stated in Table 2 below. The slurry was then cast in a plaster mold after which it was demolded, dried under ambient conditions and then sintered at a temperature of 900^{0}C. Then after filtration rate test was carried out on the samples.

Table1: Composition of materials for rice husk ceramic water filter (RHF) on a Vol/Vol basis.

S/No	Clay	Rice husk
A	85	15
B	70	30
C	50	50

Table2: Composition of materials for water filter with hydrogen peroxide (POF) as pore former

S/No		Clay (g)	Hydrogen peroxide (ml)
A		2600	30
B		2600	45
C		2600	60

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For the production of water filter using hydrogen peroxide, Edaa clay was crushed dried and sieved. 2600g was weighed out and for each of the samples. The clay weighed out was then mixed with water and a thick consistency achieved through the use of a blunger. Different volumes of hydrogen peroxide as stated in table 2 was then added to the individual slurries of clay and mixed thoroughly to get a homogenous mix and the resulting slurry was cast in a P.O.P mould to attain a pot shape. The pot filter was allowed to dry for two weeks and then fired in a gas fired kiln at 1000 ^{0}C.

Filtration Rate

Pretreatment like soaking the ceramic filters in water for 24 hours was done and it helped to clean the filter pores from the dust and burning material.

Table.3: Flow rate of prepared filters (L/hr) for Rice husk (RHF)

Filter	1hr	2hr	5hr
As	0.14	0.153	0.37
Bs	0.39	0.57	0.79
Cs	0.62	0.83	1.41

Table.4: Flow rate of prepared filters (L/hr) for hydrogen peroxide (POF)

Filter	1hr	2hr	5hr
Ah	0.26	0.43	0.76
Bh	0.36	0.65	0.94
Ch	0.87	1.63	3.18

RESULT AND DISCUSSION

The highest filtration rate was observed in filter Ch at the rate of 0.87 l/hr. at 1hr. compared with filtration rates of other filters prepared for this study. Low filtration rate was observed in the beginning of hours. It shows high rate for filters with relatively larger pore sizes as a result of an increase in the amount of hydrogen peroxide added. The second highest filtration rate is for filter Bh. The presence of high percentage of micro pores compared to other filters can be the reason for a high filtration rate.

CONCLUSION

There are various local methods available for water treatment; most of them are effective only in removing physical contaminants of water. These methods are not very effective in removing microbiological contaminants present in water. The results here show that ceramic filters prepared with hydrogen peroxide have a potential of being more effective in terms of rate of filtration such that the pore size can be tailored to suite different purposes of filtration. For example tailoring a larger porosity in heavy metal removal from water or synthesizing a smaller porosity for removal of microbes. The ceramic filters are simple to use and easy to maintain and can be produced at low cost.

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