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Comparison of the Efficiency of Physical and Biological Treatment of Slow Sand Filter in Kahkash (Samaan) Treatment Plant

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Abstract Today, the importance of water is so obvious that it is one of the main bases of sustainable development; in fact, in current decades, the water treatment is one of the most important and complicated world issues. This study aimed to investigate the comparison of the efficiency of physical and biological treatment of slow sand filter in Kahkash (located in Chaharmahal and Bakhtiari province, Iran) treatment plant. This cross-sectional study was carried out in Kahkash, a rural area located in Charharmahal and Bakhtiari province, southwest of Iran. Sixty samples (30 in the spring and 30 in the summer) were randomly filtered. Turbidity was measured by Nephelometer using 0.02 NTU standards, color was measured by colorimetry, coliform and E.coli was evaluated by multiple tube fermentation method, Heterotrophic bacteria was assessed by pour plate method, and suspended solid was accomplished by gravimetric method. The mean amount of suspended solid, turbidity, color, Coliform, E.coli and Heterotrophic bacteria in the spring time, were 50.56, 53.92, 59.37, 91.56, 85.28, and 70.52, respectively and in the summer time were 18.22, 44.22, 40.63, 90.52, 86.13 and 76.94, respectively. There were no significant differences in the working efficiency between spring and summer times ($P>0.05$). Except for turbidity which was higher in the spring than summer ($P>0.05$).

Keywords Slow sand filter, Water treatment, Efficiency

1. Introduction

Slow sand filtration has been an effective method of treating water for the control of physical, microbiological and chemical contaminants, speciallyfor rural regions water supplies [1]. Slow sand filtration (SSF) in potable water treatment is effective in the removal of turbidity and (pathogenic) microorganisms such as enterovirus, Campylobacter, Cryptosporidium, Escherichia coli and Giardia [2]. In more recent research, SSFs, were able to remove 99.9% of experimentally added cysts of *Giardia*, *Cryptosporidium*, and coliform bacteria. *Cryptosporidium* and *Giardia* fall in the size range of 1–25µm [3]. Slow sand filters have also demonstrated their ability to remove viruses from water supplies [4]. This method has been shown to be successful for herbicides and polar pharmaceuticals contaminant removal [5]. The treatment processes in slow sand filters are mainly attributed to naturally-occurring physico-chemical and biochemical processes [6]. The efficiency of slow sand filtration depends on the media material and the depth of the filter [7]. In slow sand filters, raw water flows by gravity through a column of sand and layer of support gravel and flows out an under drain collection grid to the treated water storage and distribution system [5].

SSF is generally the third stage of water treatment after reservoir storage and rapid filtration, prior to disinfecation [8]. However, slow sand filters can also provide a single-stage treatment for raw waters within certain water quality limits of turbidity and algal content [4]. Simplicity, and low capital and operating costs are other principal advantages of SSF compared with more complicated methods of water treatment.

SSF is utilized under several conditions and scales ranging from household level to the large scale at a potable water production plant [9]. The purpose of this study to investigate the comparison of the efficiency of physical and biological treatment of slow sand filter in Kahkash (Chaharmahal and Bakhtiari province) treatment plant.

2. Materials and Methods

2.1. Study Area

This cross-sectional study was carried out in Kahkash, a rural area located in Charharmahal and Bakhtiari province, southwest of Iran.

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2.2. Sampling

Sixty samples (30 in the spring and 30 in the summer) were randomly filtered. Samples were collected from the source in 300 mL glass bottles sterile. Aseptic conditions were transported in coolers with ice in a temperature below 4°C to the Research Laboratory and Diagnostic Microbiology of the Shahrekord University of Medical Sciences in order to perform microbiological analysis.

2.3. Analytical Measurements

Turbidity was measured by Nephelometer using 0.02 NTU standards, color was measured by colorimetry, coliform and E.coli was evaluated by multiple tube fermentation method, Heterotrophic bacteria was assessed by pour plate method, and suspended solid was accomplished by gravimetric method. To evaluate the microbiological quality of the samples were analyzed for total coliform, coliform and heterotrophic plate count according to methodology described in the American Public Health Association guidelines [10]. In order to check the Most Probable Number (MPN) of total and faecal coliforms (*E.coli*) was used the technique of Multiple Tube Fermentation. The results were expressed as MPN/100ml. The heterotrophic bacteria count was performed using the pour plate technique, which were spread in 1 ml of the dilutions of 1 ml and 0.1 ml in sterile Petry plates and then added Plate Count Agar.

3. Results and Discussion

In spring and summer working efficiency percent mean of suspended solid, turbidity, color, Coliform, E.coli, Heterotrophic bacteria were 50.56, 53.92, 59.37, 91.56, 85.28, 70.52, 18.22, 44.22, 40.63, 90.52, 86.13, 76.94 percentage, respectively (Table 1). There were no significant differences in the working efficiency between spring and summer ($P>0.05$) (Table 2). Except to turbidity that working efficiency turbidity in spring was higher than summer ($P>0.05$).

The highest 91.56% and lowest 18.23% efficiency were belonged to total coliform and suspended solid, respectively.

Nassar and Hajjaj reported that about efficiency of slow sand filter. The average percent removal the median value is 65.92% and standard division is 0.285 on fecal coliform removal [11]. The average percent removal the median value is 86.77% and standard division is 0.111 on suspended solid removal is not sensitive [11].

Table 1. Percent removal type of parameters during summer and spring

Parameters	Summer			Spring		
	Inlet(mg/l)	Outlet(mg/l)	Efficiency%	Inlet(mg/l)	Outlet(mg/l)	Efficiency%
Suspended solid (mg/l)	32.2	26.33	18.23	62.1	30.17	50.56
Turbidity (NTU)	8.3	4.63	44.22	7.66	3.53	53.92
Color(Pt-Co)	21.56	12.8	40.63	24.76	10.06	59.37
Total coliform/100ml	1614.36	152.99	90.52	1288.53	108.69	91.56
E.coli/100ml	956.2	132.58	86.13	796.66	117.29	85.28
Heterotrophic Plate Count/1ml	406.1	93.63	76.94	405.86	119.36	70.59

Table 2. Relationship between season and mean of removal efficiency

Parameters	Mean±SD		P-value
Suspended solids(mg/l)	Summer	11.7±4.5	0.868
	Spring	22.91±10.5	
Turbidity(NTU)	Summer	37.67±15.5	0.042
	Spring	57.91±17.3	
Color(Pt-Co)	Summer	40.09±15.3	0.147
	Spring	53.63±10.5	
Total coliform/100ml	Summer	88.94±11. 2	0.881
	Spring	89.51±17.52	
E.coli/100ml	Summer	80.4±26.19	0.62
	Spring	83.14±14.77	
Heterotrophic Plate Count/1ml	Summer	73±23.1	0.55
	Spring	76±14.8	

Raudales and colleagues reported that about slow sand filtration has been observed to remove a high percentage of *Phytophthora*, *Fusarium*, bacteria, nematodes, and viruses from irrigation water [12], Hijnen and colleagues reported that about slow sand filtration has been observed the high capacity of mature slow sand filters to remove *Cryptosporidium* oocysts and spores of C. perfringens. Bruijn and Clark concluded that the removal efficiency of suspended solid 80% [14].

4. Conclusions

Access to safe drinking water has been an important national goal in rural area and other areas.

Slow sand filtration (SSF) is one of the oldest water treatment processes used to produce microbiologically safe drinking water. It is shown that safe drinking water was achieved by a combination of a protected and high quality source at the initial point and maintaining quality from the initial supply (source) point through to final consumption. Our study showed efficiency of physical and biological treatment of slow sand filter was relatively desirable but , for water quality improvement it is suggested that a chemistry and microbiology lab in treatment plant be set up. Also filter washing and cleaning should be accomplished on time.

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