Reviving Tradition and Securing Health: A Low-Cost Ceramic Pot Filters by Local Potters

Water security and water safety are serious challenges faced by low and middle-income countries. With growing populations, rapid urbanization, and depleting groundwater levels, the demand for water continues to increase while availability declines. This situation further leads to lack of access to safe drinking water and rising cases of waterborne diseases. According to the WHO and UNICEF Joint Monitoring Programme (2022), 2.2 billion people globally lack access to safely managed drinking water. Contaminated water and poor WASH practices are major contributors to public health crises, particularly affecting children, with around 1.3 billion cases of diarrhea occurring annually (UNICEF & WHO, 2022). In 2015, the World Health Organization estimated that improved access to safe drinking water and sanitation could reduce the global disease burden by nearly 4 percent (Kumar et al., 2022).

Access to safe drinking water remains a significant challenge in rural and marginalized communities caused by prevalence of chemical and microbial contamination in drinking water. At the same time, traditional potters in rural India face declining livelihoods due to reduced demand for clay pots. Pottery, a traditional skill passed down for generations, is losing ground to increase in industrialization and mechanization. The production of ceramic pot filters (CPFs) by these local artisans can address dual challenges providing a safe drinking water solution while restoring a source of livelihood and preserving cultural heritage. The CPF being low cost and locally produced also fits very well for adoption by the low income households.

Potters already possess knowledge of working with the major raw material clay, and traditional firing techniques. With scientific support and training, they gain capacity to produce ceramic pot filters very fast. The approach promotes production of affordable and culturally accepted water treatment solution using local resources, skills, and labor, making it best option especially in marginalized community. CPFs offer point-of-use water treatment and safe storage in a single unit, reducing the risk of recontamination of treated water to ensure safe drinking water.

S M Sehgal Foundation, India designed its first ceramic pot filter prototype in 2015, where both the filter and receptacle were made from ceramic materials. In this model, filtration occurred through a filter disk. The filtered water got collected in the receptacle placed under the filter and the treated water was dispensed via a spigot. With technical support from IIT, Jodhpur, CAWST, Canada, and Potters for Peace, United States, this evolved into a refined model named MatiKalp. MatiKalp is composed of clay mixed with combustible materials to create porosity, a small amount of sand to improve workability, and colloidal silver to enhance microbial disinfection. When fired at high temperatures, the clay mixture transforms into a durable, porous ceramic pot that filters suspended particles and contaminants effectively. Colloidal silver, a suspension of nanoparticles, helps in the disinfection of pathogens by breaking down cell wall and preventing biofilm formation.

MatiKalp is a household level water treatment solution. It is cost effective and affordable even for the poorest of the poor households. The filter unit consists of four key parts: a lid to protect from dust, a ceramic pot for filtration, a receptacle for collecting filtered water, and a spigot to dispense water by minimizing the risk of recontamination. MatiKalp receptacle is developed in three versions: one with a ceramic, another with high-quality food-grade plastic, and a third with a stainless-steel receptacle. Raw water is poured into the ceramic pot, where it filters through micro-pores developed in the clay pot body, and the filtered water is stored in the receptacle, ready for use. Flow rate is highest when the pot is full and gradually slows down as the water level in filter lowers.

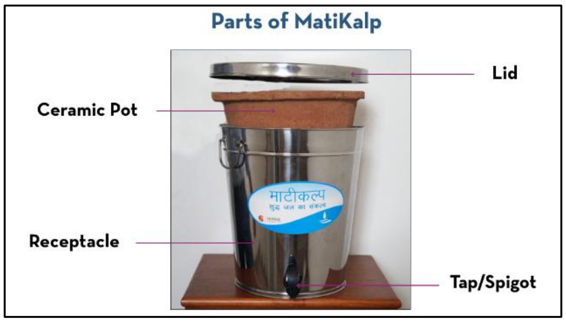
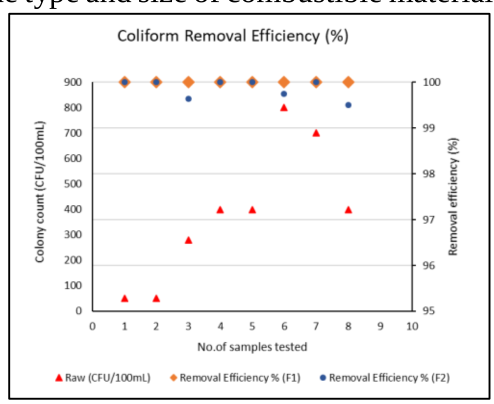


Figure 1 showing the parts of MatiKalp

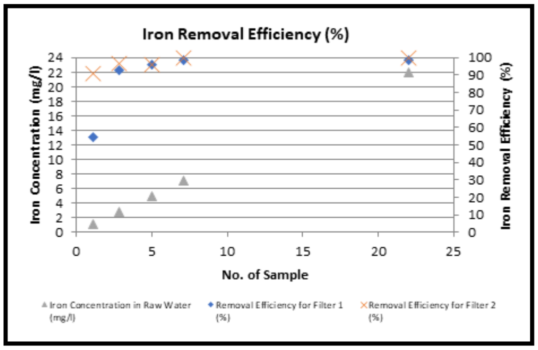
Figure 2 showing the different version of MatiKalp

The CPF removes microbial contaminants, turbidity, and even chemical contamination like iron and manganese. The filtration process involves sedimentation, mechanical trapping, oxidation, and adsorption. The pore size of the CPF is controlled through the type and size of combustible material used. According to Clasen et al. (2015), ceramic pot filters can reduce diarrheal diseases by up to 61 percent, making them one of the most effective point-of-use water treatment technologies. The antimicrobial efficiency of the silver-impregnated filter ensures microbial reduction up to 98 to 99.99 percent, according to third-party testing by TERI School of Advanced Studies (2024), which used the APHA standard methods. The membrane filtration test showed almost complete removal of total coliform bacteria in raw water samples spiked with sewage (50 to 800 CFU/100mL).

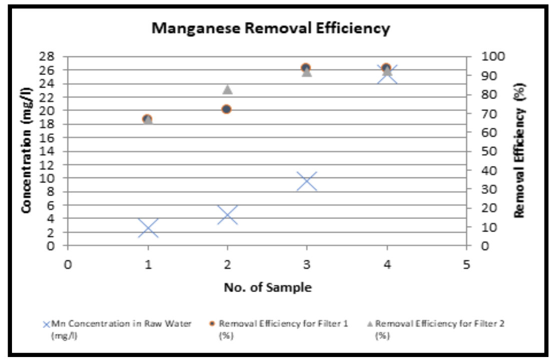


Membrane Filtration (APHA 9222 A)

Iron removal efficiency was found to be between 99 to 100 percent, bringing down iron concentrations from as high as 22 mg/L to within the Bureau of Indian Standards (BIS) permissible limit of 0.3 mg/L. Manganese levels, ranging between 2.7 to 26 mg/L, were reduced by 92 to 94 percent after filtration. Manganese is a common groundwater contaminant in several parts of India, and its removal is critical for ensuring drinking water safety in affected regions (BIS IS 10500:2012).



Phenanthroline Method (APHA 3500-Fe B)



Persulfate Method (APHA 3500-Mn B)

Cleaning and maintenance of the CPF are essential for optimal flow rate. Flow rate decline with the accumulation of suspended particles on the internal sides of the ceramic pot. The inner surface of ceramic pot filter should be gently scrubbed with a soft brush without using soap or chlorine to remove surface deposits. Receptacles, lids, and spigots must be regularly cleaned to prevent secondary contamination. Regular inspection for cracks or leaks is necessary to ensure long-term performance.

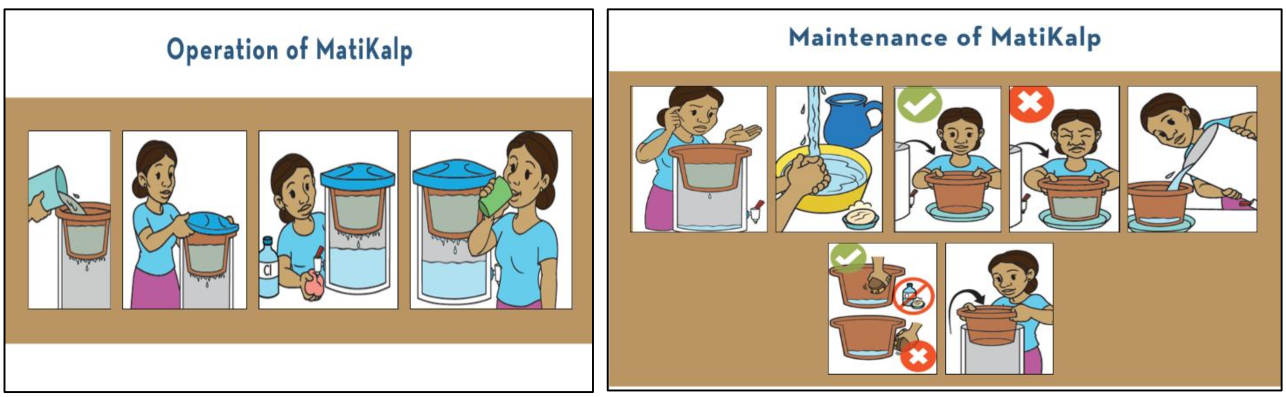


Figure 3 showing the operation and maintenance of MatiKalp

In an effort to address other contaminants, a feasibility study was conducted on integrating Zero-Valent Iron (ZVI) technology into MatiKalp for arsenic removal. The study explored configurations including single-stage and two-stage ZVI filters with and without diffusers. The study concluded that Arsenic, a serious health risk in many groundwater sources in India, could be effectively reduced through such innovative adaptation.

Figure 4 showing the arsenic removal in CPF through ZVI

The success of MatiKalp is attributed to several factors like affordability for low-income households, preservation of local pottery skills, livelihood generation, and the user-friendly, electricity-free operation suitable for rural settings. Its main part the filter, resembling traditional earthen pots, ensures high social acceptability and trust. Additionally, its eco-friendly production reduces environmental impact.

Despite these advantages, challenges remain. Inconsistent quality can hinder user confidence leading to trust in local production, which underscores the need for strict quality assurance and potter training. Variability in clay sources may introduce contaminants, necessitating raw material testing. Slow filtration rates require user education to set realistic expectations. Fragility of the clay product require careful handling and packaging. Supply chain limitations due to manual production can impact scalability and demand timely interventions in logistics and market development.

Several innovations have improved MatiKalp design and production efficiency. These include increasing the filter wall thickness to 19 mm for improved filtration effectiveness and durability, integrating a built-in collar in the mold design to simplify production and finishing for potters. Furnace designs have evolved from traditional leaf spring bases to dome-shaped brick base and reduced firebox sizes for greater efficiency and heat control. Furthermore, design of manual filter presses have been upgraded to hydraulic systems to improve consistency and increase production rate along with reduction in labor cost.

A community-based local enterprise model has proven effective in scaling production and adoption. In this model, NGOs play a pivotal role in initial phase by mobilizing communities, creating demand, building capacity through potter training, ensuring quality control, and establishing supply channels. This collaborative approach fosters sustainability and community ownership.

In economic terms, the users of CPFs reported a significant reduction in household medical expenses associated with waterborne diseases saving up to INR 850 per month. This confirms to the study 'Interventions to improve water quality for preventing diarrhea' conducted by Clasen et al. (2015). Thus, MatiKalp not only contributes to improved health outcomes but also reduces financial burdens for vulnerable households.

References

Clasen TF, Roberts IG, Rabie T, Schmidt WP, Cairncross S. Interventions to improve water quality for preventing diarrhoea. Cochrane Database of Systematic Reviews 2006, Issue 3. Art. No.: CD004794. DOI: 10.1002/14651858.CD004794.pub2. Accessed 11 March 2025.

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