PAN AFRICAN MATERIALS INSTITUTE (PAMI)

WORKSHOP MANUAL ON WATER FILTRATION

AT THE
AFRICAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (AUST)

Date: 1st – 7th NOVEMBER, 2015

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Supporting Instructors: Ebenezer Annan, Edward Ampaw & Emmanuel Arthur

Workshop Schedule

DAY 1:

a. Brief introduction to ceramic water filters
b. Flow rate experiment

Day 2:

a. Group discussion on household water treatment methods/technologies
b. Experiment - Bacteria testing using 3M petrifilm plate (or coliform count testing)

Day 3:

a. Groups complete workbook questions
b. Overall summary

INTRODUCTION

The sustainable development goals (SDG's) highlight the need to ensure water availability and its sustainable management for all by 2030. Its sub-theme emphasises on the need to achieve universal and equitable access to safe and affordable drinking water for all. The possibility of achieving this target is foreseeable by adopting proven water filtration systems.

Safe drinking water is defined as water that does not provide significant risk to the health of the individual over a considerable life time. According to the World Health Organization, an individual needs to consume at least 2 litres of safe water per day. It is also known that 20% of all children die before age 5 due to water related issues; illustrating how important water is to the survival of humans. Although there are water bodies in communities, their purity is questionable and therefore the need to purify these water bodies to make them safe for drinking. Among the point-of-use water treatment (household treatment) methods is the use of ceramic water filters. The efficacy of ceramic water filters in the removal of various categories of contaminants has been proven.

In this practical session, you are expected to know the following: how (i) to use ceramic water filter in purifying water, (ii) to compute the permeability or flow rate of a ceramic water filter and (iii) compare the different treatment processes filtered water.

Figure 1.0 illustrates a simple approach to the use of ceramic water filters in water filtration.

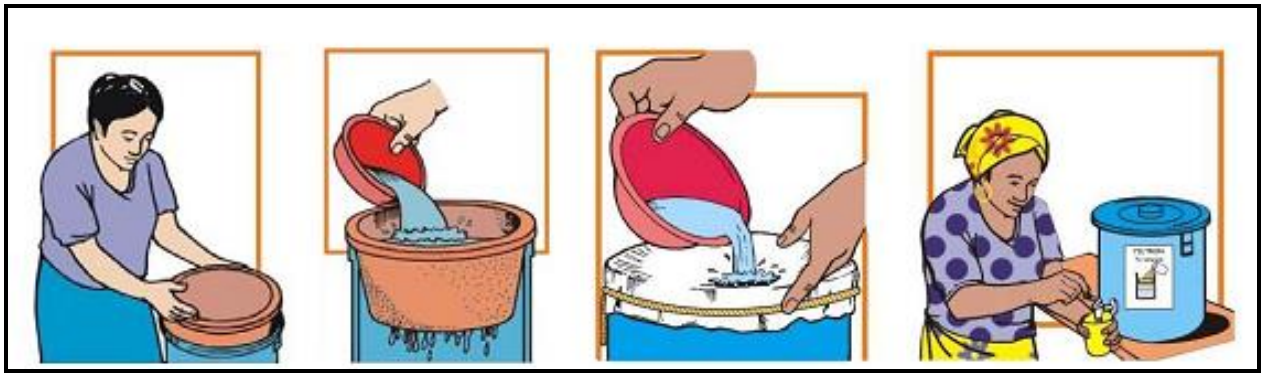

Figure 1.0: schematic diagram of how to use ceramic filter for high turbid water.

Brief Theory

The flow through porous ceramic can be described by using Darcy's equation. This equation developed in the 1950's by Darcy basically gives the relation between flow rate Q, change in pressure ΔP, cross-sectional area A, and viscosity, μ,

$$Q = \frac{KA\Delta p}{L\mu}$$

Where, L is the travel path through filter and K, permeability constant (m^2). $\Delta p = \rho g \Delta h$, ρ is density, g acceleration due to gravity, and Δh is change in height (or water-head). Note that 1Darcy $= 0.9869 \times 10^{-12} m^2$.

The flow rate Q, can be computed either by considering the volume (Liters), ΔV, or mass (Kg), ΔM, of water discharged per hour (Δt). Simply put, the Flow rate, $Q = \Delta V / \Delta t$.

MATERIALS

Ceramic water filter, Water samples, 3M Petrifilm plate, Calibrated Bucket, Conical flasks (1000mL) or beakers, and 1ml pipette.

EXPERIMENTAL PROCEDURE

I. Arrange the ceramic water filter system as shown in figure 2. Fill the filter to brim with water. Cover the filter to prevent possibility of particles falling into the water.

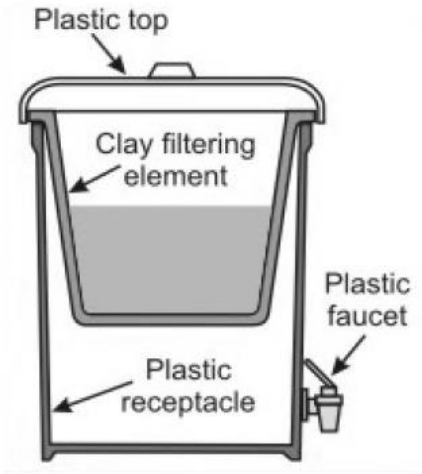

Figure 2: Schematic diagram of experiment set-up

II. Measure volume of water discharged every 30minutes. Complete the table below for a total time of 3hours.

Time (minutes)	Total Volume discharge (L)	Flow rate (L/hr)	Water Head (m)
30			
60			
90			

III. Now using a 1mL pipette, release water sample A onto 3M plate. Ensure the top film of the 3M plate lifted and water released (onto the red circle only). Use your spreader to slowly ensure even distribution. Estimate the total Coliform units formed (if any) over 24hrs?

IV. Repeat experiments (I) and (II) for water sample B

V. Plot a graph of flow rate as a function of time for the water samples A and B

VI. Determine mean and range values for the flow rates of the filters.

ATTEMPT THE FOLLOWING QUESTIONS

1. Briefly give an alternative physical measurement for computing flow rate.

2. Do you observe any pattern in the flow rate values? Explain the factors that might have affected flow rate data obtained.

3. Based on your response to Question 2, what will be your recommendation for a household that uses ceramic water filter in order to obtain at least 2Liters of safe drinking water?

4. From your experimental results, how many liters of filtered water can your ceramic filter produce at the maximum water-head for 12hours? Will it be enough for a small household (of four people)? Give explanation for your answer.

5. For each of the following itemized filtered water samples below, state/tick which you will recommend safe for drinking? Discuss the basis of your answer.

	YES	NO
Boiled water	☐	☐
Tap water	☐	☐
Bore-hole water	☐	☐
Ceramic Filtered water	☐	☐

6. (a) Based on your knowledge gained from this workshop, suggest (with rationale) a new design for the ceramic water filter system, and ascertain its marketability.

   (b) Provide a schematic diagram of a multi-ceramic water filtration system which has the potential of providing safe drinking water for a community of 300-500 people. You may use data from your experiment for explanation.