Experimental Research on Treatment of Greywater using a Prototype

S.Christopher Gnanaraj, Ramesh Babu Chokkalingam, S.K.M. Pothinathan, R.Rekha

Abstract: Water is principal standard resource brought by nature. Freshwater deficiency is a noteworthy issue impacts no less than one fifth of the aggregate masses and more will be affected on account of people advancement. Now a days the openness of consumable water isn’t abundant. Hence to satisfy the need and demand, the best course of action is recycling, and treatment of family wastewater except an irreplaceable part for the human activities. We pick diminish water reuse and stimulate near bore well. For this examination unrefined water and bore water is accumulated from three one of a kind domains, which is attempted by physical and naturally while treating. This ask about expected to consider the efficiencies of unravel treatment for greywater reuse with three models using fine aggregates, various sizes of coarse aggregate, powdered activated carbon in view of quick sand channel thought and complexity and bore water standards. Physic-blend parameters viz. turbidity, pH, CHEMICAL OXYGEN DEMAND (COD), DISSOLVED OXYGEN (DO), Total dissolved solids (TDS), Conductivity, Hardness and alkalinity were penniless down. Organic parameters including coli form were finished by two strategies. The empirical formulas were additionally developed utilizing this investigation. The correlation between’s pH-turbidity, pH-EC, pH-DO, pH-BOD, turbidity-Hardness, turbidity-DO, turbidity-COD, BOD-DO, BOD-COD were derived. The expulsion proficiency of pH, turbidity, hardness, ELECTRICAL CONDUCTIVITY(EC), DISSOLVED OXYGEN(DO), BIOLOGICAL OXYGEN DEMAND(BOD) and CHEMICAL OXYGEN DEMAND(COD) were between 50% - 90%, 75% - 90%, 70% - 85%, 50% - 90%, 85% - 99%, 70% - 90% and 55% - 90% individually. It is a convincing system for treatment of diminish water when appeared differently in relation to the standard method so it can be executed on little scale at houses, structures et cetera. The result get also nearer to the ground water of different sources. The best level of capability were high, showing the capacity of the structure, and proposing their change keeping in mind the end goal to achieve ordinary viability.

Keywords: About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Water is important natural resource brought by nature. 70% of global surface is surrounded by water only 30% are fresh water [10]. Now-a-days the availability of potable water is not abundant the amount of water available for use on the planet is very finite. To satisfy the needs and demand the best solution is recycling and treatment of household wastewater because of less contamination. Grey water is the type of wastewater from the household with low contaminations. Grey water is also termed as sullage [1], gets its name from its cloudy appearance and from its status as being neither fresh nor heavily polluted. Sullages have less impurity compared to black water. The Grey water includes bath, shower, hand basin, washing, and kitchen wastewater [2]. Some author removed kitchen wastewater for consideration. The contaminants like disease causing organisms. Chemical from soap, detergents, shampoo, dyes, mouthwash, toothpaste etc. Common contaminants present in grey water are salts, food particles, oil, surfactants, microorganisms [10] Ground water plays a vital role for the human activities. 50-80% of the total household wastewater is greywater [1,3]. Greywater represents up to 70% of total consumed water but contains only 30% of the organic fraction and 9 to 20% of the nutrients [5]. Organic loading is the major difference between greywater and sewage. The cost of treatment is less due to low level of treatment includes sedimentation, filtration and adsorption applied to the greywater. The possible reuse option for the treated water are urinal and toilet flushing, irrigation of lawns, washing of vehicles and windows, and preserve wetlands, recharge into ground, agriculture and etc. Despite the relatively low concentration of contaminants, greywater constituents are known to be recalcitrant [7]. It additionally diminishes the reliance on huge foundations, for example, dams and desalination exchange plants in this way enhancing the nature of freshwater biological systems and lessening clashes over water assets [14]. Reusing of grey water will secure the amphibian biological systems by diminishing the preoccupations of freshwater, lessening the amount of supplements and other dangerous contaminants entering conduits [15]. Grey water regularly contains a different pathogens,Grey water safe utilize requires some cleansing [16]. At the point when grey water is appropriately overseen, it can be a profitable asset for both cultivation and agribusiness producers [17]. The guidelines for dim water reusing relies upon area, application, it typically incorporates parameters, for example, natural, solids and microbiological substance of the water [18].
The contaminants that can be found in grey water involve an expansive scope of xenobiotic substance which is an engineered synthetic, including both natural polluting influences and metals [19]. The advantages of reusing Sullage incorporates crisp water extraction, not very many effect on septic tank, ground water energize, security of ground water table [37]. The reuse of greywater in many parts of the world helps to reduce the usage of potable water by up to 50%, sewage generations and it reduces money and increasing the effective water supply in regions where demand of water is more. Reuse of grey water can be added to the existing water source. Particularly in arid climatic region [4] Reuse of greywater for on-site irrigation is becoming a common practice in entire worldwide, particularly in areas that face water demand. The experimental ideas is to treating of greywater to nearby bore well to satisfy the demand by the concept of rapid sand filter [29] with activated carbon treatment and finding its efficiency and empirical formulas

II. MATERIAL STUDY

I. COARSE AGGREGATE

Coarse aggregates are frequently used to retain coarse particles and to sufficiently reduce turbidity. Coarse layer used as a filter medium. It can be replaced upon cleaning. such pre-filtration can be done either horizontally or vertically. The filtration rates for a coarse filter are lower than those for a conventional filter. The different sizes of coarse aggregates are 6-12mm, 12 -20mm, 20-40mm were sieved then washed 10 times and dried for sometimes and used to fill in the filter for respective depth as per referred journal.

B. FINE AGGREGATE

Fine aggregate works as a physical strainer, a biological renovator and a biological recycler of all wastewater passing through the layer. Sand’s moisture, temperature, acidity and nutrient will make the pathogens present in water to die. The final aggregates of sizes 1mm was collected by sieve and washed for multi time to remove the dust and dried for sometimes and used to fill in the filter as per respective referred by journal.

C. ACTIVATED CARBON

Activated carbon has been used as a water filtering medium for purification of water, which was kept inside the cotton rolls in between the layer of fine aggregates. The purpose of activated carbon is used primarily to remove taste and odor. The powdered activated carbon to remove dissolved organics. It was widely used for removal contaminants in water due to their high capacity for adsorption.it can remove the total suspended solids and BOD effectively over 99% to 1mg/l and also improves the taste and odour of the water.

Physical Adsorption - During this process, the adsorbates are held on the surface of the pore walls by weak forces of attraction known as Van Der Waals Forces or London dispersion forces.

Chemisorption - This involves relatively strong forces of attraction, actual chemical bonds between adsorbates and chemical complexes on the pore wall of the activated carbon.

III. EXPERIMENTAL SET UP

This setup was done with the grey water, as per the journal on the rapid sand filter with activated carbon concept which is collected from three different household greywater. The setup was constructed by PVC pipe. The model of this filter is a circular pipe of 90 mm with 2m long. For this setup we used different size of coarse aggregate, fine aggregate, and powdered activated carbon. The size of the aggregates are listed by, For coarse aggregate 20- 40mm, 12-20 mm, 6-12mm. For fine aggregate 1mm and addition to that activated carbon. The arrangement of the setup in the following order first layer is followed by 20mm of 20cm second layer is about 12mm of 20cm and followed by 6mm of 20cm aggregates next layer by fine aggregate of 10cm and activated carbon layer. For separating this layer plastic screens are used. The inlet and outlet are fitted with top and bottom end of the pipe. The treated grey water will be collected in the separate container.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Layer</th>
<th>Arrangement</th>
<th>Depth</th>
<th>Size And Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>horizontal</td>
<td>10cm</td>
<td>1mm aggregates</td>
</tr>
<tr>
<td>2</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>horizontal</td>
<td>20cm</td>
<td>6-12mm aggregates</td>
</tr>
<tr>
<td>3</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>horizontal</td>
<td>20cm</td>
<td>12-20mm aggregates</td>
</tr>
<tr>
<td>4</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>horizontal</td>
<td>20cm</td>
<td>20-40mm aggregates</td>
</tr>
<tr>
<td>5</td>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Vertical</td>
<td>10cm</td>
<td>1mm aggregates and powdered activated carbon</td>
</tr>
<tr>
<td>6</td>
<td>6&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Vertical</td>
<td>20cm</td>
<td>6-12mm aggregates</td>
</tr>
<tr>
<td>7</td>
<td>7&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Vertical</td>
<td>20cm</td>
<td>12-20mm aggregates</td>
</tr>
<tr>
<td>8</td>
<td>8&lt;sup&gt;th&lt;/sup&gt;</td>
<td>Vertical</td>
<td>20cm</td>
<td>20-40mm aggregates</td>
</tr>
</tbody>
</table>

IV. WORKING OF MODEL

A litre of grey water is poured in the top of sand layer arranged in the horizontal bed. The water simply flows through the sand layer, then followed by coarse aggregate of three different sizes. If any suspended particles present in the greywater are left behind in the top layer of sand easily and contaminnants starts removed in this layer, till the course aggregate layer. It takes some time to filter for purify, the Flowing water through the horizontal bed. After passes through the horizontal bed layer of the filter, it reaches the vertical bed layer which contains sand layer, coarse

Table 3.1 Experimental setup
aggregate as same as that of horizontal bed layer but it contains additional layer of activated carbon in between the sand layer.

V. TESTS AND DISCUSSIONS

A. pH
The pH of grey water before treatment are 8.3, 7.3 and 7.9 and the value after treating the water values ranges between 6.9 to 7.5. The permissible limit for potable water standards is 6.5-8.5.

B. TURBIDITY
Turbiditiy is due to the suspended particles. The turbidity of greywater before treatment are 287, 130, 110 and the values after treating the values obtain from 20 -70. The permissible limit for potable water is 10.

C. HARDNESS
The hardness present in the greywater before the treatment were 45, 52, 47 and hardness after the treatment ranges from 15-25. The permissible limit for potable water is 500.

D. ELECTICAL CONDUCTIVITY (EC)
The electrical conductivity in the greywater before the treatment were 540, 280, 240 and after the treatment it ranges from 180-450. When EC is less than 500 there is no detrimental effect on plants.

E. DISSOLVED OXYGEN (DO)
In raw water and domestic wastes. Dissolved oxygen is the factor which determines whether the biological processes undergoing a change are aerobic and anaerobic. It is a single test which will immediately indicate the sanitary status of streams. The dissolved oxygen present in the greywater before the treatment were 4.8, 5.2, 4.2 and after the treatment it ranges from 1.4-2. The permissible limit for the potable water is 40% saturation.

F. BIOLOGICAL OXYGEN DEMAND (BOD)
The BOD is the amount of oxygen require by bacteria while stabilizing decomposable organic matter under aerobic conditions. Polluted water does not contain sufficient oxygen in solution to maintain aerobic condition during decomposition. BOD present in the greywater before treatment were 3.8, 4.3, 3.3 and after treatment it ranges from 0.5-4.3.

G. CHEMICAL OXYGEN DEMAND (COD)
The COD test is based on the concept that a large majority of organic compounds can be completely oxidized by the action of strong oxidizing agent in acidic medium. The quantity of oxygen require is proportional to organic matter. The COD present in the greywater before the treatment were 600, 500, 400 and after the treatment the value ranges from 130-300.

H. BIOLOGICAL TESTING
Coliform testing is done for both the untreated sample and treated sample and measure the bacteria count. The result obtained was 102 count and in untreated water it is nil. The bacterial count is also measured by the glass plates. The procedures described in this protocol, we should able to perform plating procedures without contaminating media.

Isolate single bacterial colonies by the streak-plating method. Use pour plating and spread plating methods to determine the concentration of bacteria. Perform soft agar overlays when working with phage. The presence of bacteria in un treated water is resulted as 120 counts whereas after treating the result found was nil presence of bacteria.
Experimental Research on Treatment of Greywater Using a Prototype

<table>
<thead>
<tr>
<th>TS- C4</th>
<th>pH</th>
<th>Turbidity</th>
<th>Hardness</th>
<th>EC</th>
<th>DO</th>
<th>COD</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.4</td>
<td>26</td>
<td>19</td>
<td>19</td>
<td>1.6</td>
<td>1.19</td>
<td>180</td>
</tr>
</tbody>
</table>

hardness, EC, DO, BOD, COD ranges 50%-99%, 75%-90%, 70%-85%, 50%-90%, 85%-95%, 5%-90%

Table 6.1 TREATING EFFICIENCY

VII. EMPIRICAL EQUATIONS TO FIND THE WATER QUALITY PARAMETERS AT NTH TRIAL:

Equations have been developed to get the value of various parameter (pH, turbidity, hardness, EC, DO, BOD, COD) after Nth Trial based on the results obtained from 1st, 6th, 11th, 16th and 21st trial.

From this equation, x value be the number of trials for all 1-7(s.no.) the water used to treat, Here mentioned the interval of five trials such as 1st, 6th, 11th, 16th, 21st etc. y be the value get by the equation using x. y value is to find the value of 1.pH, 2. turbidity, 3. hardness, 4. Electrical conductivity, 5. DO, 6. BOD and 7. COD respectively

Table 7.1 EMPIRICAL EQUATION TO FIND THE WATER QUALITY PARAMETERS AT nTH TRIAL.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>PARAMETER</th>
<th>EMPIRICAL EQUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>y = -0.0083x^3 + 0.0893x^2 - 0.2024x + 7.52</td>
</tr>
<tr>
<td>2.</td>
<td>Turbidity</td>
<td>y = 0.3042x^4 - 3.8083x^3 + 16.396x^2 - 26.992x + 84.8</td>
</tr>
<tr>
<td>3.</td>
<td>Hardness</td>
<td>y = 0.5714x - 0.8286x + 15</td>
</tr>
<tr>
<td>5.</td>
<td>DO</td>
<td>y = 2</td>
</tr>
<tr>
<td>6.</td>
<td>BOD</td>
<td>y = -0.0317x^4 + 0.4367x^3 - 2.1783x^2 + 4.6533x - 2.08</td>
</tr>
<tr>
<td>7.</td>
<td>COD</td>
<td>y = 26x + 174</td>
</tr>
</tbody>
</table>

The efficiency of the treatment for various properties were studied and the results were as follows pH, turbidity, hardness, EC, DO, BOD, COD.

Fig 7.1 Vale of pH at various trails

Fig 7.2 Vale of EC at various trails
VIII. CORRELATION BETWEEN pH, TURBIDITY, EC AND HARDNESS

Fig 8.1 Correlation b/w pH and Turbidity for Sample 1

Fig 7.3 Val of DO at various trials

Fig 7.4 Val of Turbidity at various trials

Fig 7.5 Val of BOD at various trials

Fig 7.6 Val of Hardness at various trials

Fig 7.7 Val of COD at various trials
Experimental Research on Treatment of Greywater Using a Prototype

Fig 8.2 Correlation b/w pH and Turbidity for Sample 2

Fig 8.3 Correlation b/w pH and Turbidity for Sample 3

Fig 8.4 Correlation b/w pH and Ec for Sample 1

Fig 8.5 Correlation b/w pH and Ec for Sample 2

Fig 8.6 Correlation b/w pH and Ec for Sample 3

Fig 8.7 Correlation b/w Turbidity and Hardness for Sample 1
Fig 8.8 Correlation b/w Turbidity and Hardness for Sample 2

Fig 8.9 Correlation b/w Turbidity and Hardness for Sample 3

TABLE 8.1 CORRELATION BETWEEN VARIOUS PARAMETERS AND ITS RELATION

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Sample</th>
<th>Equation</th>
<th>Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation b/w pH &amp; Turbidity</td>
<td>1</td>
<td>( y = 0.3042x^4 - 3.8083x^3 + 16.396x^2 - 26.992x + 84.8 )</td>
<td>The relation between the pH &amp; Turbidity are directly proportional to each other. pH increases with turbidity increases</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>( y = 0.0917x^5 - 0.2964x^4 + 0.2119x + 28 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>( y = -0.3x^5 + 3.3286x^4 - 8.1714x^3 + 24.24 )</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Sample</th>
<th>Equation</th>
<th>Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation b/w pH &amp; Ec</td>
<td>1</td>
<td>( y = -2.5x^5 + 30x^4 - 122.5x^3 + 205x + 300 )</td>
<td>The relation between pH and EC. They are directly proportional to each other. pH increases with EC increases</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>( y = 0.8333x^5 - 3.9286x^4 + 5.2381x + 228 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>( y = -1.25x^5 + 14.167x^4 - 53.75x^3 )</td>
<td></td>
</tr>
</tbody>
</table>

IX. CONCLUSION

From the above discussion, the following conclusions are drawn:

- The results reported in the experimental study indicate that the contaminants from the household wastewater may be effectively removed by the rapid sand concept with activated carbon over the other conventional methods.
- From this study, high efficiency with low cost and economical ways of treating raw water technologies were used. This is one of the best ways to treat household wastewater and reusing.
- From this study, the physical method is sufficiently enough to treat, and empirical values are derived to finding the value of respective.

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Experimental Research on Treatment of Greywater Using a Prototype


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