

# Physical Remediation of Grey Waters – A Possible Solution to Clean Cooum River

Naveen A.<sup>1</sup>, Rathnavel Pandian T.<sup>2</sup>, Suresh Babu J.<sup>3</sup>, Kamalakannan Anbarasu<sup>4</sup>

<sup>1,2</sup>Department of Biotechnology, Sri Venkateswara College of Engineering, Sriperumbudur, Tamil Nadu, INDIA

<sup>3</sup>Department of Chemical Engineering, Sri Venkateswara College of Engineering, Tamil Nadu, INDIA

<sup>4</sup>Deputy Manager, Dairy Microbiology Laboratory, Quality Control Department, TCMPPF, Aavin, Sholinganallur, Tamil Nadu, INDIA

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**Abstract:** The Cooum River, an ancient glory of Tamil Nadu, India, is now one of the dump yards for all the waste that the city of Chennai generates. The stretch of Cooum River through the city is extremely polluted. The study tries to investigate the possibility of producing biogas from the sewage waters of Cooum. Water samples were collected from seven different banks along the river and characterized for biogas production by testing for five basic parameters namely; Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Total Dissolved Solids (TDS), Total Suspended Solids (TSS) and pH. The highest COD value obtained was 772 mg.L<sup>-1</sup> at Chennai Central, which wasn't satisfactory for feasible production of biogas. An in-depth analysis of other parameters like comparatively low TDS and TSS values made it possible for the use of common filtration technique to carry out physical remediation of water. Water was passed through two filtering units; gravity sand and carbon filter. The filtering units were optimized for the following parameters; bed height, particle size, diameter of the filter bed and water flow rate. The clear water thus attained was completely characterized. The results obtained were found to be within the permissible limits for potable water, except for increased levels of ammonia. Thus, this water obtained could be used as a source of water for irrigation.

**Keywords:** Cooum River; Biogas; Sand Filter; Carbon Filter; Physical Remediation.

## 1. INTRODUCTION

Cooum River, the urban brook of Chennai, earlier known as the Triplicane River, starts 70 km [Bunch M. J et al, 2001, 2003a] away from the city in Tiruvallur district adjoining the Chennai district. The Cooum River originates from a small rural village in the north most part of Chennai, which bears the same name "Cooum". It is one of the shortest classified rivers pouring into the Bay of Bengal, [Bunch M.J et al, 2003b] currently a drainage course inside Chennai collecting in excess of 75 small tankers of sewage every day. Once a fishing river, it is now a drainage tank because of Chennai's sudden population burst and rapid expansion without prior planning.

In the olden times, Cooum River was used as a fresh source of clean water. Later due to various reasons the drainage discharge of the city was mixed along with the river water and this has made the river contaminated and unfit [Ananthapadmanabhan S, 1998]. for any purpose. Even the color of water flowing in the Cooum River has changed because of this continuous discharge. As off today it is one the most polluted and dirty rivers around the world. The toxicity level of water is also above normal. The total catchment area of the river is about 400 square kilometer and the bed width ranges from 40 m to 120 m. The capacity of the river is 19,500 m<sup>3</sup>.s<sup>-1</sup> and the anticipated flood discharge is around 22,000 m<sup>3</sup>.s<sup>-1</sup> [Gunaselvam M, 1999].

Water sample for analysis of biogas production was collected from around seven different banks along the river and tested for five basic parameters namely; COD, DO, TDS, TSS and pH [Wan Azlina et al, 2009]. The highest COD value obtained was 772 mg.L<sup>-1</sup> at Chennai Central. The values obtained weren't sufficient for feasible production of biogas at any of the seven outlets. A further in-depth analysis of other parameters like comparatively low TDS and TSS [Gilbert M Masters, 2008a] values made it possible for the use of common gravity filtration techniques to carry out physical remediation of water.

Physical remediation is the process of remedying something, in particular of reversing or stopping environmental damage by using physical techniques like sedimentation, coagulation, filtration etc. The two basic gravity filtration units were used to carry out the physical remediation of Cooum water, namely; sand filter and carbon filter. The filter units were optimized for the following parameters; bed height, particle size, diameter of filter bed and water flow rate [Rodgers M et al, 2005] Before passing the water through the filter units, the water was allowed to settle in a sedimentation tank to remove large suspended particles.

The intent of this work was to get pure good quality water which could at least be used for the purpose of gardening and irrigation in parks in and around Chennai. The sand filter basically removes the suspended solids as well as to some extent reduces the total dissolved solids in water. Whereas the carbon filter is used to remove the grayish color of water and also reduce the amount of organic matter present in water [Yuan Tian, 2012]. Finally the water outlet from carbon filter was chlorinated to purify it to a greater extent so that it is suitable for the intended purpose.

## 2. MATERIALS AND METHODS

### 2.1 Analysis of water samples

Water samples were collected from seven different banks along the Cooum River namely; Maduravoyal, Arumbakkam, Aminjikarai, Chetpet, Chennai Central, Chintadripet, Marina Beach Mouth in 500mL sterile sample bottles. The samples were analyzed for five parameters namely COD, DO, TDS, TSS, pH by following the standard protocol [Metcalf & Eddy, 2003a]. The pH of sample was analyzed using a standard pH meter.

### 2.2 Construction of sand and carbon filter

The sand and carbon filter were constructed using PVC pipes open at one end and the flow rate was controlled using a valve. The filtering unit was optimized for the following parameters; bed height, particle size, diameter of filter bed and water flow rate. Figure 1 shows the basic design of filtering units.

The packing material in sand filter differed in micron size of sand used varying from top to bottom in increasing order. Fine particles were placed at the top and gravel sand occupied the bottom most part [Metcalf & Eddy, 2003b]. The water before being pumped into the sand filter was allowed to settle in sedimentation tank for 30 minutes to remove the large suspended particles. The water was then allowed to flow through the sand filter and the flow rate was calculated. The water from the sand filter was again analyzed for the five above mentioned parameters.

The water from sand filter was then passed through carbon filter. Two industrial grade carbon (Grade1 & Grade2) were used in two separate columns, to find out which grade is best for the process. The water was allowed to flow under gravity from the sand filter and outlet flow rate of the carbon filter was estimated. The water collected from the outlet of carbon filter was again subjected to analysis for the above mentioned five parameters.

### 2.3 Chlorination of water

The filtered water was chlorinated with sodium hypochlorite to disinfect the water. To the filtered water 0.5mL of 1M sodium hypochlorite was added per liter, to the filtered water.

The water is allowed to stand for 24h in a tank to remove the odor caused by chlorine.

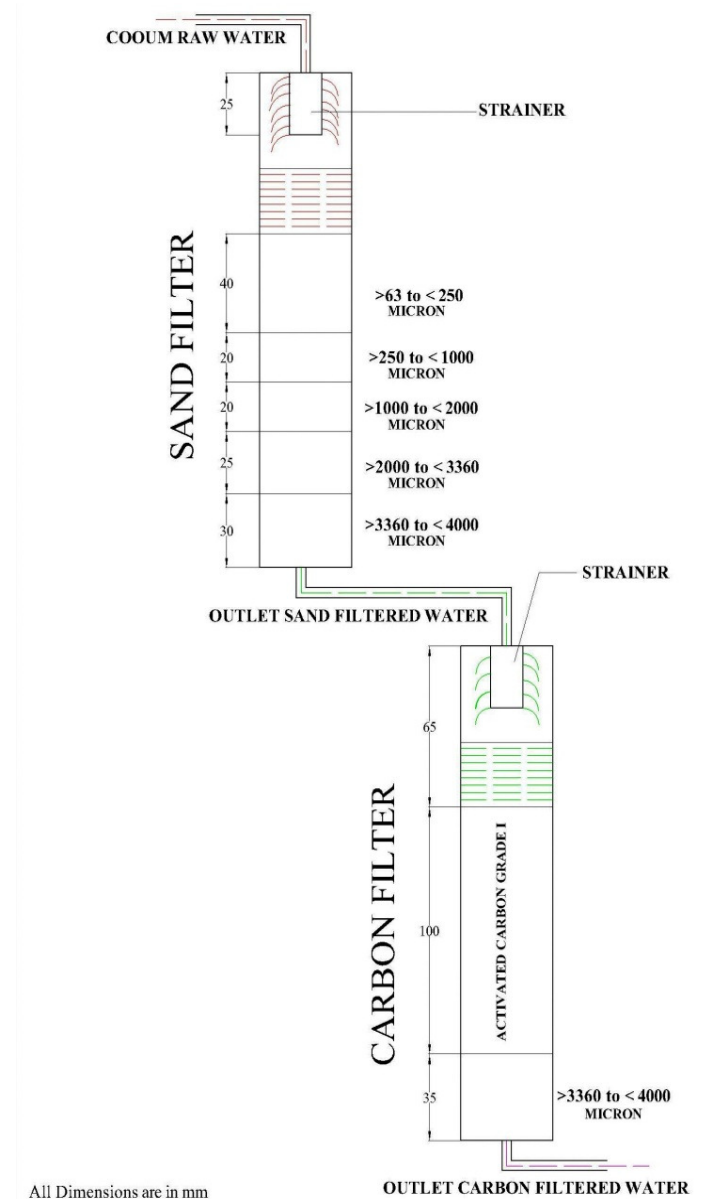


Fig. 1. Optimized design of filtering units [Langenbach K, 2009] [Antonina Torrens, 2009]

### 2.4 Final analysis of water

The filtered water after chlorination was given to King Institute of Preventive Medicine and Research, Guindy, Chennai, to check if the water sample is potable or not. 5L of water was collected in a sterile sample bottle and given for complete characterization of filtered water. King Institute of Preventive Medicine and Research is a Government of Tamil Nadu, India organized institute for analyzing the potability of water. The results were obtained in 15 days.

### 3. RESULTS AND DISCUSSION

#### 3.1 Initial Characterization of Cooum water

The samples collected from 7 different banks of the river were analyzed and the experimental values are reported in Table 1. These values were studied in depth for biogas production.

**Table 1. Experimental values of different water samples.**

S.No.	Place of Collection	COD (mg.L <sup>-1</sup> )	DO (mg.L <sup>-1</sup> )	TSS (mg.L <sup>-1</sup> )	TDS (mg.L <sup>-1</sup> )	pH
1.	Maduravoyal	544	0	45	1010	8.5
2.	Arumbakkam	628	0	78	1020	8
3.	Aminjikarai	756	0	50	1270	8.3
4.	Chetpet	592	0	256	1020	8.5
5.	Chennai Central	772	0	160	1200	8.4
6.	Chindaripet	504	0	355	2110	8.5
7.	Marina Beach Mouth	474	0	1420	4710	8.5

The values obtained had a significant similarity among them. All values when compared, were found to be within a particular range proving that the condition of water is almost similar throughout the city. The average pH value of water in all seven places was around 8.4, giving us a clear idea about the alkaline nature of water and also continuous discharge of human waste into the river [Ayyappan, 2012]. This alkalinity might be mostly due to the presence of dissolved basic salts like ammonia and also due to the presence of carbonates and bicarbonates. The dissolved oxygen content was found to be zero in all the places. This is the main reason for the decrease in the number of flora and fauna species in the river [Rajaram et al, 2008]. This factor favored the production of biogas from the water body, as the production process would face no hindrance from the aquatic life nor will the ecosystem of species growing in the river be affected. The COD values obtained were in the range of 400 to 800 mg.L<sup>-1</sup>, [Gilbert M Masters, 2008b] with the highest value found at Chennai Central (772mg.L<sup>-1</sup>). The COD levels obtained weren't satisfactory for feasible production of biogas.

#### 3.2 Characterization of water after passing through sand and carbon filter

Due to relatively low TDS and TSS values of water samples, the water could be easily be passed through both sand and carbon filter and the water collected was characterized completely. Table 2. reports the five parameters analyzed along with respective experimental values for both sand and carbon filters.

**Table 2. Water analysis after passing through sand and carbon filter**

S. No.	Parameters	Raw Water	Sand Filter	Carbon Filter	
		(Central)		Grade 1	Grade 2
1.	COD (mg.L <sup>-1</sup> )	736	736	256	704
2.	DO (mg.L <sup>-1</sup> )	0	0	4.9	5.0
3.	TDS (mg.L <sup>-1</sup> )	942	929	927	927
4.	TSS (mg.L <sup>-1</sup> )	160	84	84	84
5.	pH	8.5	8	8	8

RESULTS OF EXAMINATION OF SAMPLES OF WATER

Misc-619

From:- Thiru.K.ANBRASU, No.152,Sundaram Pillai Nagar, Tondaiyarpet, Chennai-600 081.

Collected by:- Thiru.K.Anbrasu.

Date of collection	22.08.2012		
Date of Receipt	22.08.2012		
Source as per Label	Well at No.152, Sundaram Pillai Nagar, Tondaiyarpet, Chennai-81.		
<b>Bacteriological Examination</b>			
Total colonies per ml. On agar at 37°C	1800		
MPN of Coliform bacteria per 100ml.	1100		
Nature of Coliform bacteria isolated.	E.Coli I		
<b>Results of vibrio test.</b>			
<b>Physical Examination</b>			
Colour .. .. .	Whitish		
Turbidity .. .. .	20		
Smell .. .. .	Disagreeable		
Total solids (105 Degree C)	1820		
Carbonate hardness as CaCO <sub>3</sub>	292		
Non-Carbonate hardness as CaCO <sub>3</sub>	68		
Total hardness as CaCO <sub>3</sub>	360		
Chlorides as Chlorine	420		
Ammoniacal nitrogen Directness	Present		
Albuminoid nitrogen	-		
Oxygen absorbed (Tidy's test)	7.04		
Nitrate -nitrogen	0.5		
Acidity/Alkalinity Phenolphthalein asCaCO <sub>3</sub>	44		
Methyl Orange	292		
Fluoride as Fluorine	1.0		
pH Value	8.5		
Iron as Fe Total	0.15		
Ferrous	Nil		
Manganese as Mn.	Nil		
Nitrite nitrogen	Trace		
Sulphate	Present		
Phosphate	Trace		
Toxic substance			
2600 CONDUCTIVITY	2180		
Microscopical Examination.	Monas Species, Euplotes sp & Amorphous matter		

**Fig. 2. Complete characterization of treated water (SI Units followed)**

From the data obtained it is found that there is a significant decrease in COD and TSS which is mainly due to carbon and sand filter respectively. Grade 1 carbon filter is found to be more efficient for the process as it decreases COD content to a greater extent when compared to grade 2 carbon. The color of water also significantly reduced from grayish black to yellow in grade 2 carbon and mild whitish in grade 1 carbon. The flow rate was found to be  $1.5\text{L.h}^{-1}$  and  $2.5\text{L.h}^{-1}$  for gravity sand and carbon filter respectively.

### 3.3 Final analysis of water

The water obtained from carbon filter after subjection to chlorination was given to King Institute, Guindy, Chennai for complete characterization. Table 3. shows the complete report given by King Institute.

Chemical analysis reveals that the water obtained from carbon filter is hard in nature with total hardness of  $360\text{mg.L}^{-1}$ . The water is of poor organic purity as evident by presence of ammoniacal nitrogen and high oxygen absorbed (Tidy's Test) value  $7.04\text{mg.L}^{-1}$ . The adverse chemical characteristics of the water sample show that the source of water is subjected to subsoil pollution. Bacteriologically the water is very poor in quality showing evidence of undesirable contamination by the presence of *Escherichia coli* organism of faecal origin. Hence, as such the given water is unfit for human consumption and other household purposes but could be used for gardening and irrigation purpose.

## 4. CONCLUSION

The Cooum River is a polluted river which has been flowing for years through the heart of Chennai. The stinking cesspool has made the city prone to many diseases and at the same time stopped the progress to build a high tech city. Biogas production from cooum waters seems to be a non economical and no gain process because the COD values of water samples obtained are very low when compared to optimal value required for biogas production. In order to utilize this water a simple gravity filtration technique consisting of a slow sand filter and carbon filter can be setup along the banks of the river, so that water gets purified and can be used as a source of water for the gardens in and around Chennai. This will not only utilize the dirty water available in the river in plenty but also help in spreading green energy by providing water for irrigation of gardens. Nature on its own takes care of the recycling of water and this is one additional step in contributing to the nature's ecosystem.

## 5. ACKNOWLEDGMENT

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