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**Clay and Animal Dung Ceramic Filter for Water Purification, Design, Processing and Analysis**

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**ABSTRACT**

Ceramic pot filters and packing with different materials are a household water treatment solution in areas where people rely on untreated surface water, or where the risk of contamination during water distribution and storage is high. In this Study was to design a ceramic filter from traditional materials, investigate its efficiency, to characterize of the ceramic filter materials, and compare the results of water analysis with WHO guideline and Sudanese Standard. A two design types of ceramic filter, and packing column with ceramic were prepared by clay materials and animal dung ratio; A (1:1), B (1:2), and C (2:1) for ceramic filter, and D (1:1) for structure packing and E (1:1) for random packing. The physical and chemical properties were determined for ceramic materials using absorption method, compressive strength machine and the Scanning Electron Microscope (SEM) with a coupled energy dispersive spectroscopy (EDS). The sample of water was collected from the Blue Nile. The physical and chemical properties of water were determined before and after treatment. The results of physical properties of the best ceramic materials A (1:1) showed that; absorption was 25% with flow rate of water 2.0 L/hr, and the compressive strength was 0.375 MPa. The SEM result with a coupled EDS of ceramic material was rich in pores particles and it contains dominantly oxygen, carbon, silicon and aluminum. The results of untreated water and treated by ceramic filter and Packing column with ceramic material were studied, the quality of treated water ceramic filter type A (1:1) was the best one, but for the flow properties of treated water packed column with ceramic materials was the best.

**INTRODUCTION**

The United Nations World Water Assessment Programme (WWAP) (2015) demonstrates how water resources and services are essential to achieving global sustainability and states that water is at the core of sustainable development. The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) (2014) indicate that although the drinking water target of the Millennium Development Goal (MDG) was globally met in 2010, 748 million people still lacked access to an improved drinking water source in 2012, and most of these people are poor with over 90 percent living in rural areas and almost a quarter relying on untreated surface water. Generally only 60% of the country's population has access to clean and safe water for domestic use (WHO/UNICEF, 2010). The major route of transmission of diseases such as cholera, typhoid, amoebic and bacillary dysentery and other diarrheal diseases to humans is through drinking contaminated water (Kosek et al., 2003). One such an intervention is by the use of ceramic water

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filters, a ceramic material is an inorganic, non-metallic material produced as a result of the action of heat and subsequent cooling (Kingery et al., 1976). A simple, acceptable, low-cost intervention at the household and community level can dramatically improve the microbial quality of household stored water (Sobsey, 2002). A household water treatment system (HWTS) is effective if it produces sufficient safe drinking water for a family in the long-term (Hunter, 2009). Oyanedel-Craver and Smith (2008) concludes that silver coated ceramic pot filters (CPFs) represent an effective and sustainable technology for poor communities. Several laboratory studies have been conducted to assess the effectiveness of ceramic pot filters (CPFs) presenting promising results, including Oyanedel-Craver and Smith (2008), van Halem *et al.* (2007, 2009), Sobsey *et al.* (2008), Lantagne *et al.* (2010), Mwabi *et al.* (2013) and others. The purpose of this study was therefore to make ceramic water filter from local materials and use packing filtration technique to study their effectiveness in improving the quality of treated water.

## **MATERIAALS AND METHODES**

### **Materials**

The clay mineral and dung of animal was used, the sample of water was collected from the Blue Nile (Gezira location, Hantoub area) on April, 2017.

### **Instrument**

Oven Gallen Kamb, model DV-160, Compressive Strength Machine, model Cat. C46V2, MILANO-ITALYI collected in Civil Laboratory in the University of Gezira, and Scanning Electron Microscopic, oxford instrument x-max, Model TC110 and made in Germany, with a coupled energy dispersive spectroscopy (EDS) were used to characterize the ceramic filter collected in Regional Forensic Laboratories. The Flame Photometer (corning: Model NO.400), Refractometer, pH meter, Digital Balance, TDS/conductivity meter, and Electrical Conductivity meter, Model HI 8633 conductivity meter were used to determine the physical properties of water was collected in Chemical Engineering Laboratories in the University of Gezira.

### **General procedure**

The dung of animal and a clay mineral were first cleaned, dried, crashed and sieved. The powders of clay and dung of animal were mixed in the different ratio by weight, Water was added to improve on their workability, the mixtures were then compacted in cylindrical shape of diameter 9 cm, height 13 cm and thickness 0.7 cm. the ceramic bodies were air dried and then fired, two design types of ceramic filter, and packed column with ceramic were prepared by clay materials and animal dung ratio; A (1:1), B (1:2), and C (2:1) for ceramic filter, and D (1:1) for structure packing and E (1:1) for random packing.

The physical and chemical properties were determined for ceramic materials using absorption method, compressive strength machine and the Scanning Electron Microscope (SEM) with a

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coupled energy dispersive spectroscopy (EDS). The sample of water was collected from the Blue Nile. The physical and chemical properties of water were determined before and after treatment by pH meter, Electrical Conductometer (EC), total dissolved solid (TDS), titration method to determine total alkalinity, anion of chloride, sulphate, carbonate, bicarbonate, hardness, cations of calcium, and Flame Photometer to determine sodium and potassium.

**RESULTS AND DISCUSSION**

The results of physical properties for the ceramic filter shown in table (1), the filter C (2:1) was higher flow rate of water than the other filters but the compressive strength was very low, the filter B (1:2) was very low of flow rate and high compressive strength, filter A (1:1) was acceptable flow rate and compressive strength so that the filter A (1:1) was the best than the others ratio.

**Table 1: The physical properties for the ceramic filter**

Filter Composition (dung of animal : clay)	Flow Rate of Water (L/hr)	Compressive Strength (MPa)	Absorption Percentage
A (1:1)	2.00	0.375	25.5
B (1:2)	0.75	0.750	20.5
C (2:1)	3.00	0.025	29.0
D (1:1)	4.00	-	-
E (1:1)	6.50	-	-

**Mineralogical Description under the Scanning Electron Microscopic**

In figure (1) and (2), the mineralogical aspects of the ceramic filter particles are outlined in figure 1: the porosity of the surface is clearly visible. The scanning electron micrograph of this figure shows the typical random shapes of the clay particles. The clay was rich in pores particles; the clay was also characterized by the utilization of dispersive energy of spectroscopy.

The EDS analysis shows that the studied contains dominantly oxygen, carbon, silica, and aluminum. However, the elements: iron, calcium, magnesium, potassium, and titanium, and are occurring in lesser amounts.

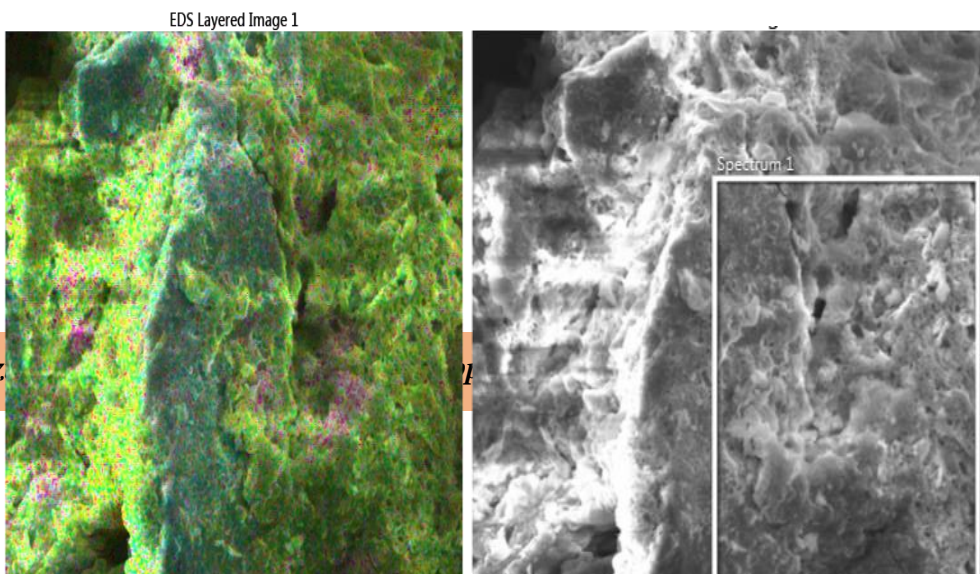


Figure 1: The energy dispersive spectroscopy of the clay

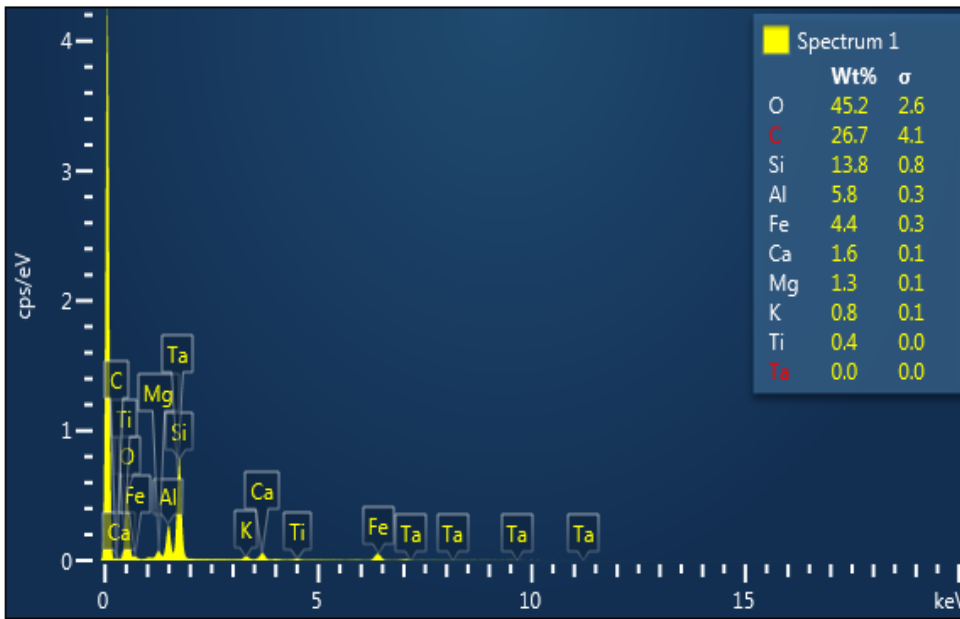


Table 2: The physical properties for the water

Filter Composition (dung :clay)	Untreated Water	Treated Water					WHO Maximum Permissible	Sudan Maximum Permissible
	-	Shape filter						
		A(1:1)	B(1:2)	C(2:1)	Random D(1:1)	Structure E (1:1)		
pH	8.5	8.3	8.9	8.7	7.5	7.8	8.5	8.5
EC( $\mu$ S/cm)	215	225	294	270	270	294	750	1600
TDS (mg/L)	125	130	180	160	165	177	1000	500

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Shown Table (2), the physical properties for the water were studied for all filters with in Sudanese and WHO maximum permissible. Generally filter shape structure A (1:1) was the best than the others. Shown Table (3) all results of the chemical properties for the water with in Sudanese and WHO maximum permissible.

All chemical and physical properties for the treated water according to the permissible level recommended by WHO guideline and Sudanese standard. The ceramic filter was rich in pores particles, and contains dominantly oxygen, carbon, silica, and aluminum. The filter composition A (1:1) is best one for water purification, the treated water by it were within the permissible levels of WHO guideline and Sudanese standard.

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