International Journal of Thesis Projects and Dissertations (IJTPD)
Vol. 6, Issue 3, pp: (38-43), Month: July - September 2018, Available at: www.researchpublish.com

Sewage Water Treatment Using Modified Charcoal Filters

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Abstract: **Increasing human civilization is generating large amount of waste and sewage and at the same time demand for water is also increasing. As the available water sources are limited, recycling of sewage has become need of time. Current study involves the construction of filters using charcoal and some antimicrobial agents to filter sewage water. The filter was constructed using layers of charcoal in order of decreasing surface area of adsorption. Characterisation of the filter was done and physical parameters of sewage water before and after filtration were tested. To reduce the microbial load of the filtered water sample, addition of various antimicrobial agents into the filter was done. The antimicrobials used were silver, lemon and 10% vinegar. The microbial load of sample was determined by standard plate count technique and count was found to be TLTC (too less to count), 1.62×10^6 cfu/ml, TLTC (too less to count) for silver, lemon and 10% vinegar respectively. From the obtained results it can be stated that the filter is efficient in sewage water treatment. The obtained water can be recycled and used for recreational purposes like in toilets, for washing purposes, in agriculture, etc.**

Keywords: **Sewage, Filter, Charcoal, Anti-microbial agents.**

I. INTRODUCTION

India accounts for 2.45% of land area and 4% of water resources of the World but represents 16% of the world population. With the present population growth rate, the population is expected to cross 1.5 billion mark by 2050. The Government of India has predicted the demand of water will increase to 1180 Billion Cubic Meters in 2050 with 2.5 times increase in domestic and industrial water consumption [1]. This leaves us with increase in the generation of large amount of waste water and its treatment. Disposal of sewage is important as it may cause pollution and lead to water borne diseases. Direct release without any treatment may have negative impacts on aquatic life, public health and on environment. Oxygen depletion in water may pose threat to aquatic life. Polluted water may cause bacterial and viral infections in human population. To overcome all these problems, in all cities of India sewerage system has been developed. The sewerage system of Mumbai was constructed about 130 years old and it includes 1830 Km long sewer network, 65412 manholes, 51 pumping stations and 7 treatment plants [2]. Treatment of large amount of sewage generated every day is very much tedious and expensive. Hence, to reduce the load from Municipal sewerage system initiatives should be taken at domestic level. The present study involves treatment of sewage water at domestic level with the use of naturally available agents. The agents used for treatment are charcoal, lemon, heavy metal and vinegar. Charcoal was selected as it has good adsorbent property thus can adsorb organic matter present in water more effectively [3]. Heavy metal, lemon and vinegar were used as antimicrobial agents [4], [5], [6], [7]. Thus, the main aim of this research is to construct a filter that can be used at a domestic level to treat sewage water.

II. MATERIALS AND METHODOLOGY

A. Collection of sample:

The domestic sewage water from society drainage was collected in clean and contamination free bottle of 1 litre.

B. Pre-treatment analysis:

Pre analysis of collected sewage sample was carried out in which physic-chemical parameters such as total solids (TS), total dissolved solids (TDS), pH, temperature, colour and odour were checked. Along with above parameters, microbial load was calculated using standard plate count technique. Most probable number was determines by Multiple tube fermentation technique.

C. Construction of filter:

Construction of filter was carried out using charcoal powder and various anti-microbial agents. First filter which was constructed consist of charcoal layer arranged in descending order of their surface of adsorption i.e. activated charcoal, charcoal powder and charcoal beads (Fig. 1). Three combination filters were constructed by incorporating various anti-microbial agents in charcoal filter. First combination filter was composed of Charcoal filter with heavy metal as antimicrobial agent i.e. Silver with charcoal powder (Fig. 2). The second combination filter was constructed using lemon slices (Fig. 3). In this, layer of lemon slices was placed at bottom of charcoal filter. In the third combination filter, charcoal filter was modified by incorporating 10% Vinegar solution in charcoal powder (Fig. 4).

D. Post-treatment analysis:

Sewage water was filtered and analysed for reduction in Physic-chemical parameters and microbial load enumeration.

III. RESULTS

A. Pre-treatment Analysis:

Physico-chemical parameters such as Total Solids (TS), Total Dissolved Solids (TDS), pH, temperature, colour and odour was determined for collected sewage water sample (TABLE I) (Fig. 5). Microbial count was estimated by Standard Plate Count (Fig. 7). where average count was found to be 1.357 x 10^7cfu/ml and 1.272 x 10^7cfu/ml by spread plate and pour plate method respectively (TABLE II). Presence of coliforms in the given sample was carried out by performing MPN test (Fig.8), (Fig. 9). Acid as well as gas production in all tubes confirm the presence of coliforms in given sewage sample (TABLE III). IMViC test was also performed to detect the presence of indicator organism.

TABLE I: Physico-chemical characterisation of sewage sample

Test	Observations
pH	4.5
Temperature	35^{o}C
Odour	Stenching
Colour	Black
TDS	12.7mg/l
TS	5.4mg/l

TABLE II: Total microbial load estimation by Standard plate count

Dilutions	Spread plate count in cfu/ml	Pour plate count in cfu/ml
Average cfu/ml	1.357 x 10^7cfu/ml	1.272 x 10^7cfu/ml

TABLE III: M.P.N analysis of sewage sample

No	Media	Sample	A	B	C	D	E
1	Double strength	10ml	++	++	++	++	++
2	Single Strength	1ml	++	++	++	++	++
3	Single Strength	0.1ml	++	++	++	++	++

Key: '+' acid production, '++' acid and gas production

Fig.1 Charcoal filter

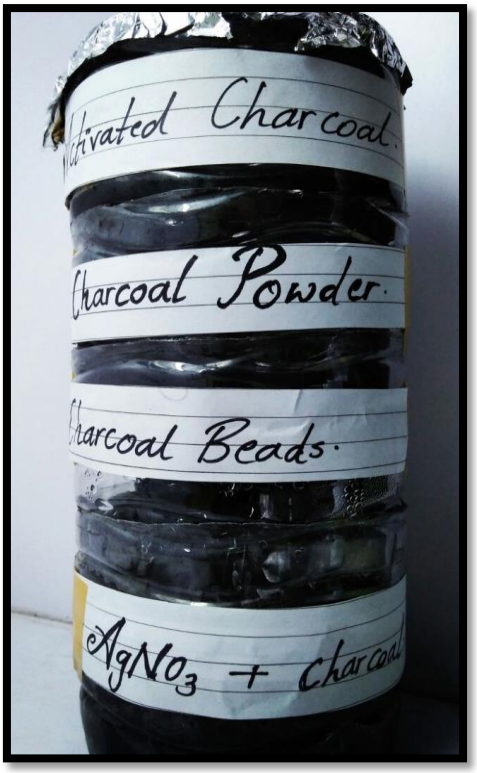

Fig. 2 Combination filter of charcoal with heavy metal

Fig. 3 Combination filter of charcoal with lemon slices

Fig. 4 Combination filter of charcoal 10% Vinegar

B. Treatment of sewage sample using constructed filters:

Collected sewage sample was filtered through charcoal filters and combination filters. For filtration 100 ml of sewage sample was used. Post-filtration, collected water sample was analysed for Physico-chemical parameters and microbial load.

C. Post-treatment Analysis:

Physico-chemical parameters of treated sewage sample through various filters showed marked changes in their characteristics (TABLE IV) (Fig. 6). In case of charcoal filter very high microbial count was reported, which confirms the need of incorporation of anti-microbial agent in charcoal filters. Anti-microbial property was imparted in filters by incorporating heavy metals, lemon slices and 10% vinegar in different combination filters. Sewage sample when filtered through this modified filters, remarkable decrease was reported in microbial load (Fig. 10). Alterations in Physoci-chemical characteristics were also reported (TABLE IV). Decrease in coliform count was also reported after performing MPN of treated sewage sample.

TABLE IV: Physico-chemical and microbial load characterisation of treated sewage sample

Parameters	Charcoal filter	Charcoal filter with heavy metal i.e.Ag	Charcoal filter with lemon slices	Charcoal filter with 10 % vinegar
pH	7.2	7.4	3.5	5.5
Temperature	28^{o}C	28 ^{o}C	28^{o}C	28^{o}C
Colour	Colourless	Colourless	Turbid	Colourless
Odour	Odourless	Odourless	Pungent	Odourless
TS	4.0	2.8	4.8	2.0
TDS	3.0	3.9	4.0	3.4
Spread plate count	TNTC	TLTC	1.62 x 10^{6}	TLTC
Pour plate count	TNTC	TLTC	TLTC	TLTC

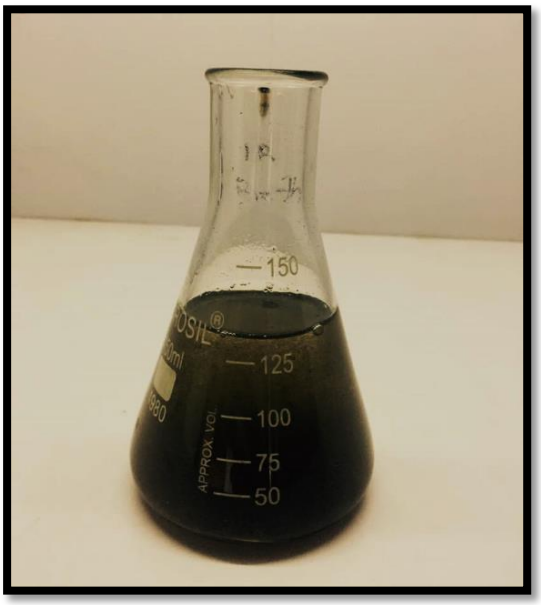

Fig. 5 Sewage water sample

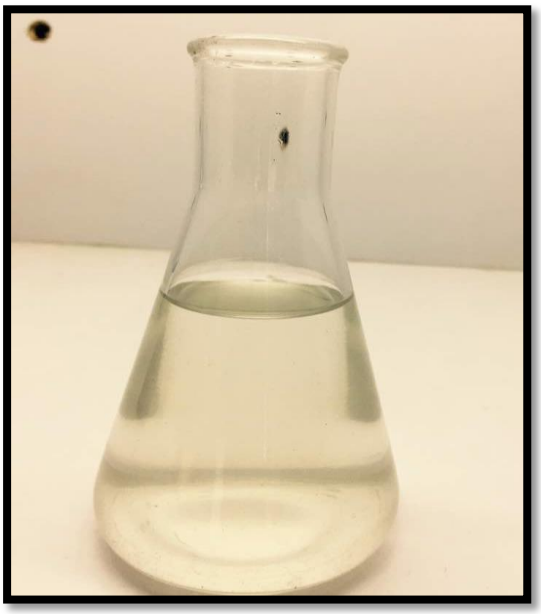

Fig. 6 Filtrate obtained after filtration through filters

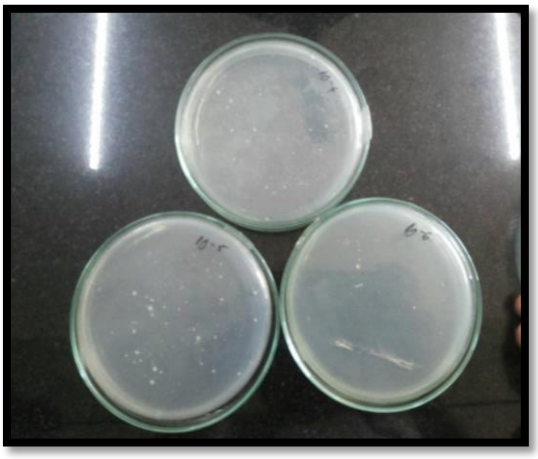

Fig. 7 Microbial count of sewage sample by SPC

Fig. 8 MPN analysis of sewage sample

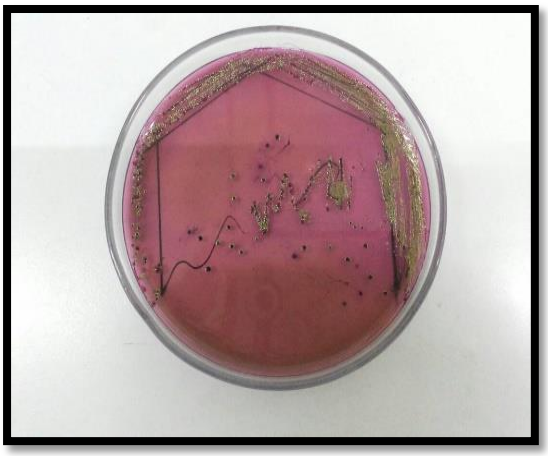

Fig. 9 Confirm test of MPN

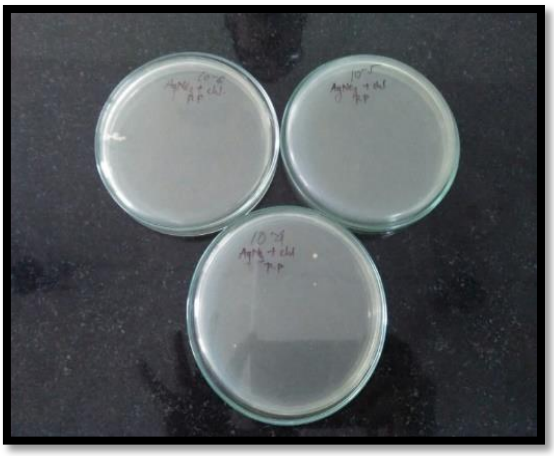

Fig. 10 Microbial count of treated sewage sample by SPC

IV. CONCLUSION

The present study aimed to treat sewage water at domestic level with the help of some unique properties of charcoal, lemon, heavy metal and vinegar. Four charcoal based filters were constructed in which activated charcoal was mainly incorporated as it has good adsorption property. The efficiency of filter was analysed by filtration of 100 ml of sewage water through the filter. Simple charcoal filter effectively decreased total dissolved solids from 12.7 mg/l to 3 mg/l. pH of water has been increased to neutral value. When the microbial load was enumerated of treated sewage, numerous microbial count was reported. Thus, simple charcoal filter may control physical parameters of sewage but will not be efficient to decrease microbial load. Hence, further modification was carried out to increase efficiency and durability of simple charcoal filter to reduce microbial load along with organic content. Three combination charcoal filters were constructed with incorporation of anti-microbial agents such as heavy metal, chemicals and natural agents. Efficiency of these filters in treatment of sewage water was analysed by checking physical parameters and enumerating microbial load. All the three combination filters showed marked changes in physical parameters of sewage water. Also the microbial load was decreased to too less to count. Hence, such combination charcoal filters can be used as a good alternative over commercial filters to treat sewage at domestic level. This filter has advantage over commercial filters that it's construction is relatively simple and it is more cost effective. The sewage from drainage of societies can be passed through the filter in order to obtain clear water which is not toxic as well as reusable. Water obtained by filtration can be used in toilets, to water plants, washing cars etc. Thus the load on natural sources of water can be reduced and the problem of scarcity of water can be resolved.

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