Preparation and Characterization of a Low Cost Ceramic Water Filter disk from clay compositeand Nanoparticles

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Abstract:
In this study, preparation and characterization of ceramic water filter disk was carried out. Ceramic water filter disk was fabricated from locally sourced materials like clay, saw dust and green synthesized Ag-Cu bimetallic nanoparticles and was manufactured by local labor. The fabricated Ceramic Water filter disks were sintered at 900°C for 1 hour in furnace with heating rate 1°C/min.Density and Porosity test were conducted.SEM studies of the Ceramic Water filter disk were carried out.

Keywords: Bimetallic**,** Ceramic water filter disk, Density, Porosity and SEM

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Introduction:

Ceramic water filters (CWF) are effective and low costwater filters that depends on the pore size of ceramic material to filter out few chemical and physical contaminants and microorganisms like bacteria, protozoa, and microbial cysts [1]. This makes them ideal for use in developing countries like India.Nanomaterials can be used for point of use systems or small-scale for water systems. In the developing countries like India access to safe drinking water and water borne diseases are the problems faced by many people. Researcher uses various porous ceramic membranes to support fabrication methods. Most membrane was fabricated by powder pressing, past processing, and colloidal processing methods which are homemade and commercial[2]. Slip casting and dry pressing methods are widely used in lab scales, the extrusion method used in industry [3].

Our approach uses Ag-Cu bimetallic nanoparticle synthesized using leaf extract[4] in ceramic water filter to enhance bacterial disinfection. Silver, copper and other metals have been used for centuries to store portable water. Antibacterial properties of these metals are well known [5]. Firing-in is the technique where nanoparticles are mixed with raw materials ceramic before firing process [6] .Silver and Copper acts as a bactericide, both silver and copper nanoparticles inactivates DNA replication [7, 8]The efficiency of these filters is improved by the addition of silver into the filter's design[9]The primary purification mechanism is to deactivate the bacteria as they move through Ag-Cu bimetallic nanoparticles added in the ceramic disk structure. The large pore size in the ceramic water filter allows rapid flow by gravity, without any need for suction or pressure. Viruses ranging from 10nm to 100nm in size may be able to pass through the ceramic water filter disk if the pore is not small [10] As far as we know, this is the first attempt to prepare Ag-Cu nanoparticles added ceramic disk as a point-of-use water purifier.

Methods and Materials:

CWFs are manufactured from clay, sawdust arereferredas burn-out materials. During the firing process of burn-out material, filter porous structure is created. Fabrication of ceramic waterfilter diskincludes the following steps rawmaterial selection, processing, mixing, pressing, drying, firing, and bimetallic Ag-Cunanoparticleapplication. Quality and characteristics of clay influenceceramic water filter disk quality.

For this study, Ceramic water filter disk was manufactured from the clay soil collected locally with guidance of the local potters and screened with 0.5mm sieve size. From the furniture manufacturers saw dust was collected and was screened with 0.5mm sieve. Deionized water was added uniformly on dry mixture of clay, saw dust and bimetallic Ag-Cu nanoparticles to get a smooth mixture.Clay mixture was moulded into disk shape Fig-1. The disk shaped filter material was dried in open air for 3-5 days to remove excess moisture to avoid crack during the firing process [11].The disk was fired in a kiln for 900^{o}C with 1^{o}C/min heating for 1h.The disks were left in the kiln to cool overnight.

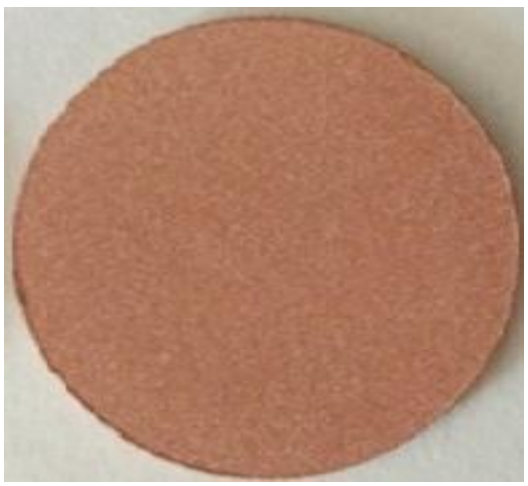


Fig-1: Ceramic filter disc shaped

Characterization:

Clay and Ag-Cu ceramic disk was tested for density and Scanning Electron Microscopy (SEM). The density test and porosity test was calculated according to the Archimedes method by weighing the samples in the air and in the water [12].To calculate the density the sample was weighed when dry in air then soaked in deionised water at room temperature. To ensure that the air in the open pores of the disk filter replaced by the deionised water,for about two hours the sample soaked in water was boiled and allowed to cool to room temperature for 20h.The disk is weighed in air (A) and then again (B) in the water. The density test of the disk ρ can be calculated as follows:

$\rho = \frac{A}{A-B}\ (\rho_0-\rho_L) + \rho_L$……….Eq (1)

ρ = Density of the disk

A = Weight of the disk in air

B = Weight of the disk in the water

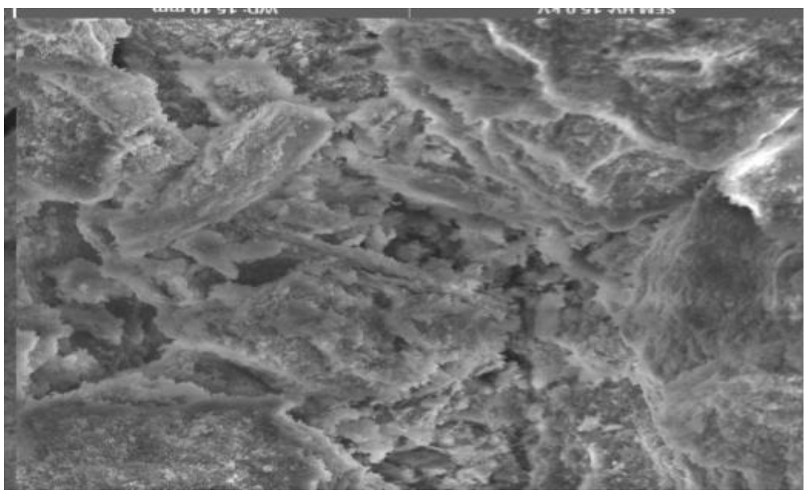
ρ_0 = Density of the water

ρ_L = Density of air

Apparent porosity (P) %= (soaked mass (g)-mass in air (g))/………..Eq (2)
(Soaked mass (g)-Suspended mass (g))

Results and Discussions:

The density test and apparent porosity of ceramic water filter disk were calculated according to equation (1) and equation (2) found to be 1.35g/$cm^3$and 43%.Density and porosity had a strong inverse relation. Porosity of the ceramic water filter disk is the major factor for removing the micro size particles with physical process like clogging, adsorption and inertia [13].The majority of harmful microbes can be filtered out with help burn-out saw dust pores of about 1micron.Less porous material remove microorganisms effectively reported by [14].Large size microorganisms are blocked and retain from flowing through ceramic material [15].The ceramic disk act as a filter that traps debris along with larger parasites and bacteria when contaminated water is poured inside the disk [16].The porosity of the ceramic water filter disk mass is roughly proportional to the volume of combustible material added [17].



The SEM micrographs obtained after firing of the ceramic water filter disk at a temperature of 900°C are presented in Fig-2.The pores correspond to the sawdust .The addition of Ag-Cu bimetallic nanoparticle in the ceramic water filter disk results in a modification of the structure having important fraction of pores at the nanoscale.The average diameter of these pores is 5nm.

Conclusions:

In this study a ceramic water filter disk fabricated from locally available materials was reported. Density and porosity test were carried out, it can be deduced that density and porosity are inversely related. The SEM image shows the pore distribution of the ceramic water filter disk. Further research is required to understand the quality of water before and after filtration.

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