

FLUORIDE REMOVAL IN YEMEN

Phase II pilot: Introducing the Fluoride Nilogon filter at household and community levels

Introduction

Access to clean water is a major challenge in Yemen, particularly in Al-Dhale'a Governorate. People used to rely on shallow water sources, but these are now insufficient due to declining rainfall. Residents have begun digging groundwater wells in response. The groundwater often contains harmful substances, especially high fluoride levels, which pose serious public health risks. Understanding the geochemical mechanisms behind fluoride presence is crucial in Al-Dhale'a, as groundwater is the only water source. High fluoride levels particularly affect children who suffer from dental and skeletal fluorosis. The general population also faces increased health risks, exacerbated by limited awareness of fluoride consumption.

Target Areas

ZOA targeted the villages in Al Hussein and Al Azariq district in Al-Dhale'a due to severe health complications associated with excessive fluoride intake. In Khouber village, residents report various health issues, including dental and skeletal fluorosis, arthritis, and other musculoskeletal disorders. The fluoride concentrations in the groundwater in these areas have alarmingly exceeded the WHO's recommended limit of 1.5 mg/l, reaching levels between 9.3 mg/l and 10.5 mg/l.

Fluoride Nilogon Filter

To address fluoride contamination, ZOA explored several options for fluoride removal. Advanced methods like reverse osmosis and distillation, commonly used in centralized water systems, are unavailable in Yemen. Instead, ZOA adopted the Fluoride Nilogon filter, a low-cost and environmentally friendly solution developed by Tezpur University in India. The fluoride removal process relies on chemical reactions involving limestone, phosphoric acid and fluoride ions, followed by physical filtration through a layer of sand to ensure clean water.

The usage of the Nilogon filter involves two main stages:

- 1 Activating the Limestone:** This process involves adding a specified amount of phosphoric acid to the water and allowing it to react with the limestone in a crushed limestone reactor.
- 2 Regular Treatment:** After initial activation, every routine treatment requires adding a small amount of 8.5% phosphoric acid to the contaminated water, which is then allowed to sit for a period of three hours before being filtered.

Design and Cost

The Fluoride Nilogon filter consists of two buckets, with the top bucket containing crushed limestone that reacts with phosphoric acid and fluoride to lower fluoride concentration in the water. Designed for simplicity and effectiveness, the system reduces fluoride levels to approximately 0.6 mg/l within three hours. The recurring operational costs are minimal, mainly requiring a daily addition of a small quantity of phosphoric acid. At a purchasing price of around 15 USD, the filter is an affordable solution for households.

Implementation

The project, running from August 2023 to July 2024, involved the following key steps:

- 1 Limestone Selection and Testing:** Assess the suitability of limestone for effective fluoride removal.
- 2 Installation and Distribution:** Distribute and set up 400 household filters in the targeted villages of Al-Hussein and Al-Azariq and one 18,000L capacity community filter at Khouber village in Al Hussein district, Al-Dhale'a Governorate.
- 3 Testing:** Monitor fluoride levels in both the inflow and outflow water from 200 filters to assess its effectiveness.
- 4 Community Engagement:** Conduct meetings to raise awareness about the health impacts of fluoride and gather feedback from residents.



Results

The fluoride levels in both the inflow and outflow water from the Nilogon filters were monitored to assess its effectiveness. The results show the successful reduction of fluoride levels from 10.5 mg/l to below the WHO standard of 1.5 mg/l. The Fluoride Nilogon filter was widely used, with nearly all respondents actively utilizing it. A 99% compliance rate was observed in training on the filters' use and maintenance. The quality of the filter received positive ratings from respondents, with a combined 99% considering it good, very good, or excellent. There was a high level of awareness regarding fluoride and fluorosis, with many respondents able to identify common signs and health risks associated with high fluoride intake, particularly for infants and children.

Recommendations

Future projects with the Fluoride Nilogon filters should consider the following:

- 1 Enhanced Monitoring, Evaluation, and Water Source Selection:** Regular assessments should be conducted to monitor the sustained usage and effectiveness of the Fluoride Nilogon filter, ensuring ongoing adherence to water treatment practices. Future interventions should prioritize areas with accessible community water sources or incorporate water source rehabilitation into the project to address potential water scarcity challenges.
- 2 Enhanced Community Engagement and Education:** Community engagement initiatives should include targeted awareness campaigns, training on filter maintenance, and educational workshops on fluorosis prevention and the safe use of phosphoric acid in filters. These initiatives can address misconceptions

and ensure that beneficiaries understand proper application. Pre-project awareness sessions are essential to mitigate concerns and promote informed usage.

- 3 Community-Based Water Treatment:** Water treatment projects should prioritize community preferences. The positive response to water treatment at a community level suggests that this approach may be more effective and widely accepted than household-level solutions.
- 4 Water User Committee Commitments:** Commitments from Water User Committees should be clearly documented and community contributions should be realistic and attainable.
- 5 Communication with Partners:** Communication with partners is essential to avoid challenges. Assigning a dedicated focal point for communication can help address issues promptly and ensure smooth project implementation.
- 6 Phosphoric Acid Supply:** Ensuring the supply of phosphoric acid is essential for the sustainable, long-term use of the filters.

Conclusions

The project successfully reduced fluoride levels from 10.5 mg/l to below the WHO standard of 1.5 mg/l through using the Nilogon filter at both the household and community levels. Residents from the villages of Khoubur which located in Al Hussein district and Habeel Ghadas village which located in Al Azariq district, now understand the importance of fluoride-free drinking water for their health and have access to the tools to purify contaminated water.

This project, designed as Phase II of a pilot initiative, builds on ZOA's earlier intervention in Lahj Governorate. In this phase, the project aimed to refine and scale the approaches introduced in Phase I while incorporating community-based water treatment alongside household-level treatment to enhance water access and quality at multiple levels. This project was made possible through the support of ZOA's FoCo funding. We thank Prof. Robin Kumar Dutta and his team from Tezpur University for their technical support.



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