Performance of multistage filtration using different filter media against conventional water treatment systems

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Abstract

This study was aimed at introducing multistage filtration (MSF) (a combination of slow-sand filtration (SSF) and pretreatment system - horizontal flow roughing filter (HRF)) as an alternative water treatment technology to the conventional one. A pilot- plant study was undertaken to achieve this goal. Evaluating the MSF performance vs. the existing conventional system in removing selected physical and chemical drinking water quality parameters together with the biological water quality improvement by the MSF without chemical use was done. Evaluation of the effectiveness of the MSF system utilizing locally available material, i.e. gravel, improved agricultural waste (charcoal maize cobs) and broken burnt bricks as pretreatment filter material was also done The benchmark was the Kenya Bureau of Standards (KEBS) values for the selected parameters. Results showed that with proper design specifications, MSF systems perform better than conventional systems under similar conditions of raw water quality and environmental conditions. The tested locally available materials can also be effectively used as pretreatment media with each allowing a filter run greater than 82 d and therefore could serve as alternatives where natural gravel is not readily available. With special reference to the bacteriological quality improvement, the MSF greatly improved the bacteriological quality of the water recording removal efficiencies of over 99% and 98% respectively for *E. coli* and total coliforms. Despite the observed performance, MSF should be complemented with chlorination as a final buffer against water-borne diseases. However, in this case, the dosing will be greatly reduced when compared to the conventional system.

Keywords: multistage filtration, gravel, charcoal maize cobs, broken burnt bricks, pretreatment, conventional

Nomenclature

HRF:	Horizontal flow roughing filter
HRFB:	HRF with broken burnt bricks as filter medium
HRFC:	HRF with charcoal maize cobs as filter medium
HRFG:	HRF with gravel as filter medium
SSF:	Slow-sand filter/filtration
SSFB:	SSF connected to HRFB
SSFC:	SSF connected to HRFC
SSFG:	SSF connected to HRFG
MSF:	Multistage filter/filtration
MSFB:	MSF combining HRFB with SSFB
MSFC:	MSF combining HRFC with SSFC
MSFG:	MSF combining HRFG with SSFG
RSF:	Conventional treatment system
CFU:	Colony-forming units
SS:	Suspended solids concentration
NTU:	Nephelometric turbidity units

Introduction

Over 80% of the water used in both rural and urban areas in Kenya is surface water drawn from rivers, streams, lakes, ponds and springs. The water from these sources is in most cases contaminated by human and animal wastes, as well as industrial and agricultural activities. This scenario thus calls for efficient and effective treatment of water from such sources before use to avoid instances of water-borne and water- related diseases such as typhoid fever and cholera at reasonable costs. This is important because it has been reported that 70 to 80% of water-borne diseases are spread through the unavoidable ingestion of pathogenic micro-organisms and parasites in drinking untreated water especially surface water (Tebbutt, 1992). It has also been shown that inadequate water supply both in terms of quantity and quality coupled with poor sanitation globally account for approximately 30 000 deaths daily, many of them infants and 80% of such cases occur in rural areas (WHO and UNICEF, 1996). A WHO report during the celebration of world water day on 22 March 2001 (theme "*Water for Health*") showed that in Kenya, only 49% of the total population has access to safe water according to UNICEF statistics.

In providing water on a large scale, slow-sand filtration and conventional treatment methods (of coagulation – flocculation – sedimentation – rapid filtration – chlorination) are mostly used, the Kenyan practice, like in most other countries, being to adopt the conventional water treatment method. This system is, however, quite demanding in chemical use, energy input and mechanical parts as well as skilled manpower that are often unavailable, especially in rural areas of developing countries. This scenario calls for appropriate technologies that utilise locally available materials, skills and other resources in accessing potable water. One such technology is MSF (Wegelin, 1996). This system consists of a pretreatment stage followed by SSF. Worldwide experience with roughing filters and SSFs shows the significant potential of this treatment concept in producing potable drinking water from polluted turbid water (Wegelin, 1996). Application of MSF in Europe has, according to Wegelin et al. (1990), shown tremendous success in Dortmund, Germany (Waterworks of Dortmund), Austria (Graz Water Supply Authority) and Aesh in Switzerland among others. In

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