



Virus Removal From Treated Wastewater in Modified Garden Soil Columns, Kuwait

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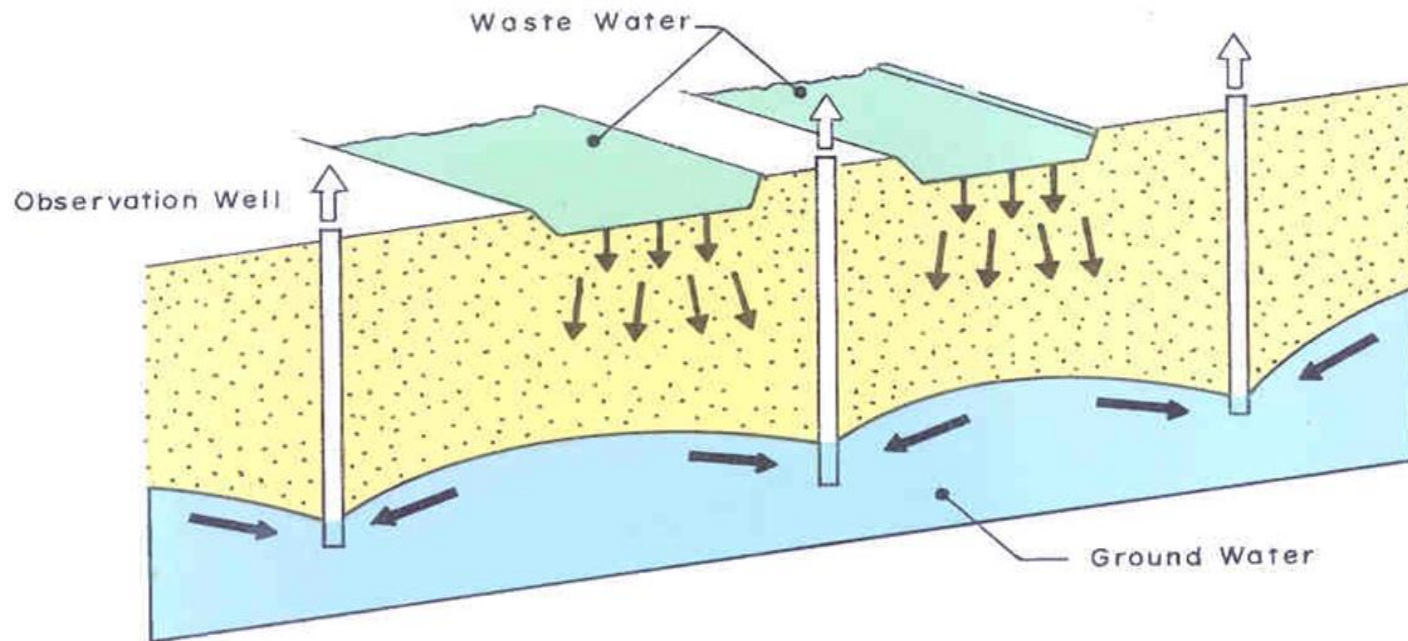
Overview

- **Introduction.**
- **Objectives of Study.**
- **Methodology.**
- **Results and Discussion.**
- **Conclusions.**
- **Recommendations.**

Introduction

- **Soil Aquifer Treatment (SAT) technique is an economically attractive method for the treatment of wastewater for restricted and unrestricted irrigation.**
- **A laboratory study concentrated on the tertiary treated wastewater from the Sulaibiya Wastewater Treatment Plant, treated by a natural and modified garden soil from Sulaibiya area.**

Soil Aquifer Treatment (SAT) Technique



Objective of the Study

- The objective of the study was to assess the removal of coliphage viruses from treated wastewater using natural soil and modified garden soil column experiments in Kuwait.

Methodology

- **Soil Collection and Analysis.**
- **Soil Column Design and Construction.**
- **Column Operation and Maintenance.**
- **Water Sample Collection and Analysis.**

Soil Column Design and Construction

- The columns for the tests of virus were constructed using polyvinyl chloride (PVC) pipes 0.5 m in length and 0.1 m in diameter.
- The total length of a column contained 0.05 m of gravel, Soils: 0.1 m of natural soil, 0.1 m of natural soil mixed with garden soil, 0.1 m of constant wastewater head, and a margin of safety. The gravel in this study was used as a filter zone to prevent the passing of fine materials through the outlet.

Soil Columns Experiments



Soil Column Operation

- The tertiary wastewater was pumped daily from the Sulaibiya DMC to a high level 1893 I tank through a PVC line. The tertiary wastewater was fed to four soil columns simultaneously.
- All columns were subjected to short flooding and drying cycles of 1 d of flooding followed by 1 d of drying for 4 months.
- Samples of effluent were collected 24 h after the flooding periods.

Water Sampling and Analysis

- Influent and effluent coliphage samples were collected following cycles of flooding periods.
- Samples were collected using sterile 100 ml glass bottles with glass stoppers, and they were analyzed within 4 h of collection.
- Virus samples were analyzed by the staff of Water Research Center at KISR using the standard methods for the examination of water and wastewater (APHA, 2005).
- Fresh bacteria and coliphage media were prepared at the end of each month.

Collection of Effluent Samples



Preparation of E. Coli Bacteria Media



Sterilization of Coliphage Media (MTSA)



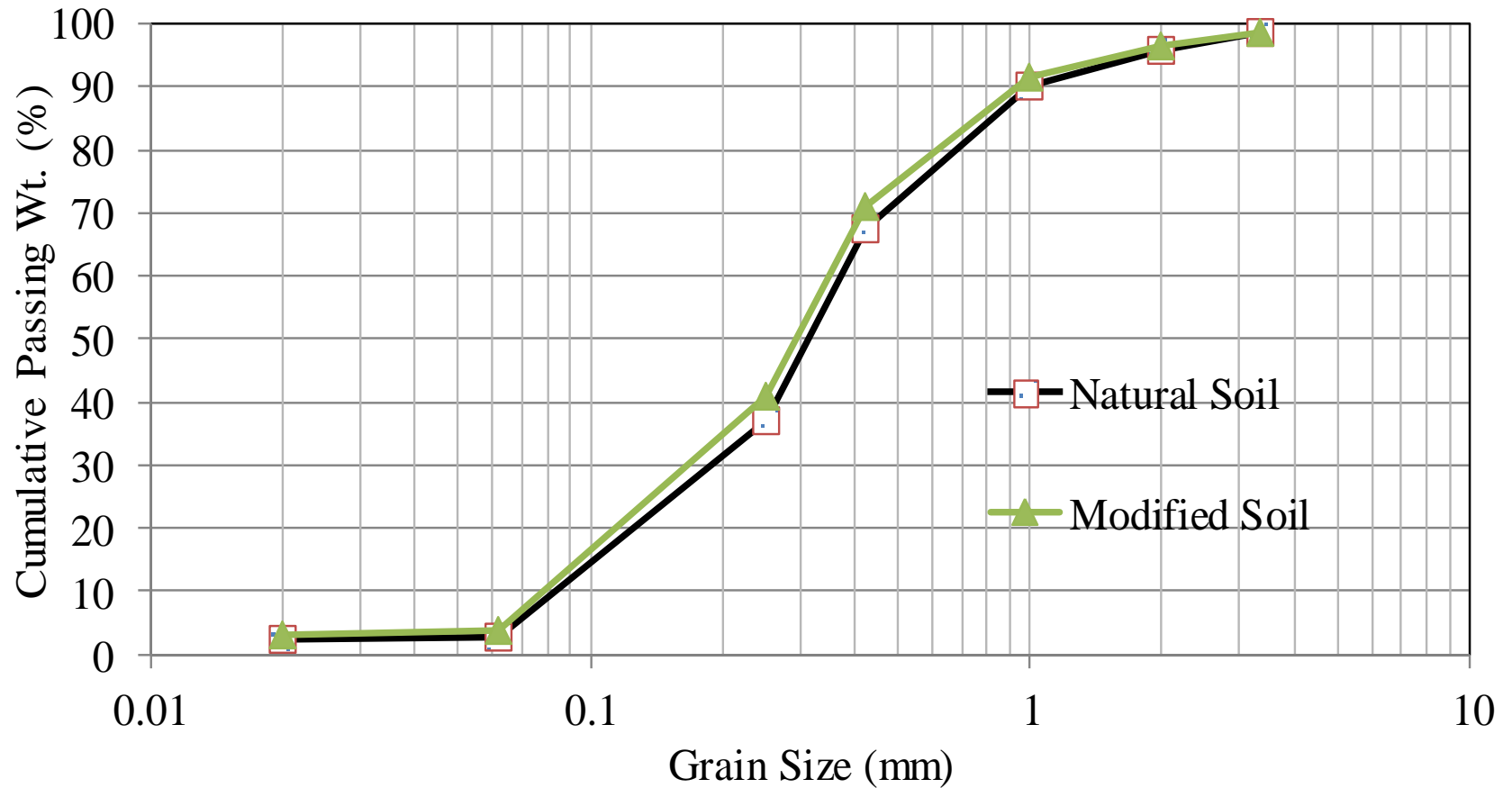
Preparation of Treated Wastewater for Coliphage Analysis



Study Results

- **Soil Analysis.**
- **Virus Removal Efficiency of Soil.**

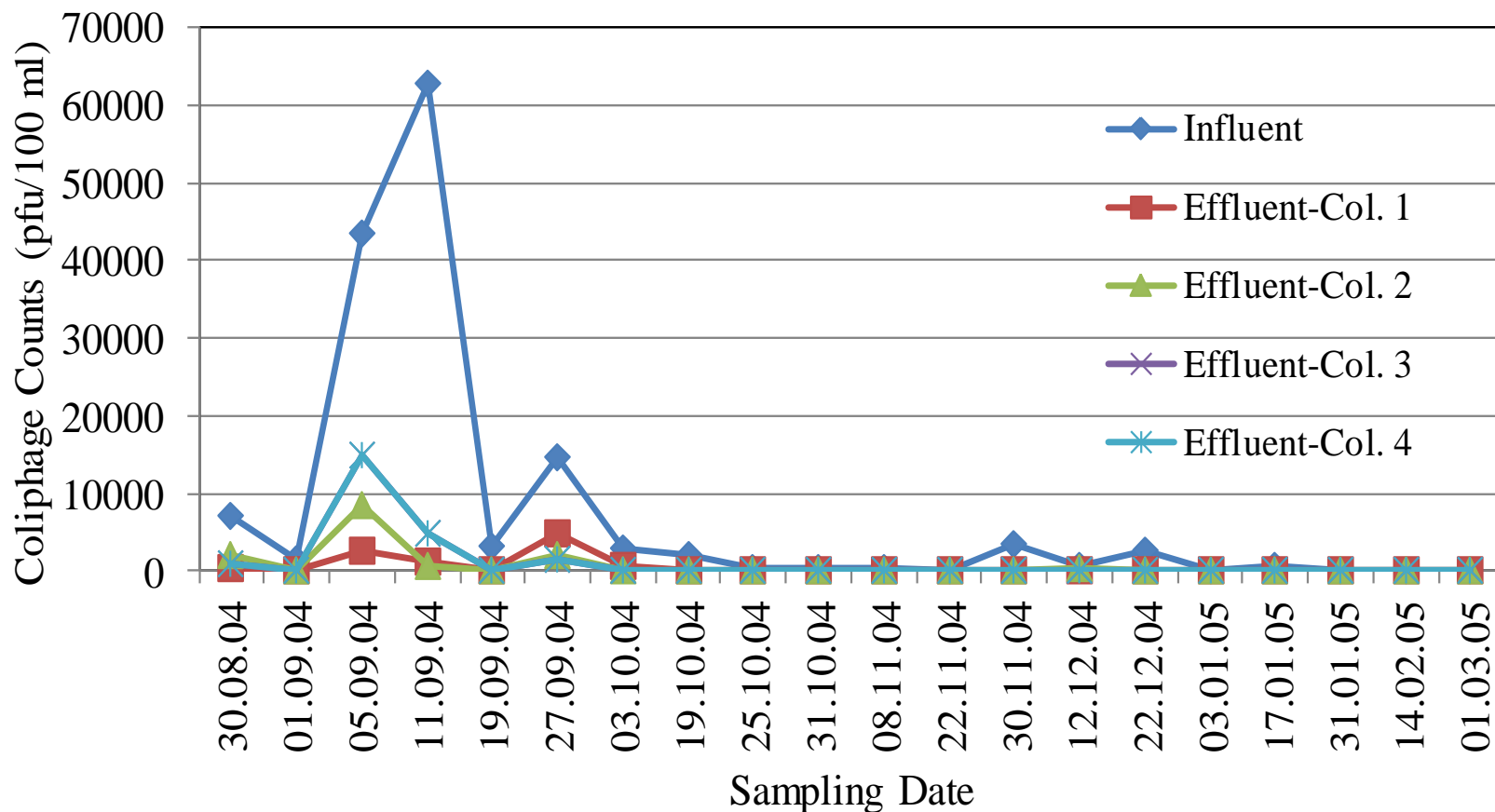
Grain Size Distribution



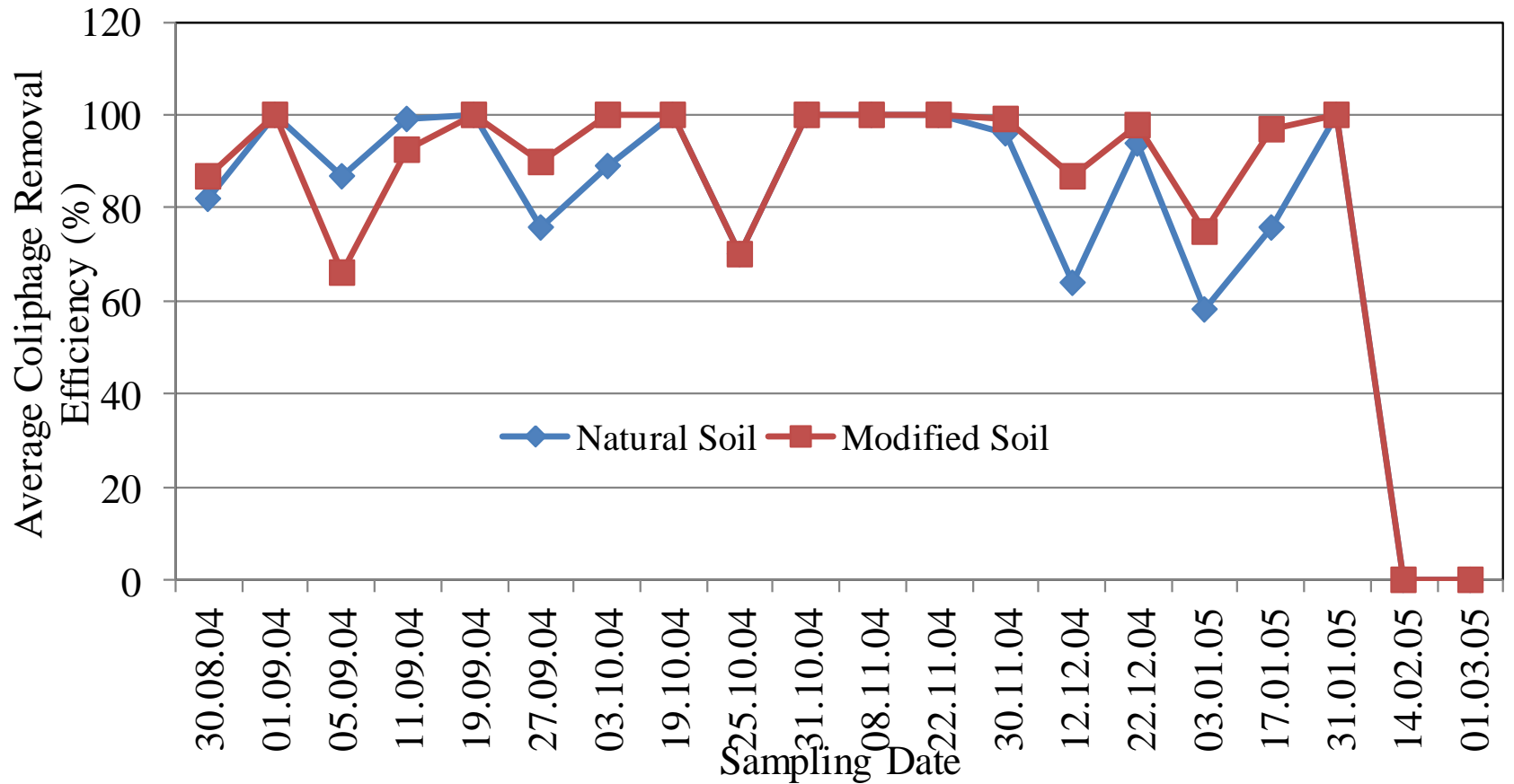
Soil Properties

Soil Parameter	Natural soil	Modified soil
Porosity(%)	33.0	44.0
Specific Surface Area (m ² /g)	8.22	5.88
TOC (mg/kg)	343.23	907.18
CO ₃ (%)	5.0	5.0

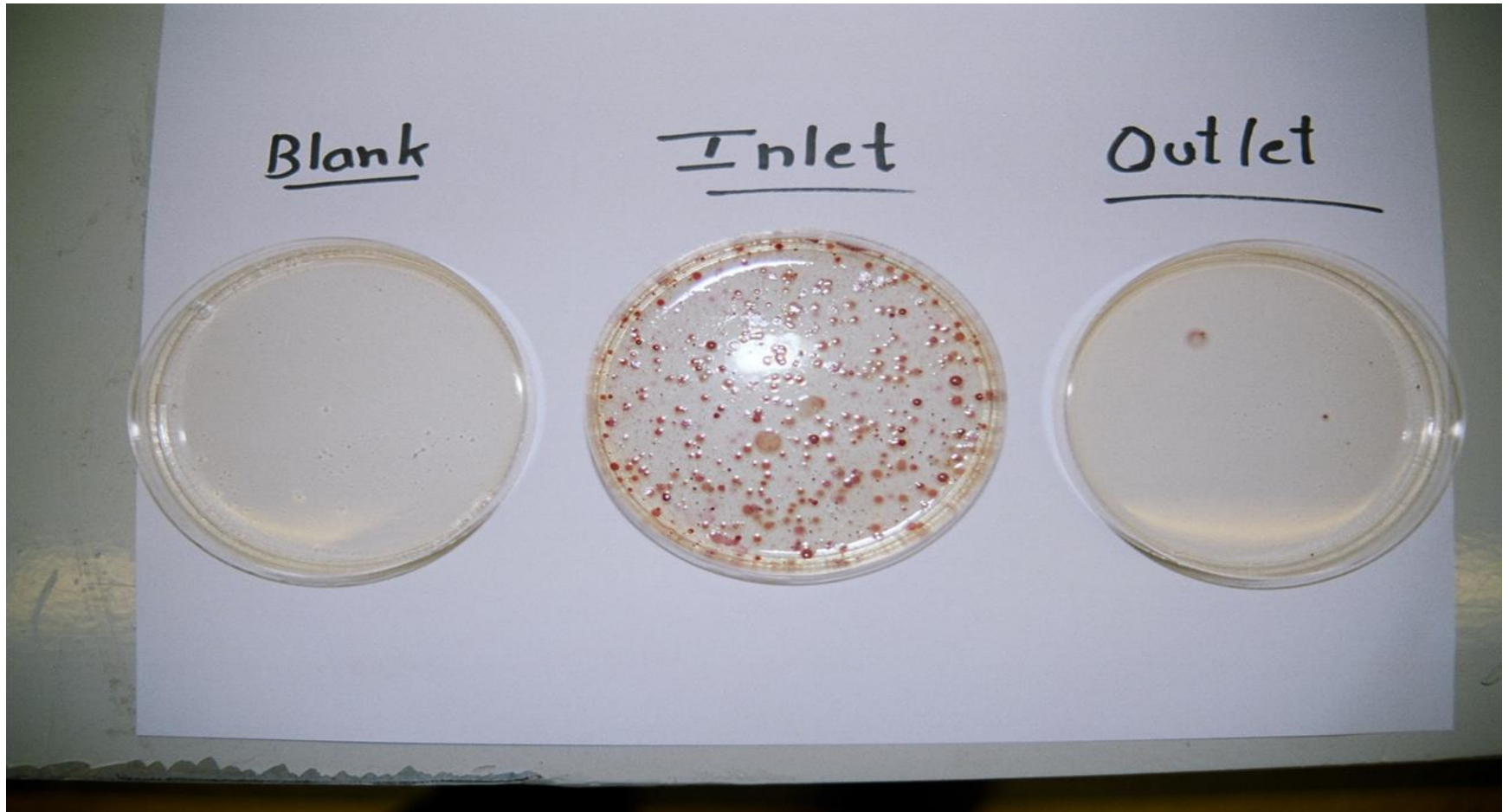
Coliphage Counts in Influent and Effluent Samples



Coliphage Removal Efficiency



Coliphage Viruses before and after Passing Modified Garden Soil



Conclusions

- Soil column experiments were carried out to determine removal of coliphage viruses from the treated wastewater using Sulaibiya natural soil and amended soil mixed with garden soil.
- High counts of coliphage viruses were found in the tertiary treated wastewater (62800 pfu/100 ml) and their counts was reduced after mixing it with RO treated wastewater.
- The laboratory results revealed that coliphage removal for Sulaibiya soil ranged between 58 and 100% with average value of 88.4%, while their removal efficiency using modified garden soil was 60 and 100% with average value of 92.3%.
- The soil properties such as amount of fines, organics, and the infiltration rates were important factors that increased the coliphage removal from the treated wastewater.

Recommendations

- **The removal efficiency of viruses from the wastewater using the SAT system in the field should be evaluated.**
- **The operation of SAT system should be applied separately for both the RO-treated wastewater, and tertiary treated wastewater to compare the bacteria and virus removal efficiency from both types of water.**
- **In agricultural areas, the treated wastewater should be passed through a filter zone of sandy soil mixed with 1% garden soil before this water is used for irrigating the agricultural areas.**

Acknowledgements

- The author would like to thank Kuwait Foundation for the Advancement of Sciences (KFAS) and Kuwait Institute for Scientific Research (KISR) for funding this study.
- I would like to extend my sincere gratitude to the KISR Management Team.