Report on removal of bacteria from raw water by filtration through domestic TERAFIL water filter with / without chemical treatment

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September- December 2010

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INTRODUCTION:

TERAFIL[TM] is a sintered red clay porous media useful for purification of drinking water. It is invented by Mr. S. Khuntia, Scientist-G of Institute of Minerals and Materials Technology (Formerly Regional Research Laboratory), Council of Scientific and industrial Research, Bhubaneswar during the year 1998. The TERAFIL[TM] is prepared from the mixture of red clay (silt clay), river sand and wood saw dust; which are highly inexpensive and available abundantly in rural sector of the country. For production of Terafil media; all the materials are first mixed thoroughly at particular proportion and particle sizes, then puged with water, molded in desired shape, dried under sun and sintered at elevated temperature to obtain 'Terafil' water filtration media.

During sintering of Terafil, the wood particles are burnt and clay particles are sintered around the sand particles leaving elliptical / circular large size pores in between. The pores are not connected with each other unlike white ceramic water filter candles. These pores are separated by very thin clay walls (membranes) which are semi-permeable in nature. The thin clay walls contain a large numbers of ultra-fine capillary openings. The capillary openings bridge a set of the large pores on either sides of a thin clay wall. During filtration process, water flows from one pore to another pore through the capillary openings by the pressure of water on the Terafil and the pores always function like micro-reservoirs for holding water inside the Terafil. Water able to flow easily through the capillary openings even at very less pressure of raw water, since thickness of the ultra fine clay walls is very less, within 100 micron. When a Terafil media (disc) is fixed at the bottom of a container and raw water is allowed to pass through the Terafil, the raw water is filtered leaving behind the sediments and impurities on top surface of the Terafil. Diameter of capillary openings is within 0.2 to 0.3 micron which is much smaller than size of most of the microbes and suspended particles present in raw water. Therefore almost all suspended particles & microbes etc. can not travel with water inside the Terafil during filtration process. Generally these sediments are removed from top surface of Terafil time to time and core of Terafil never gets clogged unlike white ceramic candle. So long operational life of Terafil is obtained easily. The red clay of Terafil is activated during sintering process and negatively charged. Therefore soluble iron and some heavy metals present in raw water are also removed by ion-exchange or adsorption process and the same get precipitated on the top surface of the Terafil in long run. In this way turbid raw water can be filtered and treated into clean drinking water. About 99% of turbidity, 90-95% of micro-organisms, 90-95% of soluble iron, colours etc. are effectively removed from the raw water during filtration process through the Terafil. Removal of 100% bacteria can be achieved when about 0.003 gm/lit of normal bleaching powder is added to the filtered water. Average rate of filtration of turbid raw water (50-100NTU) with 250mm water head over the Terafil disc is 13ml/hr per cm^2 of top surface area of Terafil disc. Rate of filtration increases by many folds at higher water pressure. The average turbidity of the product water is 0.5 – 3 NTU irrespective of any high turbid raw water is used. Iron content of the filtered water is within 0.3 mg/lit, permissible limit of BIS. More over the pH of water is always improved during filtration of acidic water. Therefore Terafil water filter is able to provide good quality clean drinking water from surface or ground water sources for a long period with minimal expenditure.

However it was required to test efficacy of Terafil water filtration disc for removal of total coliform as per standard test protocol. Therefore studies for removal of bacteria through Terafil candles were carried out continuously for 30 days by the project staff of the project RSP-29 in Rural Tech laboratory of IMMT (CSIR), Bhubaneswar-751013.

SEM pictures of Terafil disc
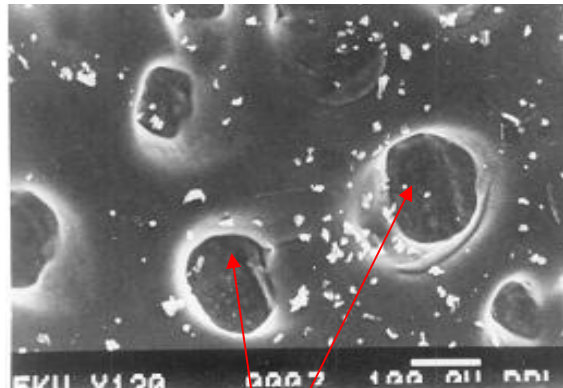
Pore
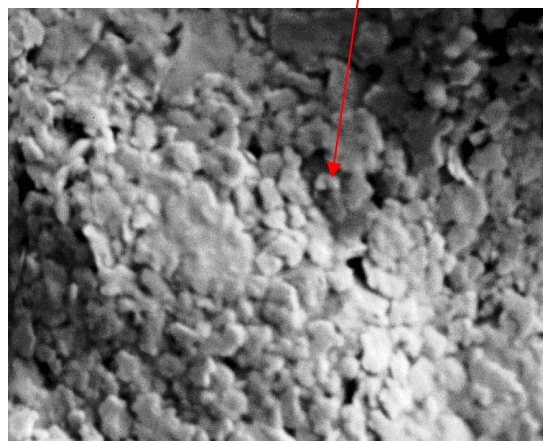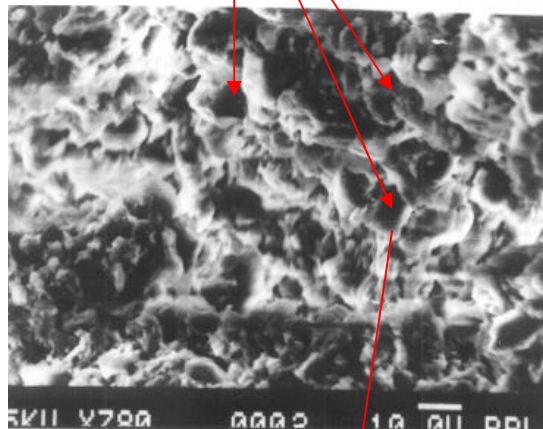
Capillary openings in thin clay wall (membrane) separating pore

Performance study of 30 ltr. capacity Domestic Terafil Water Filter, fitted with food grade plastic container and three sets of 100 mm diameter Terafil disc for removal of bacteria, with & without treatment with normal bleaching powder.

**100 mm diameter Terafil water filtration disc
fitted with food grade plastic holder**
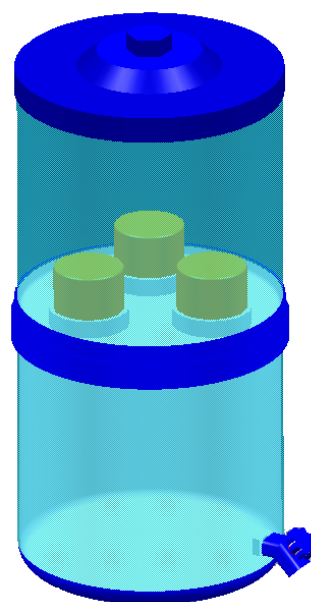
30 Ltr. capacity Terafil water filter fitted with 100 mm. diameter Terafil disc.

Methodology:

15 sets of 100 mm diameter Terafil water filtration disc were collected randomly from M/S. Modern Pottery Industry, Bhubaneswar, a manufacturer of Terafil water filter & licensee of IMMT (CSIR), Bhubaneswar since the 2000. These candles were fitted with five sets of Terafil water filter containers for filtration of raw water and study removal of bacteria during filtration through Terafil disc as well as by chemical treatment of raw water.

Following parameters were studied for continuous 30 days.

- Source of Raw water   :   Vanivihar lake, Utkal University, Bhubaneswar
- Quality of raw water   :   Lake Water is contaminated with sewerage water of domestic & hospital from nearby areas.
- Total coliform count in raw water without chemical treatment.
- Total coliform count in product water after filtration through Terafil water filter without chemical treatment.

- Total coliform count in raw water after treatment with different quantities of normal bleaching powder (30-32% chlorine).
- Total coliform count in product water after filtration of bleaching powder treated raw water.
- Chlorine in normal bleaching powder.
- Free chlorine in treated raw & filtered water.
- Iron, pH, Turbidity, TDS, Temperature and rate of filtration

Analysis of both raw & product water were carried out simultaneously as per the protocols of **standard methods of examination of water, Ed. 2.1 1993-01Indian Standard Drinking water – Specifications of Bureau of Indian Standard.**

(A) Total Coliforms:

The total coliform group includes the entire aerobic and facultative anaerobic gram negative, non-spore forming rod shaped bacteria, which ferment lactose with gas formation at 37°C.

Method Used: standard plate count
The standard plate count procedure provides a standardized means of determining the density of aerobic and facultative anaerobic heterotrophic bacteria in water. This is an empirical measurement because bacteria occur singly, in pairs, chains, clusters or packets and no single growth medium of all bacteria in a water sample.

Medium Used: Mac Conkey Agar (MERCK- 61935505001730) for microbiology. (Mag. Date: April 2009, Expire. Date: March 2012)
USP/IP and EP recommended medium for isolation and differentiation of Coliforms and enteric pathogens based on lactose fermentation.

Test protocol followed was IS: 3025-(Part-10)1984.

(B) Turbidity:

Turbidity was measured on comparison of the intensity of light scattered by the sample with the intensity of light scattered by a standard reference suspension under the same conditions. Higher the intensity of scattered light, higher the turbidity. **Eutech make, TN-100** was used for measuring the turbidity. The unit of turbidity is NTU. Minimum detectable limit of the instrument is 0.02 and maximum is upto 500 NTU
Test protocol followed was IS: 1622-1981.

(C) Iron as Fe: (Total Iron)

Iron as Fe was estimated calorimetrically by **Spectroquant Nova-60**. The unit of iron is mg/ltr. Minimum detectable limit of the instrument is 0.01mg/l and maximum is 5mg/l.

Test protocol followed was standard methods of examination of water, Ed. 2.1 1993-01Indian Standard Drinking water.

(D) TDS:

TDS was measured by **WTW Multi 350i TDS METER**. The unit of TDS is mg/ltr. Minimum detectable limit of the instrument is 1.0 mg/l and maximum is 2000 mg/l

(E) pH:

The pH was measured by **WTW Multi 350i** pH meter.

(H) Chlorine:

Chlorine was estimated calorimetrically by **Spectroquant Nova-60.** The unit of Cl_2 is mg/ltr. Minimum detectable limit of the instrument is 0.01mg/l and maximum is 6.0 mg/l.

Source of Raw water : Vanivihar Lake (Mixed with sewerage water from hospital & domestic households)

Table-1

Cycle No.	DATE	RAW WATER						FILTERED WATER (After filtration through TERAFIL disc(candles)) (with out any chemical treatment)					% OF BACTERIA REDUCTION
		pH	TURBIDITY (NTU)	IRON (mg/l)	TDS (mg/l)	TEMP. (°C)	TOTAL COLIFORMS 24 HOURS (CFU/ML)	pH	TURBIDITY (NTU)	IRON (mg/l)	TDS (mg/l)	TOTAL COLIFORMS 24 HOURS (CFU/ML)	
0th	26.9.10	7.13	0.07	0.02	198	26.0	*(With sterile distilled water)* 00	7.09	0.04	0.01	246	00	--
1st	27.9.10	7.23	21.6	2.24	263	26.5	3.17×10^6	7.02	0.62	0.13	261	4.3×10^2	99.9864
2nd	28.9.10	7.11	25.3	2.69	284	27.0	3.63×10^6	7.20	0.72	0.12	271	3.7×10^2	99.9898
3rd	29.9.10	6.92	24.7	2.97	256	27.5	3.51×10^6	7.09	0.53	0.12	251	3.8×10^2	99.9891
4th	30.9.10	6.98	29.3	2.66	269	27.0	3.46×10^6	7.13	0.63	0.13	257	3.7×10^2	99.9893
5th	1.10.10	7.14	25.3	2.76	263	26.5	3.12×10^6	7.51	0.88	0.15	249	5.4×10^2	99.9826
6th	4.10.10	4.16	22.3	2.58	272	26.0	2.37×10^6	7.63	0.42	0.14	263	5.5×10^2	99.9767
7th	5.10.10	7.02	25.9	2.41	266	25.0	2.48×10^6	7.71	0.47	0.12	237	4.6×10^2	99.9814
8th	6.10.10	7.12	28.6	2.06	267	24.0	2.51×10^6	7.66	0.96	0.17	260	4.6×10^2	99.9816
9th	8.10.10	7.06	40.3	1.64	243	27.0	2.76×10^6	7.51	1.15	0.20	244	4.8×10^2	99.9826
10th	11.10.10	7.04	24.7	2.00	258	28.5	2.89×10^6	7.97	1.12	0.19	230	4.8×10^2	99.9833
11th	12.10.10	7.02	20.5	1.83	251	27.5	2.86×10^6	8.02	1.08	0.19	228	3.9×10^2	99.9863
12th	13.10.10	7.05	22.5	1.98	249	27.0	2.77×10^6	7.98	1.02	0.20	238	3.6×10^2	99.9870
13th	14.10.10	7.04	18.8	1.93	253	26.5	2.34×10^6	7.69	1.03	0.20	266	3.8×10^2	99.9837
14th	15.10.10	7.11	24.2	2.01	254	24.5	2.68×10^6	7.61	0.97	0.18	260	4.7×10^2	99.9824
15th	19.10.10	6.96	19.9	2.02	258	29.0	2.82×10^6	8.10	1.15	0.15	215	4.9×10^2	99.9826
16th	20.10.10	7.02	21.5	1.98	253	24.0	2.73×10^6	8.02	1.02	0.14	263	4.5×10^2	99.9835

Cycle No.	DATE	RAW WATER						FILTERED WATER (After filtration through TERAFIL disc(candles)) (with out any chemical treatment)					% OF BACTERIA REDUCTION
		pH	TURBIDITY (NTU)	IRON (mg/l)	TDS (mg/l)	TEMP. (°C)	TOTAL COLIFORMS 24 HOURS (CFU/ML)	pH	TURBIDITY (NTU)	IRON (mg/l)	TDS (mg/l)	TOTAL COLIFORMS 24 HOURS (CFU/ML)	
17th	21.10.10	7.08	25.8	2.03	258	24.5	2.78×10^6	8.05	0.96	0.16	238	5.4×10^2	99.9805
18th	22.10.10	7.10	19.16	1.97	256	28.7	2.83×10^6	7.50	1.12	0.14	220	5.1×10^2	99.9819
19th	25.10.10	7.09	21.7	2.06	262	27.7	2.88×10^6	7.65	1.15	0.20	224	5.4×10^2	99.9812
20th	26.10.10	7.08	22.5	2.01	260	27.5	2.76×10^6	7.95	1.08	0.22	228	5.9×10^2	99.9786
21st	27.10.10	7.02	23.5	2.04	255	24.5	2.81×10^6	7.60	1.15	0.23	219	5.7×10^2	99.9797
22nd	28.10.10	7.10	26.5	2.05	253	27.5	2.83×10^6	7.65	1.10	0.23	223	4.9×10^2	99.9826
23rd	29.10.10	7.04	25.2	1.99	254	27.3	2.79×10^6	7.81	1.06	0.22	225	5.1×10^2	99.9817
24th	01.11.10	7.08	25.8	2.18	260	25.5	2.86×10^6	7.53	1.12	0.22	232	3.7×10^2	99.9870
25th	02.11.10	7.11	26.8	2.03	266	26.2	2.81×10^6	7.78	1.08	0.23	238	5.9×10^2	99.9790
26th	03.11.10	6.98	29.1	2.16	260	25.6	2.87×10^6	7.51	1.09	0.21	247	3.0×10^2	99.9895
27th	04.11.10	7.08	30.2	2.06	261	26.5	2.79×10^6	7.41	1.02	0.29	257	3.8×10^2	99.9863
28th	08.11.10	7.02	25.5	2.01	260	26.2	2.83×10^6	7.59	1.01	0.28	253	4.5×10^2	99.9840
29th	09.11.10	6.99	24.5	2.12	265	27.2	2.86×10^6	7.65	1.03	0.22	264	4.1×10^2	99.9856
30th	10.11.10	6.98	28.0	2.32	270	27.6	2.91×10^6	7.41	1.04	0.23	268	1.56×10^3	99.9463
31st	11.11.10	7.01	28.6	1.43	271	27.1	2.89×10^6	7.45	1.0	0.21	275	8.9×10^2	99.9692
32nd	12.11.10	7.06	29.7	1.44	274	27.7	2.87×10^6	7.55	1.45	0.25	280	8.8×10^2	99.9693
33rd	15.11.10	6.98	27.2	1.42	268	27.8	2.86×10^6	7.41	1.0	0.25	277	8.6×10^2	99.9699
34th	16.11.10	6.97	30.0	1.46	278	26.9	2.96×10^6	7.67	1.23	0.28	313	7.7×10^2	99.9739
35th	18.11.10	7.02	27.4	1.54	274	26.0	2.99×10^6	7.72	1.28	0.29	281	8.2×10^2	99.9725
36th	19.11.10	6.95	28.5	1.58	271	28.9	2.91×10^6	7.69	1.87	0.28	280	7.6×10^2	99.9738
0th	22.10.10	7.10	0.05	0.06	195	28.5	(With sterile distilled water) 00	7.3	0.04	0.01	239	00	---

NOTE: 15 liters of raw water are filtered through each sample TERAFIL water filters every day. Terafil discs were cleaned periodically by scrubbing with nylon brush & cleaned with the raw water. Terafil discs were not replaced during the experiments.

OBSERVATIONS VIS-À-VIS EFFICACY STUDY

Analytical results obtained during the cycle tests with respect to parameters; turbidity, Iron, pH, TDS & total Coliforms are illustrated in tables-1 & 2 respectively, from which following observations are noticed.

1. **Turbidity**

Experimental raw water exhibiting maximum 45 NTU of turbidity was passed through the Terafil discs. 30-cycles of filtration indicated the turbidity in the filtrate ranging between 0.3-1.19 NTU with the turbidity removal efficiency varying 97.35 to 99.33%. Turbidity in the filtrate obtained in all the 30- cycles, was found well within the desirable limit 5.0 NTU, as prescribed by the Indian Standard of Drinking Water IS: 10500-1991.

Fig-1: Efficiency of filtration by Terafil disc for reduction of turbidity (Without chemical treatment)
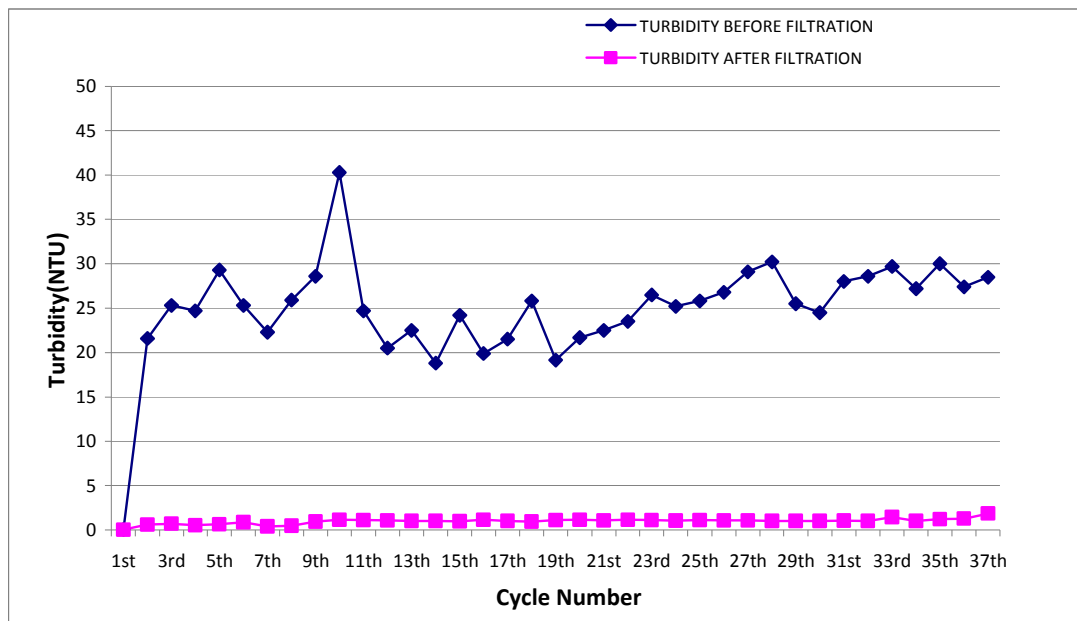

2. **pH**

pH of raw water ranges from 7.2 to 8.5 was passed through the filter. 30-cycles of filtration indicated the pH in the filtrate ranging between the desirable limit 6.5 to 8.5.

3. **Iron**

30-cycles test was conducted with the experimental raw water ranging from 1.64 to 2.97 mg/ltr. In the filtrate, iron was found ranging between 0.08 to 0.29 mg/ltr. Thereby, indicating the iron removal efficiency varying between 90.23 to 95.12%. Iron (as Fe) in the filtrate obtained during all the cycles, was found below the desirable limit 0.30 mg/l, as prescribed by the Indian Standard of Drinking Water IS: 10500-1991. However, it was observed in the 0th cycle test,

with water containing iron (as Fe) < 0.02 mg/l, was conducted, in which filtered water also indicated iron (as Fe) <0.01 mg/l.

Fig-2: Efficiency of filtration by Terafil disc for reduction of iron (without chemical treatment)
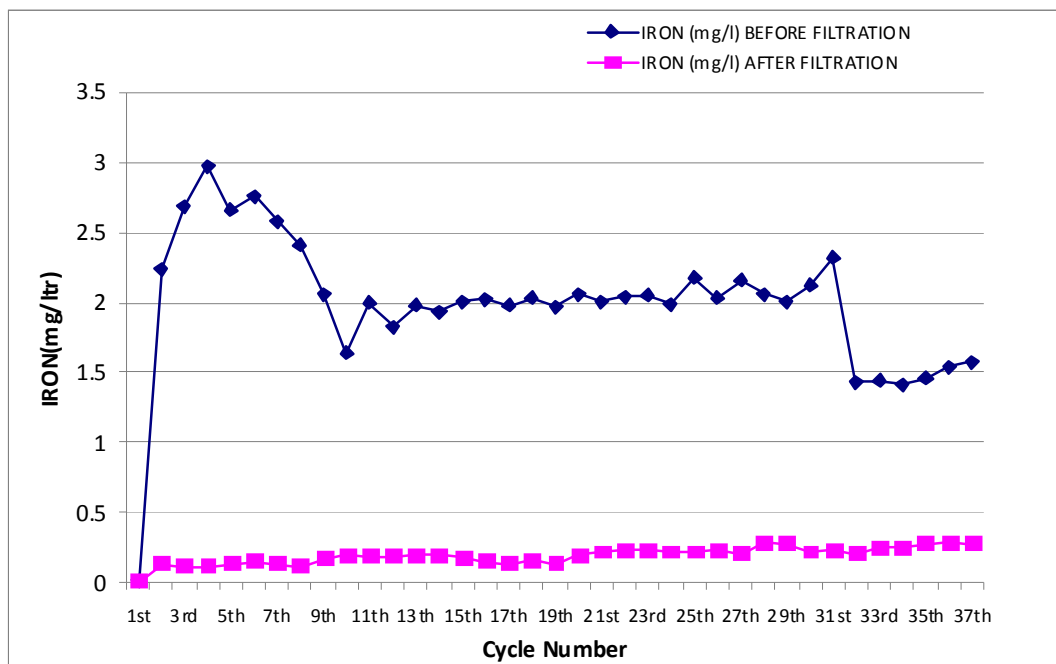
4. Total Coliforms

Experimental raw water was collected from Vanibihar lake which was mixed with domestic & hospital sewage water. The total coliform microorganisms were obtained in the range of 2.34 to 3.67 million per ml of raw water, was passed through the Terafil discs. 30 cycles of filtration indicated 370 to 890 total Coliforms per ml of water, in the filtered sample. However, 0th cycle tests, with water containing zero Coliforms, was conducted before 1st cycle & after 36th cycle, in which filtered water indicated the presence of Zero total Coliforms.

As per Indian standard specification of Drinking Water IS: 10500-1991 total Coliforms should be absent in drinking water.

Therefore raw water was treated with bleaching powder (30% chlorine) at different concentration and then filtered through the Terafil disc to study the efficiency of removal of microorganisms.

Three different concentration of chlorine (1mg/l, 2mg/l & 3mg/l of bleaching powder) were taken and mixed with raw water before filtration. The treated raw water was allowed to stand for an hour prior to filtration. Total coliform count in the treated raw water was reduced to 1.52-$2.94(x10^4)$ when 1mg/l bleaching powder was added to the raw water; total coliform reduced to 1.19-$2.72(x10^3)$ when 2mg/l bleaching powder was added to the raw water, and total coliform in raw water was reduced to zero when 3mg/l bleaching powder was added to the raw water.

Then the above mentioned treated raw water were passed through three different Terafil water filter for 30 days and total coliform count in the filtered water were obtained. The results are mentioned in table-2. Chlorine concentration in bleaching powder is 30% by weight.

Table-2

Sl. no	Date	Total Coliforms in raw water (CFU/ML)	Quantity of bleaching powder added (mg/lit)	Total coliform in raw water (After treatment with bleaching powder)		Total coliform in filtered water (After filtration through Terafil)	
				Total Coliforms (CFU/ML) After 24 hours	% of reduction	Total Coliforms (CFU/ML) After 24 hours	% of reduction
1st	27.09.10	3.17×10^6	1mg	23400	99.2618	270	99.9914
			2mg	1860	99.9413	NIL	100
			3mg	NIL	100	NIL	100
2nd	28.9.10	3.63×10^6	1mg	22300	99.3856	260	99.9928
			2mg	1770	99.9512	NIL	100
			3mg	NIL	100	NIL	100
3rd	29.9.10	3.51×10^6	1mg	19200	99.4529	330	99.9905
			2mg	1590	99.9547	NIL	100
			3mg	NIL	100	NIL	100
4th	30.9.10	3.46×10^6	1mg	21500	99.3786	380	99.9890
			2mg	1890	99.9453	NIL	100
			3mg	NIL	100	NIL	100
5th	1.10.10	3.12×10^6	1mg	22200	99.2884	350	99.9887
			2mg	2190	99.9298	NIL	100
			3mg	NIL	100	NIL	100
6th	4.10.10	2.37×10^6	1mg	23900	98.9915	390	99.9835
			2mg	2250	99.9050	NIL	100
			3mg	NIL	100	NIL	100
7th	5.10.10	2.48×10^6	1mg	23800	99.0403	330	99.9866
			2mg	1520	99.9387	NIL	100
			3mg	NIL	100	NIL	100
8th	6.10.10	2.51×10^6	1mg	26200	98.9561	350	99.9860
			2mg	2100	99.9163	NIL	100
			3mg	NIL	100	NIL	100
9th	8.10.10	2.76×10^6	1mg	25900	99.0615	350	99.9873
			2mg	1400	99.9492	NIL	100
			3mg	NIL	100	NIL	100
10th	11.10.10	2.89×10^6	1mg	27200	99.0588	500	99.9826
			2mg	2000	99.9307	NIL	100
			3mg	NIL	100	NIL	100
11th	12.10.10	2.86×10^6	1mg	26700	99.0664	270	99.9905
			2mg	1860	99.9349	NIL	100
			3mg	NIL	100	NIL	100
12th	13.10.10	2.77×10^6	1mg	22300	99.1949	270	99.9902
			2mg	1770	99.9361	NIL	100
			3mg	NIL	100	NIL	100
13th	14.10.10	2.34×10^6	1mg	19200	99.1794	300	99.9871
			2mg	1590	99.9320	NIL	100
			3mg	NIL	100	NIL	100
14th	15.10.10	2.68×10^6	1mg	26600	99.0074	460	99.9828
			2mg	1890	99.9294	NIL	100
			3mg	NIL	100	NIL	100
15th	19.10.10	2.82×10^6	1mg	19100	99.3226	230	99.9918
			2mg	1190	99.9578	NIL	100
			3mg	NIL	100	NIL	100
16th	20.10.10	2.73×10^6	1mg	26200	99.040	350	99.9871
			2mg	1710	99.9373	NIL	100
			3mg	NIL	100	NIL	100
17th	21.10.10	2.78×10^6	1mg	27700	99.0035	310	99.9888
			2mg	1500	99.9460	NIL	100
			3mg	NIL	100	NIL	100
18th	22.10.10	2.83×10^6	1mg	26400	99.0671	330	99.9883
			2mg	1470	99.9480	NIL	100
			3mg	NIL	100	NIL	100

Sl. no	Date	Total Coliforms in raw water (CFU/ML)	Quantity of bleaching powder added (mg/lit)	Total coliform in raw water (After treatment with bleaching powder)		Total coliform in filtered water (After filtration through Terafil)	
				Total Coliforms (CFU/ML) After 24 hours	% of reduction	Total Coliforms (CFU/ML) After 24 hours	% of reduction
19th	25.10.10	$2.88×10^6$	1mg	28200	99.0208	200	99.99305
			2mg	1990	99.9309	NIL	100
			3mg	NIL	100	NIL	100
20th	26.10.10	$2.76×10^6$	1mg	27900	98.9891	350	99.9873
			2mg	1900	99.9311	NIL	100
			3mg	NIL	100	NIL	100
21st	27.10.10	$2.81×10^6$	1mg	27100	99.0355	350	99.9875
			2mg	1790	99.9362	NIL	100
			3mg	NIL	100	NIL	100
22nd	28.10.10	$2.83×10^6$	1mg	27000	99.0459	350	99.9876
			2mg	1980	99.93003	NIL	100
			3mg	NIL	100	NIL	100
23rd	29.10.10	$2.79×10^6$	1mg	27000	99.0322	340	99.9878
			2mg	1830	99.9344	NIL	100
			3mg	NIL	100	NIL	100
24th	01.11.10	$2.86×10^6$	1mg	26800	99.0629	230	99.9919
			2mg	2030	99.92902	NIL	100
			3mg	NIL	100	NIL	100
25th	02.11.10	$2.81×10^6$	1mg	26700	99.0498	330	99.9882
			2mg	2090	99.9256	NIL	100
			3mg	NIL	100	NIL	100
26th	03.11.10	$2.87×10^6$	1mg	23900	99.1672	140	99.9951
			2mg	1890	99.9341	NIL	100
			3mg	NIL	100	NIL	100
27th	04.11.10	$2.79×10^6$	1mg	24200	99.1326	250	99.9910
			2mg	1990	99.9286	NIL	100
			3mg	NIL	100	NIL	100
28th	08.11.10	$2.83×10^6$	1mg	27000	99.0459	260	99.9908
			2mg	2080	99.9265	NIL	100
			3mg	NIL	100	NIL	100
29th	09.11.10	$2.86×10^6$	1mg	27300	99.0454	290	99.9893
			2mg	2110	99.9262	NIL	100
			3mg	NIL	100	NIL	100
30th	10.11.10	$2.91×10^6$	1mg	27000	99.0721	310	99.9893
			2mg	2110	99.9274	NIL	100
			3mg	NIL	100	NIL	100
31st	11.11.10	$2.89×10^6$	1mg	27200	99.0588	290	99.9899
			2mg	2210	99.9235	NIL	100
			3mg	NIL	100	NIL	100
32nd	12.11.10	$2.87×10^6$	1mg	26900	99.0627	320	99.9888
			2mg	2320	99.9191	NIL	100
			3mg	NIL	100	NIL	100
33rd	15.11.10	$2.86×10^6$	1mg	27000	99.0559	330	99.9884
			2mg	2330	99.9185	NIL	100
			3mg	NIL	100	NIL	100
34th	16.11.10	$2.96×10^6$	1mg	27500	99.0709	390	99.9868
			2mg	2360	99.9202	NIL	100
			3mg	NIL	100	NIL	100
35th	18.11.10	$2.99×10^6$	1mg	27400	99.0836	400	99.9866
			2mg	2220	99.9257	NIL	100
			3mg	NIL	100	NIL	100
36th	19.11.10	$2.91×10^6$	1mg	26800	99.0790	340	99.9883
			2mg	2290	99.9213	NIL	100
			3mg	NIL	100	NIL	100

It has been noted from the table-2 that when raw water is treated with 2mg/lit bleaching powder followed by filtration through Terafil, bacterial count in filter water in nil. Bacteria count in the treated raw water (before filtration) is bellow 2330 CFU/ml. Therefore to confirm this value, sterile distilled water is sting with different quantity of raw water and the mixture is filtered through Terafil filter to study efficiency of removal of bacteria. The results are mentioned in table-3.

Table-3
Removal of bacteria through filtration by Terafil candles
(By diluting contaminated raw water of Vanivihar lake with sterile distilled water)

Sl. No.	Date	Amount of sterile distilled water	Amount of raw water added to 10 lit distilled water	Total Coliforms after 24 hrs (CFU/ml)		Reduction through filtration (%)
				Raw water	**Filter water**	
01	25.11.10	10 Ltrs.	2ml	1200	NIL	100
02	26.11.10	10 Ltrs.	3ml	1550	NIL	100
03	27.11.10	10 Ltrs.	4ml	1760	NIL	100
04	28.11.10	10 Ltrs.	5ml	2120	NIL	100
05	01.12.10	10 Ltrs.	6ml	2460	NIL	100
06	07.12.10	10 Ltrs.	6ml	2510	NIL	100
07	08.12.10	10 Ltrs.	7ml	2970	44	98.5185
08	02.12.10	10 Ltrs.	7ml	3030	50	98.3498
09	03.12.10	10 Ltrs.	8ml	3460	150	95.6647
10	12.12.10	10 Ltrs.	8ml	3530	170	95.1841
11	06.12.10	10Ltrs.	9ml	3720	190	94.8924

Fig-3: Efficiency of removal of microorganisms through filtration in Terafil disc (without chemical treatment).
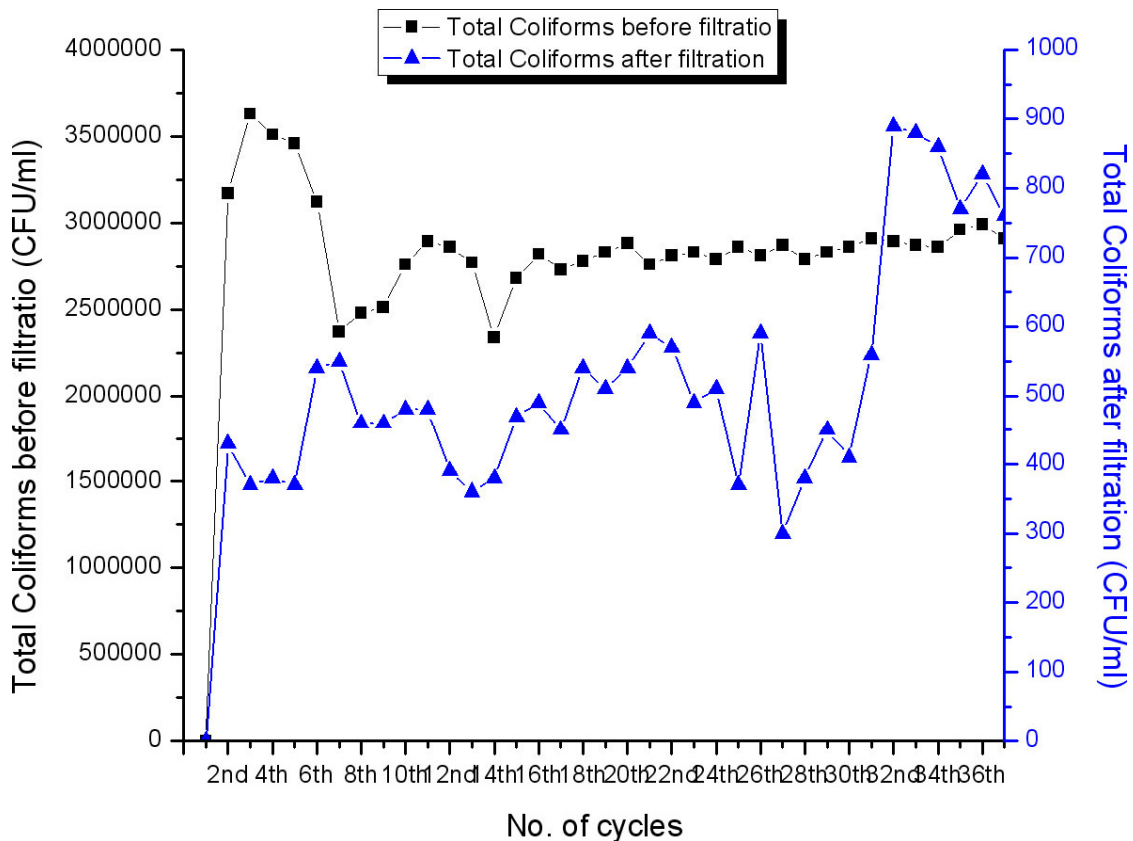

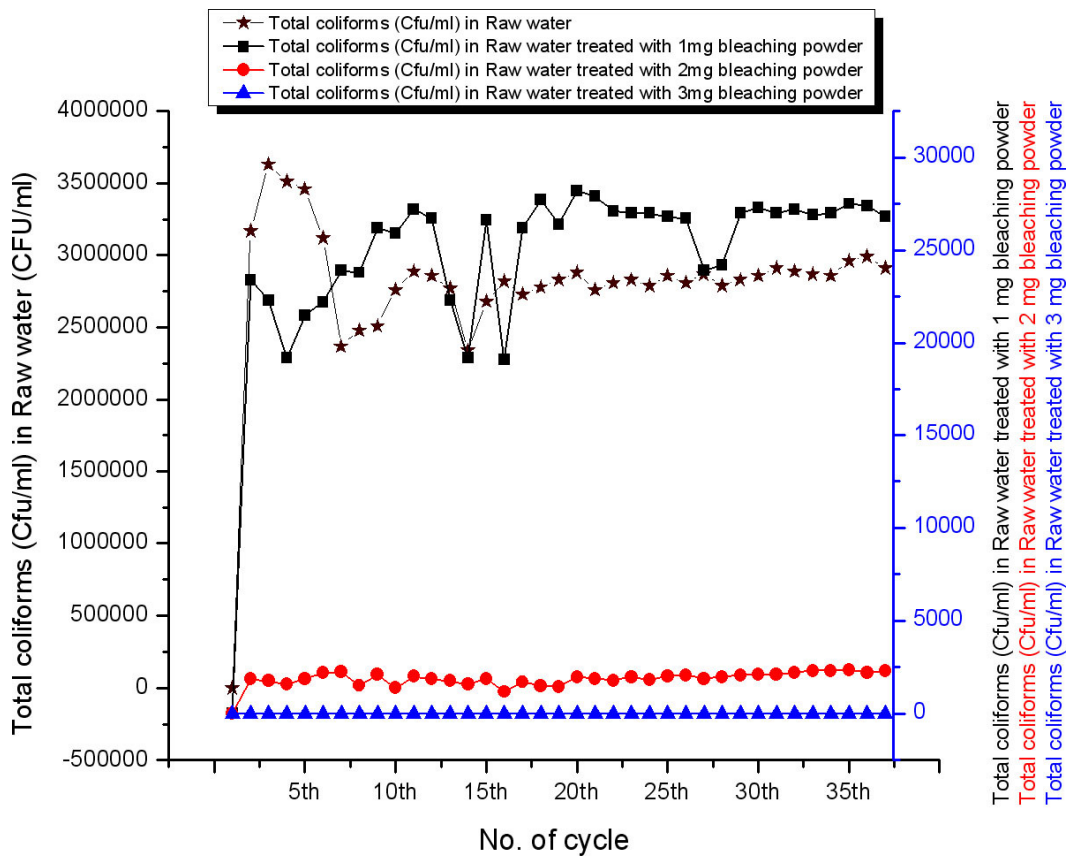**Fig-4: Efficiency of removal of microorganisms by treatment of raw water with bleaching powder**

Fig-5: Efficiency of removal of microorganisms by treatment with bleaching powder followed by filtration through Terafil disc
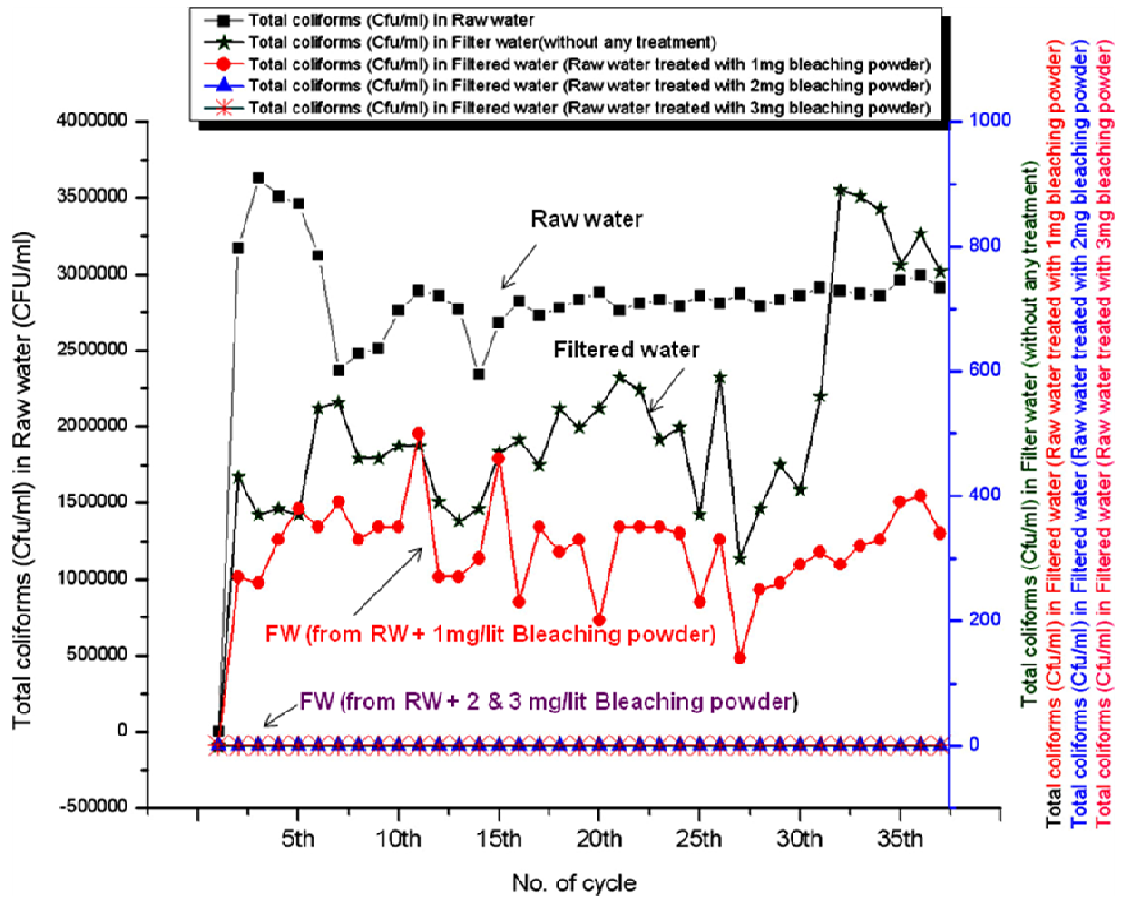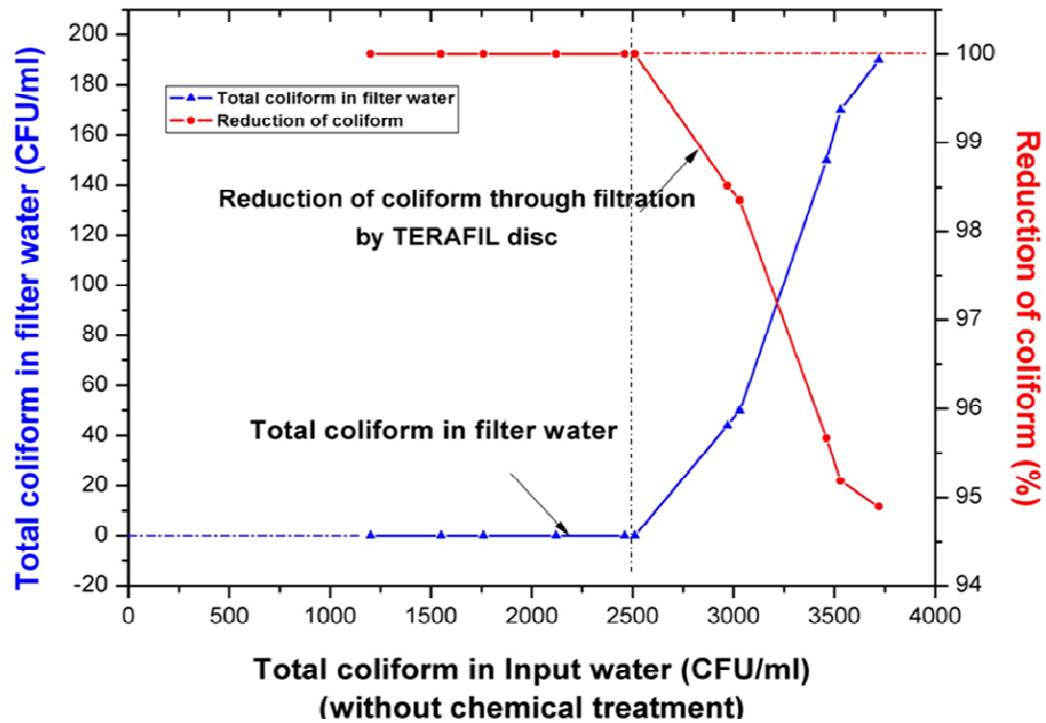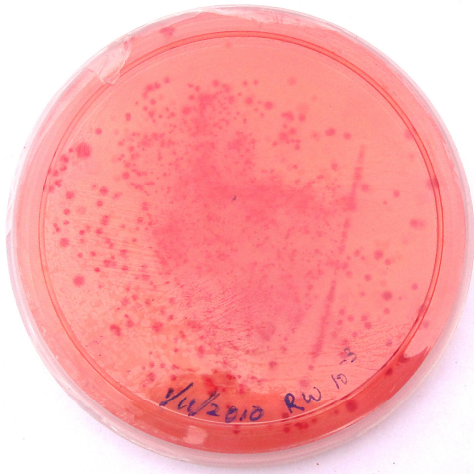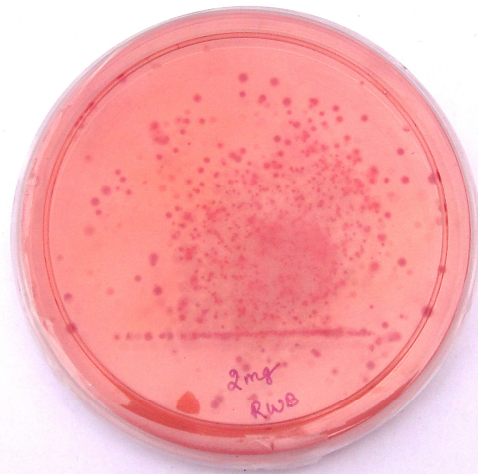

Fig-6: Efficiency of removal of microorganisms by filtration through Terafil disc Without chemical treatment

Total Coliform in diluted raw water

**Total coliform in raw water treated with
2 mg/liter bleaching powder (30% chlorine)**

**Total coliform in Filtered water
(Raw water treated with 2 mg/liter bleaching powder (30% chlorine)
prior to filtration through Terafil)**

CONCLUSION:

Study undertaken to assess the effectiveness of Terafil water filter, in removing Turbidity, Iron and total Coliform microorganisms envisage the following conclusions:

(i)   Turbidity and Iron, both the contaminants were removed effectively by the filter, as evinced by the 36 cycle test conducted. Removal efficiency in case of Turbidity was found 97.35 to 99.33%, while that in case of Iron was estimated 90.23 to 95.12%.

(ii) Turbidity & iron in the filter water obtained during the 36 cycle test were found well within the desirable limit of IS: 10500-1991(Indian Specification of Drinking Water).

(iii) 36-cycles of filtration indicated the pH in the filtrate ranging between the desirable limit of 6.5-8.5 (IS:10500-1991, Indian Specification of Drinking Water)

(iv) 99.94 to 99.98 % microorganisms were removed through filtration in Terafil filter without chemical treatment.

(v)   Total coliform count in the treated raw water is within 2330 CFU/ml, when the raw water is treated with 2mg/ltr bleaching powder in 36-cycles of experiments.

(vi) Total Coliform count became nil in the filtered water, when the raw water was treated with 2mg / ltr of bleaching powder (30% chlorine) followed by filtration through Terafil water filter.

(vii) Total Coliform count in both raw and filtered water also became nil, when the raw water was treated with 3mg / ltr of bleaching powder.

(viii) From the table-2 & 3 it is established that when raw water having total coliform count up to 2500 CFU/ml is filtered through Terafil water filter, total coliform count became nil in the filtered water.

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