# Increase of Purification Capacity and the Performance of Slow Filtering in the Removal of Bacteria in an Activated Carbon-Soil-Sand Filter Unit

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## Abstract

*Mini scale carbon-soil-sand filtering system can be highly effective on surface waters, without requiring the use of coagulation preceding filtration. It is effective in removing suspended solids, toxic metals and imposes a 98-99 % reduction in bacteria. A novel filtering system is described here, where the bacterial removal zone was set above the purification zone in the filtering system. This paper gave an introduction on the working principle of this novel filtering system, which was developed for a single-family size in rural community. It demonstrated the visualization of the flow field and the exchange of water between the different layers. It also clarified the mechanism for bacteria removal in an activated carbon-soil-aquifer filtering system. This phenomenon can be explained by the formation of bacterial flocks where bacteria were removed by irreversible separation and adsorption. The bacteria were also removed from the liquid phase by separation onto the ceramic filter. Carbon-soil-aquifer filtering systems operating at a temperature of $25^0$ C to $30^0$ C were fed with source waters characteristic of polluted surface water samples. Coliform and total count (TC) data are presented. Slow filtration lengthens filter runs and produces filtered water with less taste and odour, and free of enteric bacteria. As the quantity and quality of the world's traditional drinking water sources decline, the use of alternative water sources grows.*

**Key words**: filtering system, bacteria, separation, adsorption and drinking water

## *1.0 Introduction*

The tiny and invisible microorganisms pose a serious threat to the safety of the worlds drinking water. Water when contaminated by microorganisms, particularly by the pathogenic ones, can become a growing peril with the potential to cause significant outbreaks of various types of infectious disease. The list of potentially pathogenic microorganisms transmitted by water is increasing significantly each year. Indeed the distribution of safe drinking water to the home can no longer be taken for granted, not even in the United States and Western Europe. The average person consumes about 2-4 liters of water per day through food and drinks. All these deliberations suggest an urgent need for supply of safe drinking purposes. Pilot and mini scale carbon-soil-sand filtering system has successfully produced potable drinking water in the developed countries for a century. Cost of fabrications, usefulness of local raw materials, ease of operation and maintenance, and low energy requirements make slow carbon-soil-sand filtration system a water treatment technology that is particularly well suited for developing countries.

In the midpoint of international drinking water supply and sanitation decade (1985) only 42% of the world's rural populations and 77% of the world's urban population had access to safe drinking water excluding The Peoples of Republic of China (Rotival, A. H., (1987),. Extensive research has been performed on the efficiency of carbon-soil-sand filters for treatment of water in normal climates. When source waters are relatively low in temperature and turbidity, this process has been found to be effective in the removal of toxic elements, organics and bacteria (Bellamy, W. D, 1985, Slezak, L. A. 1984).

Tropical rivers and other surface waters, which serve as receiving waters for waste discharges and runoff also serve as water supplies for down stream communities. Low flow rates of surface waters during dry seasons will result in high levels of toxic and microbial contamination from upstream human waste, agricultural runoff and industrial processing facilities. As concentrations of faecal coliforms in untreated water supplies vary widely in developing countries (Vsscher, J. T., 1986, , polluted source water's were simulated by maintaining a filter influent concentration of approximately $10^6$ *Escherichia coli* cells per 100 ml. Adsorption with carbon-soil-sand filter has been one of the most useful techniques in water treatment. In the past, activated carbon was predominantly used to remove odor and colour producing molecules in water (Suffer, I. H., 1980). We have previously reported the removal of toxic elements (heavy metals) using the same filtering system (A. M. Yusof' 2002). In this paper, the competitive separation and adsorption microbiological pollutants (Coliform, total count etc.) are reported.

## 2.0 Methodology

The setup of the filtration system consisting of the carbon-soil-aquifer filtering system is shown in Figure 1. The experimental set-up consists of two identical columns, though only final setup was diagramed. Filter column height is 18 cm, outside diameter is 8.5 cm inside diameter is 7.3 cm and its constructed materials is polyethylene tetrathelate (PET). Granulated activated carbon, modified activated carbon and red soil particles were prepared from locally available raw materials. Sand and silica particles were collected from locally available sources. The sequence of the components, its thickness and quantity inside the filtration system is shown in Figure 1.

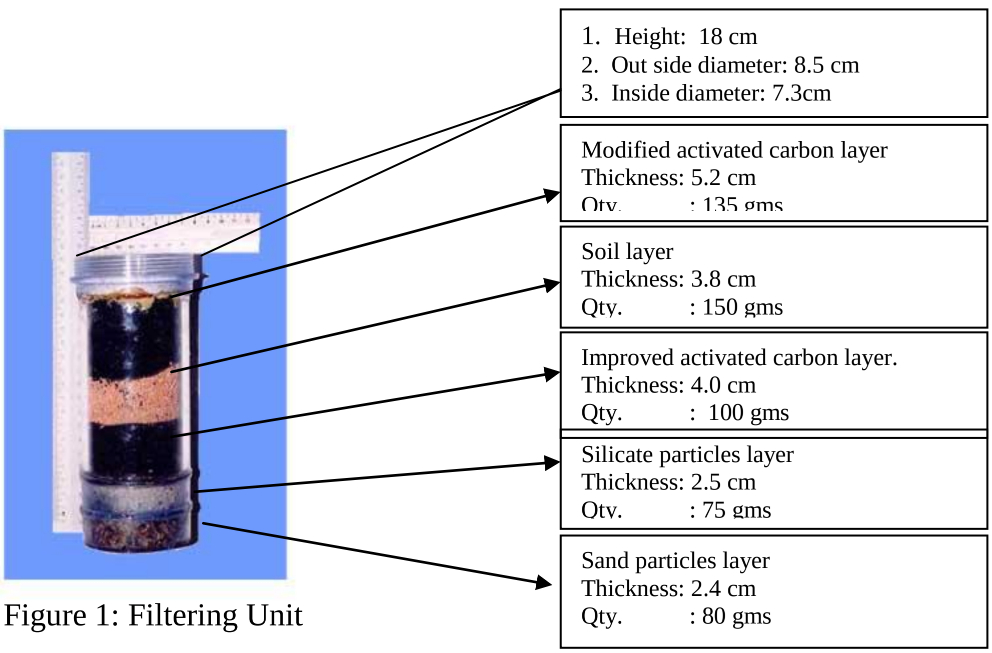


Figure 1: Filtering Unit

### 2.1 Preparation of media for Coliform and Total Count

Endo broth: About 2.4 g of (7.5 g agar 1.25 g Yeast Extract + 2.5g Peptone) MF Endo Broth mixture was dissolved in 50 mL of distilled water containing 1.0 mL ethanol. Then this was sterilized in an Autoclave at $121^0$ C, 15 psi for 20 minutes. The broth was cooled to room temperature before incubation. This medium was freshly prepared to ensure accurate results used for coliform count. 1.25 g of tryptone was added to 50 mL of deionized water and to it was added 3.75 g agar then gently heated. The pH was adjusted to 8.6 to 9.0 and then 1.25 g of glucose was added and then autoclaved. Yeast and mould count was then done.

## 3.0 Discussion

Environmentally polluted water samples were taken from various sources such as rivers, columns, tube well, sea and water falls. This naturally polluted water was filtered continuously through the filtering column for 10 days. The results of coliform and TC shown in Table 1 and Table 2. Coliform count is the most important microbiological count for drinking water.

Coliforms are quantified to assess water treatment effectiveness and the integrity of the distribution system. They are also used as a screening test for recent feacal contamination. Treatment that provides coliform-free water should also reduce the pathogens to a minimal level. A major shortcoming is that coliforms under certain circumstances may proliferate in the bio-films of water distribution systems, clouding their use as an indicator of external contamination. From the results in Table 1 it was observed that all raw water samples contain coliform except raw water from locations 10, 13 and 17. The sample taken from location 16 (waterfall water from Kota Tinggi) was observed to contain uncountable coliforms but treated water using filter column contained no coliforms. Therefore, it could be confirmed that the filtering column has produced coliform free water and safe for drinking. From Table 2, it was found that the total count includes three types of microorganisms; bacteria, yeasts and moulds which present in the raw water samples. Filtrate water supplies were selected at random from the stock. After 24 and 72 hours of observation the results showed that the yeasts and moulds could be distinguished from each other. The 24-hour observation could not distinguish between the yeast and mould but with the 72 hours observation yeast and mould were detected.

**Table 1: Coliform count in the raw and treated water samples**

| Sample ID | WHO Std. | Raw Water | Treated Water |
|---|---|---|---|
| 1 | 0/100 ml | 02 | 0 |
| 3 | 0/100 ml | 01 | 0 |
| 6 | 0/100 ml | 01 | 0 |
| 7 | 0/100 ml | 20 | 0 |
| 8 | 0/100 ml | 01 | 0 |
| 9 | 0/100 ml | 23 | 0 |
| 10 | 0/100 ml | 0 | 0 |
| 11 | 0/100 ml | 11 | 0 |
| 12 | 0/100 ml | 01 | 0 |
| 13 | 0/100 ml | 0 | 0 |
| 14 | 0/100 ml | 04 | 0 |
| 15 | 0/100 ml | 25 | 0 |
| 16 | 0/100 ml | Uncountable | 0 |
| 17 | 0/100 ml | 0 | 0 |

**Table 2: Total count in raw and treated water samples**

| Sample ID | WHO Std | Raw water/10 ml | | Treated water/10 ml | |
|---|---|---|---|---|---|
| | | 24 hours | 72 hours | 24 hours | 72 hours |
| 1 | <25/10mL | 28 | 36/14 | 09 | 11/1 |
| 3 | <25/10mL | 38 | 40/38 | | |
| 6 | <25/10mL | 02 | 4/1 | | |
| 7 | <25/10mL | 06 | 20/2 | | |
| 8 | <25/10mL | 25 | 30/18 | 13 | 18/12 |
| 9 | <25/10mL | 21 | 32/6 | | |
| 10 | <25/10mL | 15 | 15/3 | | |
| 11 | <25/10mL | 70 | 78/12 | 11 | 12 |
| 12 | <25/10mL | Uncountable | /6 | 09 | 10/9 |
| 13 | <25/10mL | 0 | 13/3 | | |
| 14 | <25/10mL | 18 | 22/88 | | |
| 15 | <25/10mL | Uncountable | /25 | 02 | 12/3 |
| 16 | <25/10mL | 08 | 8/8 | | |
| utm tap | <25/10mL | | | 00 | 00 |

### 4.0 Conclusion

Finally newly fabricated filter unit has shown in the Figure 1 has been found to be significantly improved for its removal capability of microbiological hazardous materials from the filtrated water. It provided a safe drinking water in the point of view of microbiological, toxicity, softening hardness and pH value. All kinds of parameters for drinking water fulfilled the requirements as provided by this water filter unit.

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