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Sand Filters in House Holding Wastewater Filtration System

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Abstract
This paper deals with constructing an experimental model for sand-based house holding waste water filtration system, the main objective is to construct very cheap filtration system which can be used as a station for converting the waste water produced from the kitchen of the home to a semi clean water which can be used in irrigation of the house gardens and other cleaning uses. The system is constructed as a prototype and many wastewater samples are tested, analysed and studied, exactly four samples of water with different impurities are tested, degree of acidity (PH) is used as a measurement of tested samples. It is found that for all samples (with different values of (PH)) the final tested water samples treated by this system having a 7.1 PH values which is considered closes to the pure water acidity level with PH of 7.

Keywords: *Wastewater, Filtration, Materials, Sand Grains, Water Treatment Technology, Sand Filters. PH*

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I. Introduction

Management of water supplies represents a problem in a few parts of the globe for future development. Although water demand will continue to increase, as far as the executives' water assets are concerned, the limited measure of daily new accessible water will consistently be troublesome. Such a conflict may be illuminated by different approaches, including the reuse of recompensed wastewater effluents as a renewable commodity that rises with the growth of water usage (Hamoda et al., 2004). Jordan has limited water resources and also a big demand on tidy water because of high increase on water demands, figure 1 shows the water resources in Jordan (with two-seas channel).

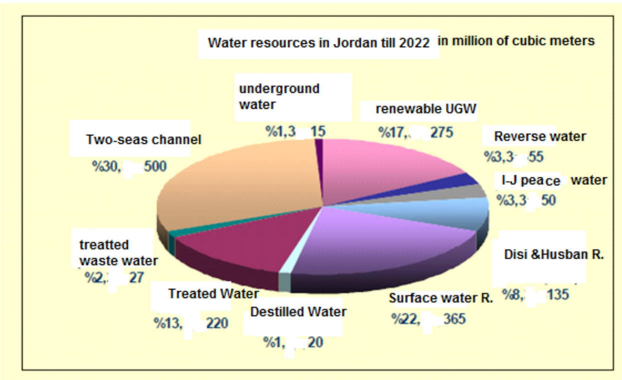

Figure 1. Water resources in Jordan till the year 2022

The execution of tertiary filtration of optional compensated effluents along these lines will increase the efficiency of water for conceivable reuse in less prohibitive applications (Hespanhol, 2004, Brito and Tinôco, 2000). For example, the use of rewarded wastewater for water systems of plants and harvests is, step by step, becoming a worldwide common practice (Lubello et al., 2004). The importance of granular medium filtration as a tertiary treatment step has recently been demonstrated, taking into account the rigid water quality prerequisites imposed upon water for reuse (Hamoda et al., 2004). This filtration evacuates generous wastewater particle steps and thereby advances efficient sanitization as well as tasteful appreciation of recycled water for lucrative work. In the field of water and waste water treatment, the film partition or membrane filtration (ultra filtration or microfiltration), which is being increasingly used, is sufficient to produce sanitized clear water that is reasonable for different types of uses. Be that as it may, microfiltration or ultra-filtration film fouling refers to a big impediment to its use (Abdessemed et al., 2000). Coagulation, adsorption and granular medium filtration cause natural colloids to be expelled, assuming a major role in fouling marvels. In the water treatment area, granular media filtration has been rehearsed for quite a while (Farizoglu et al., 2003), as of late, however, its application to tertiary treatment of waste water has been considered. In consumable water frameworks, the plan steps for wastewater channels cannot be obtained easily because channels in waterworks are usually maintained at consistent rates under generally consistent suspended-solid loadings (Hamoda et al., 2004).Sand and anthracite coal are the most well-known granular media used in filtration in wastewater treatment plants. The evacuation of suspended solids is due to the solids' physical maintenance. Hamoda et al. (2004) and Lubello et al. (2004) outlined the tertiary treatment of household wastewater using sand as a granular medium as of late. Suspended solids evacuation, unpredictable dissolvable solids and Chemical Oxygen Demand (COD) were individually 70 percent, 56 percent and 38 percent, and the process was also productive in the expulsion of pathogenic pathogens and microscopic species. Granular initiated carbon (GAC) is a increasingly active medium, as adsorption is additionally expelled by a few pollutants broken down in the gush. In any event, for this reason, the costs of GAC for the existing ones are restrictive. The use of granular adsorbent carbon from bituminous mineral coal has been accounted for as of late (Moreira et al., 2004). This material offers unique characteristics, such as an impartial zero charge purpose, synergistic action for oxidation responses and surface hardness (Moreira et al., 2003), and can be expelled by adsorptive filtration for suspended and broken solids. This examination was aimed at evaluating the presentation of tertiary filtration of urban waste water, using a granular adsorbent carbon and sand, with different molecule sizes, and taking into account the importance of granular medium filtration for gushing quality improvement in wastewater treatment plants. One of the most common treatment forms used in the treatment of water and waste water is filtration. In treating water, it is used to decontaminate surface water for consumable use, while the fundamental reason for filtration in wastewater treatment is to provide high caliber emanation with the objective of reusing it for various purposes. Gean Delise L. P. et al. in 2004. Evaluated the expulsion of suspended solids, disintegrated solids, turbidity and COD by adsorbent filtration in a granular mechanism for tertiary water treatment and reuse. In the climbing and plummeting filtration mode, various granular media comprised of sand and adsorbent carbon with different molecule sizes were used. The results showed that in the climbing filtration mode, it is conceivable to evacuate about 85 to 90 percent of the shading and turbidity using adsorbent carbon. An unexplained decrease in the shading and turbidity evacuation that could be associated with the immersion of the carbon adsorptive limit was seen after 40 hours of filtration. No adsorption was measured during the filtration with sand, and the degree of shading and COD expelled arrived separately at only half and 14 percent. A target financial list, which contains both speculation and fixed and variable working costs of a wastewater treatment plant, is defined by Gillot et al. (1999). The fundamental purpose is to normalize a strategy of cost estimation, to provide the option to look at modified circumstances of treatment. For each particular case, the enhancement of the cost basis could be explicit, particularly to determine variable labour costs. Via two contextual studies, the use of cost models and reenactment in the examination of care options is then interpreted. The primary straightforward model alludes to a plant’s structure period, while continuous control procedures are examined by unique display and reproduction in the subsequent model. It is possible that such assessments would bring in substantial reserve funds. Xiang, et al. (2014) construct a dynamic model of linear optimization to represent a framework of water environment management that integrates three sub-models with their interrelationships in mind (a financial model based on a powerful input-output model, a model of the cycle of water properties, and a model of the stream of water toxins). With regard to recreation, the model will certainly assess water use habits, water quality, and monetary advancement under certain administration targets, and propose an ideal arrangement. Accepting Tianjin as an objective territory, this study used the model to dissect the potential to use recycled water to achieve the executives' neighbourhood water condition and manageable progress plan while analysing the relevant methodologies. This study demonstrates that the constructed water state can be effectively and easily implemented by the executive structure to assess water assets and conditions while increasing the exchange off among financial and condition improvement, just as define territorial advancement plan. Mohanty et al. (2017) attempted to boost the developments in filtration and to make them increasingly economical and accessible to individuals in general, they also concentrated on developing enhanced altered working techniques for advancement in quick sand filtration. There was an attempt in this paper to create one adjusted fast sand channel and contrast it with periodic fast sand channels. The fundamental objective was to improve the general efficiency of conventional fast sand channels through some adjustment. PVC granules are used as topping material for the construction of changed channels, just as ferric chloride is often used. Strong fixation [12] split up all the material assistance to achieve the lower turbidity and all out. Sharath et al. (2017) intended to develop a Sand Filter unit that manages surface water debasement by using Sand Filtration as an elective treatment technique in Gubre-City, SNNPR, and Ethiopia to reward surface water for drinking. Three plastic Sand Filter renderings units were introduced at research center and performed around nine trials with various boundaries.

The results were broken down by Sand Filter's efficacy in expelling debasement and contrasted with the main plan boundaries between units with deference. Three exploratory findings were selected and found to have the highest efficiency of pollution expulsion. Finally, it was shown that all these three Sand Filter units achieved efficiency of over 80 percent turbidity expulsion from surface water. Clearly, from the examinations, the Sand Filter Unit 1 obtained the maximum turbidity evacuation efficiency of 88.4 percent compared to the other two Sand Filter units. The microorganisms attached to the surface of a single grain of the filtering material under a scanning electron microscope (50) were examined by Liu et al. (2019) in order to improve the SSF display. The bio-slow sand filtration technique has successfully alleviated and assists with the expulsion of microorganisms and other microbiological pollutants, as well as overwhelming metals, smelling salts, phosphorus, natural material, and turbidity of the collected water, in view of the upgrades to traditional slow sand filtration (SSF). The evacuation efficiency of bioslow sand filtration was approximately 20-30 percent on natural particulate carbon, above 95 percent on nitrogen smelling salts, and greater than 96 percent, 95 percent, 95 percent, 80 percent, 70 percent, and 60 percent on individual Cu^{2+}, Cd^{2+}, Fe^{2+}, Zn^{2+}, Mn^{2+}, and Pb^{2+}. The emanating importance meets the needs of "measures for the quality of drinking water" in China. The outcome demonstrated the bio-moderate sand filtration technique could accomplish better water quality outcomes as an accessible water treatment innovation [14].

- ***Water Resources Cycle System***

The operations of residents and producers have a huge effect on the overall water climate. Similarly, rapid economic and population growth offers levels of popularity for water assets and generous age for water pollution. The natural problems found with water assets would also be further enhanced by these trends. The action of the occupants and the structure of the industry shifts, just as progress in water recovery will discharge water assets and condition pressures and give more room for the financial turn of events [11]. As shown in Figure 2, clean water and recycled water are versatile water wellsprings. In critical and auxiliary companies and family groups, recycled water is assumed to be used. Fig.1. Shows the water stream in water assets cycle framework.

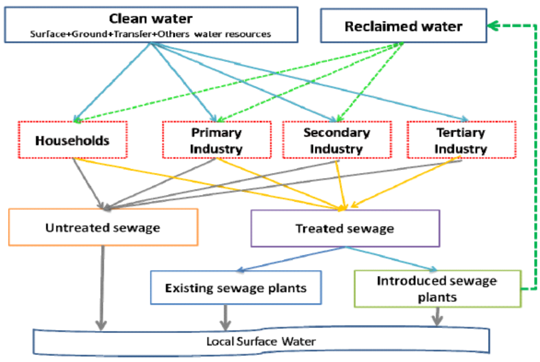

Figure 1: Water flow in water resources cycle system [11].

1.2 Sand Filters

There are many types of sand filters: slow sand filters, rapid filters and roughing filters, which will be discussed briefly in this paper.

1.2.1 Slow Sand Filters

To evacuate an enormous amount of coliforms, cryptospridum and Giardia pimples, sluggish sand filters use sand with efficient sizes of 0.15-0.35 mm. At a stream rate of 0.1-0.3 m / h (or m3 / h / m2), which corresponds to 100-300 l / h per m2 of channel territory, they operate most adequately. For example, physical procedures such as sedimentation, adsorption and stress to evacuate fine particles are used by these channels as microbiological procedures to expel natural materials and microscopic organisms. The crude water sits over the sand for a few hours before going through it, in view of the moderate channel speeds, during this period various oxidation responses separate natural content. Green growth that grows on the surface of the sand devours this natural oxidized material and discharges oxygen into the water once again. Roughing and sedimentation channels are commonly used as pre-medicines to minimize the crude water's turbidity and reduce the rate at which the moderate sand channel is stopped along these sides. It is also attractive to increase some air circulation to expand the oxygen substance of the crude water. It is also possible to use post-filtration chlorination or UV purging; in any case, such medicines are not carefully critical with a channel that operates admirably. [1, 6, 13, 15 -16].

1.2.2 Rapid Sand Filters

These filters use sand grains larger in size than slow sand filters, and the filter media's effective size is typically greater than 0.55 mm. The flow rates are typically between 4 and 21 m / h, equivalent to 400 to 2100 l / h per filter square meter. Such filters do not eradicate disease-causing entities as effectively as slow sand filters and typically involve a chlorination step after filtration. Flocculation and coagulation [1, 6, and 16] are also used as pre-treatments.

1.2.3 Roughing Filters

These filters are commonly used by accessing the water through material that is much coarser than that used in slow sand filtration or rapid sand filters to eliminate suspended solids. Typically, the filter content is graded such that the water passes through coarse sand (25 mm), medium and then fine sand (5 mm). Sometimes, flow rates are between 0.3 and 0.6 m / h (i.e. 300 to 600 l / h per m^2 of filter surface area) [6, 15].

2 Materials and Methods

Fig.2 shows the constructed model of the household filtration system. It is constructed from three main components: the waste water tank, the filtration unit, and the clean water tank and also a connecting pipes and valves. Fig.3 shows the components of the filtration unit.

Figure 2: Filtration unit

Figure 3: Sands of the filter

II. Results and Discussion

After the system is constructed, four samples of waste water are taking to be tested. Table 1 shows the characteristics of samples tested by the constructed system. We have 4 samples with different contaminates, with different colours as shown below. The results shows the properties of wastewater depending on colour of the water before treatment and the treated water and its new physical and chemical properties as shown in table 2. The colour of waste water before treatment is in general black or gray, after san filtration it becomes moderate (white) transparent or transparent i.e. it becomes colourless.

Table 1: Studied Samples

Sample number	Degree of purity(type of impurities)	Color before treatment
1	Full of impurities	Black
2	Water with Spoons	Relative white
3	Oil and water	Black
4	Black mixed with iron particles	Black

Table 2 below shows the results of the final treated water.

Table 2: Resulted Treated Water

Sample number	Degree of purity(type of impurities)	Color before treatment	Color after treatment
1	Full of impurities	Black	Gray to white
2	Water with Spoons	Relative white	Transparent
3	Oil and water	Black	Moderate transparent
4	Black mixed with iron particles	Black	Moderate transparent

Table 3 shows the samples and PH for the water before and after treatment. The values of the PH (acidity level) is considered as very important assessment measure of the water purity and acceptance of resulted treated water. It can be noticed that the values of PH of the resulted treated water are lie between 6.99 and 7.11 which are very close of the acceptable value of normal water which equal to 7.00.

Table 3: Resulted PH of the Samples

Sample number	PH before	PH after
1	7.15	7.1
2	6.90	7.09
3	6.25	6.99
4	7.30	7.11

Fig. 4 and 5 show some of waste water samples. The samples included water with oil, water with some fatty materials and other wastes.

Figure 4: Waste water samples 1

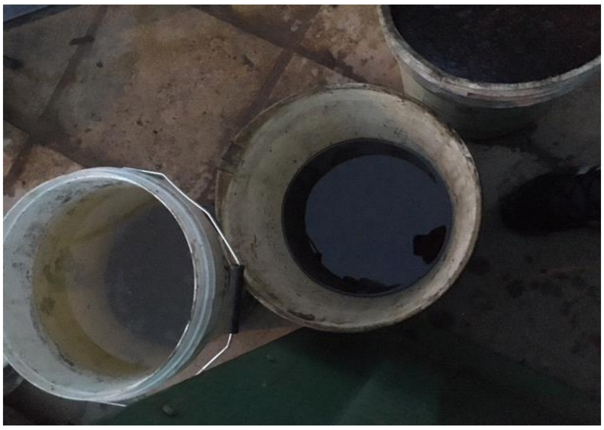

Figure 5: Some of waste water samples 2and 3

Fig. 6 show the resulted water after treatment. After treating waste water samples shown in figure 6 and 7 the resulted water is shown in figure 8 and it seems to be as pure, colourless and normal water.

Figure 6: Resulted treated waste water by the filter

Fig.7 shows the values of PH before and after filtration by sand filter. The values of PH after treating wastewater samples become around the normal level.

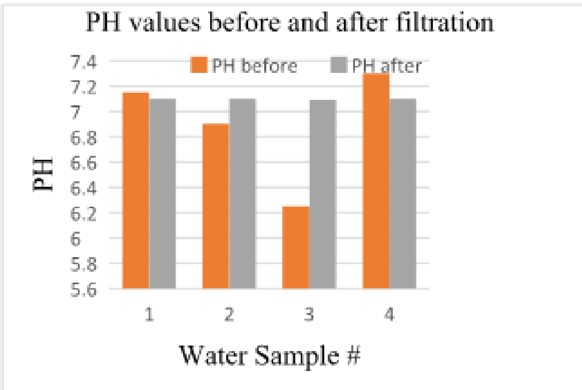

Figure 7: Comparing PH of water samples before and after filtration

In this study a local sand filter with different grain sizes is developed, the results show with using different wastewater types, the filter showed a good performance in treating them, the resulted quantities of water after filtrations are with good appearance, chemically neutral, no contaminates and can be used in irrigation or other uses. PH values of resulted water as shown in figure 10 are very close to pure drinking water (PH=7). In this study a low cost and local filtration system is constructed, it is estimated that the cost of filtration of one gallon of water doesn't exceeds 0.03 JD, this filter can treat most types of waste water to get a good water which can be used as an irrigate water for gardens, and other home uses or as a drinking water after some other chemical treatments.

-Sand filters performance and effects of porosity

III. Conclusion

-It is good to implement a home waste water treatment unit that will reduce the water consumptions and offers available clean water quantities for non-drinking sides. This water resulted after treatment can be used in industrial or irrigation applications.

-the PH of the water after treatment is nearly constant and closes to the pure water (about 7.1).

-colours of resulted water are accepted and the transparency is good.

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