CHAPTER - III

RESULTS & DISCUSSION

RESULTS AND DISCUSSION

A textile is essentially a fabric made form fibres which may be obtained from natural sources, or be produced syntheticaly by the process of engineering. The making of textiles is one of the oldest and the most fundamental crafts of a civilized community. Thus textile industry is not only regarded as one of the most ancient industries but also as one of the most important industry.

One of the important and inseparable part of the textile industry is the processing sector which has made considerable progress not only in terms of production but also in terms of providing employment. The processing sector in Ichalkaranji is engaged in bleaching, mercerizing, dyeing, printing of cotton fibre, yarn and fabrics. These textile processing units are consuming huge amounts of fresh water and generating nearly equal volumes of waste water as effluents.

The total water consumption of The Yashwant Co-operative Processors Ltd., Ichalkarnaji, is 5,00,000 litres per day, out of which 60% water is used for bleaching and mercerizing sections, 20% water is used for dyeing, 10% water is used for Finishing and other sections. like domestic purpose sanitary purpose etc. The quantity of cloth processed is 50,000 meter per day.

The total waste water effluent discharged is approximately 3,00,000 litres per day. Out of this waste water effluent discharge, 60 % is from bleaching , 16% from dyeing , 12% from mercerizing , 8% from printing and remaining 4% from finishing and other sections. like domestic purpose sanitary purpose etc.

These effluents contaminated with unused chemicals, dyes fibres etc. are disposed directly into the river Panchaganga flowing around the Ichalkaranji city. Due to this untreated waste water effluents, the river water gets polluted and water quality turned hazardous and unfit for human consumption including irrigation, plant life and animal life.

I) CHARACTERISATION

The effluents samples showed various characteristics which were analysed and the results obtained are tabulated as follows.

Table No 1 and 2 shows colour variation of the waste water effluent samples of various sections and combined effluent, respectively. All the effluent samples are very turbid throughout the various processing steps. The soluble dyes present in the effluent exhibit their colour in the streams. Certain dyes like reactive dyes and acid dyes which are not readily adsorbed, pass through the treatment plant, to the rivers and streams.

Table No. 3 and 4 shows the temperature of the waste water effluent samples of various sections and combined effluent, respectively in degree centigrade. The temperature recorded for all effluent samples varies in the range 25.0 to 32.0. which indicates that all the effluents are discharged at normal temperature.

TABLE -1.

Colour of the waste water effluent samples of various sections.

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	Whitish	Yellow	Creamish	Bluish
2.	Whitish	Yellowish	Bluish	Bluish White
3.	Whitish	Yellowish	Greenish Blue	Bluish
4.	Whitish	Yellowish	Dark Blue	Bluish
5.	Whitish	Whitish	Bluish	Bluish

TABLE -2.

Colour of the waste water samples of combined effluent.

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	Bluish	7.	Blue
2.	Bluish	8.	Bluish
3.	Greenish	9.	Pinkish
4.	Creamish	10.	Whitish
5.	Bluish	11.	Whitish
6.	Bluish	12.	Whitish

TABLE -3.

Temperature in ^{o}C of the waste water effluent samples of various sections-

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	27.0	27.0	32.0	30.0
2.	26.0	27.5	25.0	37.0
3.	27.0	28.0	25.0	25.0
4.	27.0	30.0	30.0	30.0
5.	28.0	30.0	25.0	27.0

TABLE -4.

Temperature in ^{o}C of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	28.0	7.	30.0
2.	29.0	8.	25.0
3.	29.0	9.	25.0
4.	32.0	10.	25.0
5.	25.0	11.	30.0
6.	25.0	12.	27.0

TABLE - 5.

Total Solids (TS) mg/L, Total Dissolved Solids (TDS) mg/L. and Total Suspended Solids (TSS) mg/L of the waste water effluent samples of various sections.

Sample No.	Bleaching			Mercerizing		
	TS	TDS	TSS	TS	TDS	TSS
1.	2170	1952	218	5500	5300	200
2.	1800	1700	100	1981	1766	215
3.	2484	2169	315	1946	1374	572
4.	2000	1810	190	7300	7200	100
5.	2230	2005	225	8460	8200	260

Sample No.	Dyeing			Finishing		
	TS	TDS	TSS	TS	TDS	TSS
1.	9200	8060	1140	35760	13260	12500
2.	5000	4400	600	18960	9720	9240
3.	4560	3600	960	12500	11200	1300
4.	5500	4700	800	15000	6200	8800
5.	5692	5416	276	17500	9000	8500

TABLE -6.

Total Solids (TS) mg/L, Total Dissolved Solids (TDS) mg/L. and Total Suspended Solids (TSS) mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent			Sample No.	Combined Effluent		
	TS	TDS	TSS		TS	TDS	TSS
1.	1848	850	998	7.	6720	6062	658
2.	2677	1600	1077	8.	4180	3412	768
3.	1572	588	984	9.	3542	3400	142
4.	9324	8086	1238	10.	2900	2240	660
5.	1810	810	1000	11.	2900	2660	240
6.	1500	1360	140	12.	2140	2000	140

TABLE -7.

pH of the waste water effluent samples of various sections-

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	8.36	13.99	8.6	6.9
2.	8.05	11.4	9.5	7.4
3.	8.05	11.3	8.2	7.5
4.	8.20	10.9	11.0	7.2
5.	8.30	10.8	11.1	7.2

TABLE -8.

pH of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	8.6	7.	10.0
2.	11.3	8.	11.2
3.	7.5	9.	9.0
4.	11.8	10.	9.5
5.	9.8	11.	9.2
6.	7.9	12.	10.7

TABLE -9.

Total Alkalinity (TA) mg/L Phenolphthalein alkalinity (PA) mg/L of the waste water effluent samples various sections -

Sample	Bleaching		Mercerizing		Dyeing		Finshing	
No.	PA	TA	PA	TA	PA	TA	PA	TA
1.	175.0	2500	1000	1315	1500	3000	0.0	500.0
2.	46.7	943	1005	1410	1400	2850	0.0	110.0
3.	20.0	425	1200	1410	1200	2500	0.0	125.0
4.	100.0	2000	4800	5300	2250	4500	0.0	110.0
5.	150.0	2200	4350	5000	1985	3100	0.0	130.0

TABLE -10.

Total Alkalinity (TA) mg/L Phenolphthalein alkalinity (PA) mg/L of the waste water samples of combined effluent.

Sample No.	Combined Effluent		Sample No.	Combined Effluent	
	PA	TA		PA	TA
1.	100.0	410.0	7.	1000.0	2000.0
2.	325.0	1740.0	8.	1335.0	1850.0
3.	150.0	1890.0	9.	225.0	715.0
4.	800.0	895.0	10.	85.0	300.0
5.	475.0	1025.0	11.	500.0	1500.0
6.	100.0	250.0	12.	625.0	840.0

TABLE -11.

Values of Dissolved Oxygen (DO) mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	15.69	0.0	9.31	5.468
2.	16.75	5.670	8.90	6.076
3.	17.35	3.646	8.5	4.05
4.	17.00	4.45	6.082	5.52
5.	16.50	3.441	6.48	5.03

TABLE -12.

Values of Dissolved Oxygen (DO) mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	8.1029	7.	7.501
2.	6.077	8.	6.076
3.	5.672	9.	7.089
4.	8.91	10.	6.886
5.	9.72	11.	6.07
6.	9.115	12.	6.7

TABLE -13.

Values of Chemical Oxygen Demand (COD) mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	608	- -	320	5.468
2.	710	708	6400	6.076
3.	828	- -	1408	4.05
4.	725	1248	3040	5.90
5.	650	1774	1888	6.0

TABLE -14.

Values of Chemical Oxygen Demand (COD) mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	576	7.	248.0
2.	608	8.	1400
3.	568	9.	624
4.	576	10.	808
5.	792	11.	640
6.	192	12.	290

TABLE -15.

Total Hardness mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	365	- -	92.0	70.0
2.	228	32.0	84.0	96.0
3.	170	40.0	312.0	114.0
4.	200	90.0	50.0	100.0
5.	250	90.0	94.0	105.0

TABLE -16.

Total Hardness mg/L of the waste water samples of combined effluent-

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	108.0	7.	60.0
2.	60.0	8.	70.0
3.	100.0	9.	110.0
4.	92.0	10.	170.0
5.	76.0	11.	80.0
6.	70.0	12.	80.0

TABLE -17.

Chlorides mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	1899.0	- -	59.64	39.76
2.	677.0	73.84	107.8	48.28
3.	1015.3	147.68	94.2	134.9
4.	785.0	56.8	355.0	66.0
5.	890.0	61.06	482.8	55.0

TABLE -18.

Chlorides mg/L of the waste water samples of combined effluent-

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	237.14	7.	355.0
2.	140.58	8.	305.3
3.	49.7	9.	369.2
4.	240.0	10.	198.8
5.	394.6	11.	144.8
6.	266.96	12.	151.94

TABLE -19.

Values of Residual Chlorine mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	31.0625	0.0	0.0	0.0
2.	28.4	4.4375	0.0	0.0
3.	47.925	0.0	0.0	0.0
4.	40.520	0.0	0.0	0.0
5.	42.320	4.4375	0.0	0.0

TABLE -20.

Values of Residual Chlorine mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	7.9875	7.	0.0
2.	2.6625	8.	0.0
3.	1.775	9.	2.130
4.	4.4375	10.	4.4375
5.	0.0	11.	5.325
6.	0.0	12.	0.0

TABLE -21.

Values of Nitrate Content mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	- -	0.0	0.0	0.0
2.	- -	0.0	0.33	1.0
3.	- -	0.0	0.0	1.0
4.	- -	0.0	0.0	0.0
5.	- -	0.0	0.0	0.0

TABLE -22.

Values of Nitrate Content mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	- -	7.	1.07
2.	- -	8.	- -
3.	- -	9.	0.0
4.	0.0	10.	0.0
5.	0.0	11.	0.0
6.	1.25	12.	0.0

TABLE -23.

Values of Nitrite content mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	- -	0.0	1.25	0.0
2.	- -	0.0	0.97	0.0
3.	- -	0.0	0.98	0.0
4.	- -	0.0	1.2	0.0
5.	- -	0.0	0.18	0.0

TABLE -24.

Values of Nitrite content mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	- -	7.	0.82
2.	- -	8.	0.1
3.	- -	9.	- -
4.	- -	10.	0.68
5.	0.97	11.	0.07
6.	0.12	12.	0.0

TABLE -25.

Values of Sulphate content mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	- -	- -	- -	0.4115
2.	- -	- -	0.5905	0.1934
3.	- -	- -	1.267	0.8188
4.	- -	0.0	0.323	0.6200
5.	- -	0.0	0.0876	0.3500

TABLE -26.

Values of Sulphate content mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	- -	7.	0.5349
2.	- -	8.	0.03291
3.	- -	9.	0.3979
4.	0.0	10.	0.1028
5.	0.0	11.	0.0
6.	0.288	12.	0.0288

TABLE -27.

Quantity of Oil and Grease mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	- -	- -	- -	1414
2.	- -	- -	0.5905	1680
3.	- -	- -	1.267	1540
4.	- -	2.0	0.823	1400
5.	- -	3.0	0.0876	1450

TABLE -28.

Quantity of Oil and Grease mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	--	7.	4.298
2.	--	8.	0.2626
3.	--	9.	0.0
4.	0.0	10.	5.0
5.	0.0	11.	3.40
6.	4.40	12.	1.28

TABLE -29.

Values of Biochemical Oxygen Demand (BOD) mg/L of the waste water effluent samples of various sections -

Sample No.	Bleaching	Mercerizing	Dyeing	Finshing
1.	207.0	--	163.0	365.0
2.	202.0	283.7	202.1	770.0
3.	243.4	162.0	344.0	1012.0
4.	227.3	152.0	247.0	550.0
5.	210.2	129.4	251.0	720.0

TABLE -30.

Values of Biochemical Oxygen Demand (BOD) mg/L of the waste water samples of combined effluent -

Sample No.	Combined Effluent	Sample No.	Combined Effluent
1.	121.0	7.	588.0
2.	405.0	8.	709.0
3.	243.0	9.	303.8
4.	161.0	10.	649.0
5.	669.0	11.	790.0
6.	344.0	12.	162.7

TABLE - 31 :

Heavy Metal Contents of the waste water effluent samples of various sections and combined effluent, mg/L

Processing Section	Sample No.	Sodium (Na)	Potassium (K)	Copper (Cu)	Chromium (Cr)	Iron (Fe)	Nickel (Ni)	Manganese (Mn)	Cobalt (Co)
Bleaching	1	4.8050	2.8500	- -	6.1310	0.0730	- -	- -	0.0550
	2	4.7100	2.8830	- -	6.1220	0.0650	- -	- -	0.0630
	3	4.7060	2.8400	- -	6.0950	0.0780	- -	- -	0.0480
	4	4.8200	2.8670	- -	6.0980	0.0620	- -	- -	0.0470
	5	4.7500	2.8710	- -	6.1150	0.0580	- -	- -	0.0450
Mercerizing	1	4.4050	- -	- -	6.9660	0.1970	- -	- -	0.0610
	2	4.3950	- -	- -	6.8370	0.1600	- -	- -	0.0530
	3	4.4100	- -	- -	6.7650	0.1870	- -	- -	0.0580
	4	4.3800	- -	- -	6.8430	0.1910	- -	- -	0.0520
	5	4.2970	- -	- -	6.7900	0.1760	- -	- -	0.0470
Dyeing	1	4.5090	14.2600	- -	- -	0.0870	- -	- -	0.1110
	2	4.2590	14.5400	- -	2.3780	0.2320	0.0540	0.2088	0.1470
	3	4.4320	14.4700	- -	2.2500	0.2050	0.0490	0.1920	0.1250
	4	4.4830	14.5200	- -	2.5050	0.0930	0.0420	0.1875	0.1380
	5	4.3870	14.3800	- -	2.2800	0.0970	0.0370	0.1840	0.1450
Finishing	1	4.8170	0.4980	- -	- -	0.0210	- -	- -	0.0910
	2	4.8050	0.5020	- -	- -	0.0180	- -	- -	0.1050
	3	4.7290	0.4900	- -	- -	0.0150	- -	- -	0.1080
	4	4.7650	0.4930	- -	- -	0.0220	- -	- -	0.0970
	5	4.7950	0.5040	- -	- -	0.0170	- -	- -	0.0940
Combined	1	4.4490	- -	- -	6.0060	0.0860	- -	- -	0.0860
	2	4.5790	17.5000	- -	6.7350	0.0530	- -	- -	0.0530
	3	4.6170	17.6000	- -	6.6760	0.0670	- -	- -	0.0810
	4	4.5950	17.5700	- -	6.7040	0.0750	- -	- -	0.0630
	5	4.4800	17.6500	- -	6.3250	0.0690	- -	- -	0.0720

TABLE - 32

Standards for Drinking water, S.P. Mahajan 1998.

Sr. No.	Pollutants	Permissive	Excessive
1.	pH	7.0 - 8.5	< 6.5 or > 9.2
2.	Total Solids (TS)	500 mg/L	1500 mg/L
3.	Total Hardness (as $CaCO_3$)	300 mg/L	600 mg/L
4.	Calcium (as Ca)	75 mg/L	200 mg/L
5.	Magenssium (as Mg)	50 mg/L	150 mg/L
6.	Iron (as Fe)	0.3 mg/L	1.0 mg/L
7.	Manganese (as Mn)	0.1 mg/L	0.5 mg/L
8.	Copper (as $CaCO_3$)	1.0 mg/L	3.0 mg/L
9.	Zinc (as Zn)	5.0 mg/L	15.0 mg/L
10.	Chlorides (as Cl)	250 mg/L	1000 mg/L
11.	Sulphates (as SO_4)	250 mg/L	400 mg/L
12.	Nitrates (as NO_3) 300 mg/L	20 mg/L	50 mg/L
13.	Chromium (as hexavalent)	- -	0.05 mg/L

TABLE - 33

Indian Standards for the Disposal of Industrial Effluents.

IS : 2490 (Part-I) 1981 General limits - seconds revision with 1985 Amendments.

The general Tolerance limits prescribed for the Industrial effluents by the Bureau of Indian standards.

Sr. No.	Characteristics	Tolerance limits For Industrial Effluents discharged	
		Into In land surface Waters	Into Pubilc Sewers
1.	BOD, 5 days, 20°C, mg/L	30	350
2.	COD, mg/L	250	- -
3.	pH	5.5 - 9.0	5.5 - 9.0
4.	Suspended solids, mg/L	100	600
5.	Total Dissolved Solids, mg/L	--	2100
6.	Temperature, °C	40	45
7.	Oil and Grease, mg/L	10	20
8.	Total Residual Chlorine,mg/L	1.0	- -
9.	Chromium (hexavalent),mg/L	0.1	2
10.	Copper, mg/L	3.0	3
11.	Nickel, mg/L	3.0	3
12.	Chlorides, mg/L	1000	1000
13.	Sulphates, mg/L	1000	1000

Table No. 5 and 6 shows, that total solids (TS), Total Dissolved solids (TDS) and Total Suspended solids (TSS) content of the waste water effluent samples of various sections and combined effluent, respectively in mg/L. The TS values recorded are comparitively high and variable for all effluent sections, while TDS values are comparable and tolerable for all effluent sections. TSS values of effluent samples of Bleaching, Mercerizing, Dyeing sections and combined effluent are tolerable while the values of Finishing section effluents are high as compared with the permissible values according to ISI standards.

Table No. 7 and 8 indicates pH values of waste water effluent samples of various sections and combined effluent respectively. The pH variation for bleaching section is from 8.05 to 8.36, mercerizing section is 10.8 to 13.99, dyeing seciton is 8.2 to 11.1, finishing section is 6.9 to 7.5 and combined effluent is 7.5 to 11.8. These values show that bleaching, dyeing and finishing effluents are slightly alkaline while mercerizing and combined effluents are highly alkaline. These values are slightly higher than the tolerable limits according to the ISI standards.

Table No. 9 and 10 indicates the Phenolphthalein alkalinity (PA) and Total alkalinity (TA) values of the waste water effluent samples of various sections and combined effluent, respectively in mg/L. The PA values for finishing section effluent are zero while for bleaching, mercerizing, dyeing sections, the values are varying from 20.0 to 4800.0. For combined effluent, the PA value is varying from 85.0 to 13335.0.

The TA values of bleaching, mercerizing and dyeing sections are varying from 425.0 to 5000.0 while for finishing section and combined effluent, the values are varying from 110.0 to 1850.0. The TA values of bleaching, dyeing and finishing sections are to lerable while for mercerizing and combined effluent , the values observed are very high as compared to the permissible levels for disposal of industrial waste water effluents.

Table No. 11 and 12 shows the values of Dissolved Oxygen (DO) of waste water effluent samples of various sections and combined effluent, respectively in mg/L. The DO values vary from 15.69 to 17.35 for bleaching section, 3.441 to 5.670 for mercerizing section 6.48 to 9.31 for dyeing section, 4.05 to 6.076 for finishing section and 5.672 to 9.72 for combined effluent. The average values of DO for mercerizing and finishing sections are low while for dyeing and combined effluent, DO values are medium. For bleaching section, the DO values observed are comparitively higher.

Table No. 13 to 14 shows the values of Chemical Oxygen Demand (COD) of waste water effluent samples of various sections and combined effluent respectively, in mg/L. The COD values are ranging from 608.0 to 828.0 for bleaching section, 708.0 to 1774.0 for mercerizing section, 320.0 to 6400 for dyeing section, 4.05 to 6.0 for finishing section and 192.0 to 1400.0 for combined effluent. There is high variation in COD values of mercerizing and dyeing section while for finishing section, the values are low and comparitive. For bleaching and combined effluents, the COD values are high.

Table No. 15 and 16 indicates the values of Total Hardness as

$CaCO_3$ of waste water effluent samples of various sections and combined effluent, respectively in mg/L. The values of Total Hardness are ranging from 170.0 to 365.0 for bleaching effluent, 32.0 to 90.0 for mercerizing effluent, 50.0 to 312.0 for dyeing effluent, 70.0 to 105.0 for finishing effluent and 60.0 to 170.0 for combined effluent. All these values are below permissible levels (300 mg/L).

Table No. 17 and 18 shows the values of chloride content of waste water effluent samples of various sections and combined effluent, respectively, mg/L. The chloride content values are ranging from 677.0 to 1899.0 for bleaching section, 56.8 to 147.68 for mercerizing section, 59.64 to 482.8 for dyeing section, 39.76 to 134.9 for finishing section and 49.7 to 369.2 for combined effluent. The chloride content in bleaching effluent is very high while in all other effluents, the chloride content is below the permissible levels.

Table No. 19 to 20 shows the values of Residual Chlorine of waste water effluent of various sections and combined effluent respectively in mg/L. The Residual chlorine values are varying in the range 28.4 to 47.925 for bleaching section, 1.7 to 7.9875 for mercerizing and combined effluent while for dyeing and finishing effluent, there is no residual chlorine. For bleaching effluent, the high values of residual chlorine are due to the use of chlorine for bleaching purpose.

Table No. 21 to 22 shows the nitrate content of waste water effluent samples of various sections and combined effluent, respectively in mg/L. The nitrate content is zero in effluent samples of all the sections.

Table No. 23 and 24 shows the nitrite content of waste water effluent of various sections and combined effluent, respectively in mg/L. In dyeing effluent samples, a trace amount of nitrites is observed while for bleaching, mercerizing effluent, nitrites are completely absent.

Table No. 25 and 26 shows the sulphate content of waste water effluent samples of various sections and combined effluent, respectively in mg/L. In bleaching and mercerizing effluent samples, the sulphates are completely absent while for dyeing, finishing and combined effluent, the values are varying from 0.0288 to 1.267. These values indicate that the sulphate content is observed in a trace amount in finishing and combined effluent.

Table No. 27 and 28 shows the presence of Oil and Grease of waste water effluent samples of various sections and combined effluent, respectively in mg/L. The Oil and Grease content for finishing effluent observed is very high ranging from 1400 to 1480. While for bleaching, mercerizing, dyeing and combined effluent, traces of Oil and Grease content are observed.

Table No. 29 and 30 shows the values of Biochemical Oxygen Demand (BOD) of waste water effluent of various sections and combined effluent, respectively in mg/L. The BOD values are ranging from 202.0 to 243.4 for bleaching sections, 129.4 to 283.7 for mercerizing section 163.0 to 344.0 for dyeing section, 365.0 to 1012.0 for finishing section and 121.0 to 790.0 for combined effluent. These values are compared with ISI standards. It is observed that for bleaching, mercerizing, finishing and combined effluent samples the

BOD values are below permissible level (500 mg/L) while for dyeing effluent treatment is necessary because the BOD values recorded are very high.

Table No. 31 shows the amount of heavy metals in waster water effluent samples of various sections and combined effluent respectively in mg/L. Sodium content varies in the range 4.706 to 4.820 for bleaching effluent 4.297 to 4.410 fir mercerizing effluent, 4.259 to 4.509 for dyeing effluent, 4.729 to 4.817 for finishing effluent and 4.449 to 4.617 for combined effluent. The above values indicate that the considerable amount of sodium metal is observed in all effluent samples. Potassium content varies in the range 2.840 to 2.883 for bleaching effluent, 14.26 to 14.54 for dyeing effluent, 0.490 to 0.504 for finishing effluent, 17.50 to 17.65 for combined effluent while mercerizing effluent is completely free from potassium content. Above values indicate that the potassium content is very low for bleaching and finishing effluents while for dyeing and combined effluents, potassium content observed is very high. Copper is completely absent in all the effluent samples. Chromium content varies in the range 6.095 to 6.131 for bleaching 6.765 to 6.966 for mercerizing, 2.250 to 2.505 for dyeing and 6.006 to 6.704 for combined effluent while in finishing effluent, chromium is completely absent. Iron content varies in the range 0.062 to 0.078 for bleaching, 0.160 to 0.197 for mercerizing, 0.087 to 0.232 for dyeing , 0.015 to 0.022 for finishing and 0.053 to 0.075 for combined effluent. Trace amounts of iron are observed in all the effluent samples. Nickel content varies in the range 0.037 to 0.054 for dyeing effluent while in all the remaining sections, Nickel is completely absent. Manganese content varies in the range 0.1840 to 0.2088 while in all the ramaining sections, manganese is completely absent. Cobalt content varies in the range 0.045 to 0.063 for bleaching, 0.047 to 0.061 for mercerizing, 0.125 to 0.147 for dyeing, 0.091 to 0.108 for finishing and 0.053 to 0.086 for combined effluent. Above values indicate that cobalt is observed in a trace amount in all the effluent samples.

Table No. 32 shows the standards for Drinking water, S.P. Mahajan, 1998.

Table No. 33 shows Indian standard for the Disposal of industrial effluent by the Bureau of Indian standards.

II) Treatment -

The control of water pollution by textile waste water is best achieved by a combination of several implant measures and to reduce waste volume and pollution load and also treatement of the wastes by a suitable combination of physical , chemical and biological methods.

The various implant measures include the following steps -

I) Reduction in waste volume -

Segregation of the concentrated process waste water from the less contaminated waste streams like washings and runnings or the uncontaminated streams like cooling water and the reuse of the latter contribute towards a greater economy in water usage and reduction in waste volume.

II) Application of counter current washing system -

The washing operation at the end of each process sequence in a textile mill is the most intensive operation. Each chemical process requires atleast one rinse with adequate volume of water similarly bleaching operation depends upon intermediate washing. Application of counter current system of washing helps towards economy in water consumption. In one of the largest mills in Ahmedabad, it was shown that a saving of 50% in water consumption has been achieved - Shah (1977)

III) Reuse of water -

Water reuse is restricted to the limited use of process water affected by suitable treatment given to the waste water. The treatment methodology is clearly most versatile, if it can accept the entire process waste water provided that the treated effluent will fulfill the specific requirements of the water quality of each process after combining it with fresh water.

The main advantages of reuse are -

1. Reduction in the total water demand and savings in the cost of raw water and water treatment costs.

2. Reduction in waste volume discharged into the evironment.

In some mills, a portion of the raw water used for processing is replaced with used water so that the total requirements are reduced considerably. Some of the used water needs treatment. The best treatment that yields a water of good quality is ultra filltration. The treated water could be used even for processing, especially when a single dye shade is applied.

Literature survey indicates that biologically or chemically treated water may be suitable to reuse in processing or as cooling water.

IV) Primary Treatment -

1. Screening -

All cotton finishing wastes contain fine fibres. For removal of these fibres, Bar screens and mechanically cleaned fine screens remove most of the fibres. Fine screening of the settled fibres is necessary to protect the mechanical equipments such as pumps or aerators.

2. Equalisation -

Equalisation of the waste is an essential step because of sharp variation in flow and chemical characteristics. It is essential to segregate such streams and store them in a holding tank of suitable size for subsequent release at suitable rate so as to even out the waste load. Equalisation facilitates self neutralisation of acidic and alkaline waste streams.

3. Neutralisation -

Most of the secondary biological treatments are effective only if the pH value of the effluent is between 6 to 9. pH value of the cotton finishing effluents are generally alkaline. Hence the pH value of the equalised effluent should be adjusted to be in optimum range using dilute sulphuric acid. It is reported that in some mills, boiler flue gas rich in carbon dioxide is used to neutralise the effluent.

4. Chemical Coagulation -

In a practice of treating textile waste water, the most general chemical method is addition of coagulating or flocculating agents with simultaneous pH adjustment to form a flue followed by aeration and floatation of the solids. Common coagulants are ferrous sulphate (pH 9), ferric chloride or sulphate (pH 6 to 9) and aluminium sulphate (pH 6 0) . This general form of treatment no only removes most of the colloidal and suspended material but also provides a means of reducing the colour level - Tewari et. al. (1994)

V) Secondary Treatment -

For medium scale industries, aerated lagoons is the suitable secondary treatement. Aerated lagoons are reported to be quite efficient and remove 90 % of BOD. Aerated lagoons are activated sludge units operated without sludge return. These are large holding tanks or ponds lined with cement or preferably by polythene. Their depth varies from 3 to 5 meters. These lagoons are intended for the oxidation of dissolved organic matter and hence need primary clarification. The effluent after primary treatment is passed on to these tanks and aerted mechanically. Floating aerators are the most commonly employed to supply the necessary oxygen and power to mix the lagoon contents. Recommended detention period ranges from 2 to 6 days, during which time a healthy flocculent sludge is formed which carry out oxidation of organic matter. The operation and maintenance are much simple hence this method is advantageous. The effluent from lagoons may contain bacteria and need further biological purification which is achieved by passing the lagoon effluent to maturation ponds or to secondary. Sedimentation and sludge digestion. In medium and small textile finishing mills, the size of the lagoons are reduced in proportion to the volume of effluents and aerated using fixed aerators combined treatment wiht sewage is reported to be more effective. Removal of BOD upto 95 % is reported by this method.

Tricking filter, Activated sludges and dispersed growth aeration are considered to be suitable for secondary treatment. Trickling filtration is an effective aerobic biological oxidation method. In this method waste water after primary treatment is sprinkled over a bed of broken stones. The bacterial slimes formed on the stones oxidise the waste water during its passage. The effluent from trickling filter is allowed to settle and then discharged. The trickling filters are usually circular. Instead of a bed of broken stones, plastic and PVC media are also used which gives maximum surface area for microbial film formation and light weight of plastic and PVC helps in greater economy in laying underdrains of the filter. When these materials are used , the depth of the bed may be increased more than 3 meters. Waste water is sprinkied by moving sprinklers. The gelatinous film of aerobic organisms formed on the whole surface of the filter medium absorbs both dissolved and colloidal organic matter which are then oxidised to simple substances by the metabolic activities on the bacteria in the slime. The shape of the stone is spherical and the size ranges from 2 to 10 cm. The depth of the filter bed vary from 1 meter to 3 meters. The final sedimentation tank in an integral part fo the filter, it removes the largest mass of biological growth that have been dropped from the filter media.

Trickling filters are generally intended for cotton finishing wastes and are reported to remove BOD by 40 to 85 %, suspended solids 80-90 % and total dissolved solids upto 30%. Trickling filtration is generally desirable due to its flexibility, lower operation cost and capability of handling shockloads of effluents.

Activate sludge treatment leads to greater BOD reducation but requires large units to provide the long detention periods usally needed and also required highly qualified supervision. Dispersed growth aeration generally gives somewhat lower BOD reduction than activated sludge treatement but does away with the sludges problem. It also takes a minimum operation and maintenance cost.

Textile effluent has also been treated successfully by waste stabilization pond method in combination with sewage. An oxidation pond is a large shallow pond in which waste is added at one end and effluent removed at the other end. Stabilization of organic matter is brought about by bacteria. Oxygen required for its metabolism is supplied by algae in the pond. It utilizes the carbon dioxide released by bacteria for its photosynthesis. This mutual symbiotic action is the characteristic of oxidation ponds for effective treatement, maximum sunlight penetration for photosynthesis of algae, wind action for mixing, maximum natural aeration are necessary. To fulful these requirements, oxidation ponds are constructed shallow i.e. 0.5 meter to 1.5 meter depth pond size and detention period are dependent on the type and quantity of the waste to be treated. The recommended detention period for textile waste water ranges from 10 to 30 days. It is reported that BOD removal upto 80% is achieved by this method.

Chemical treatment of lime and gypsum is very effective for removal of colour, suspended solids and fibres from cotton textile mill wastes. The performance of the hyacinth pond was satisfactory in removing the sodium by about 50 % and substantial quanitity of oil and grease. The level of BOD, TDS, chlorides and potassium were also declined by hyacinth treatment but it also increased COD and suspended solids reported by Trivedi (1986). Nemerow (1971) described chemical coagulation, Trickling filtration, Activated sludge process and Dispersed growth aeration methods for the treatment of textile effluent. Chamberlain (1954) reported the use of chlorinated. copper as to oxidise or bleach many dyes and in the reduction of BOD from sulphur dyes. Hazen (1957) used successfully the combination of trickling filters and activated sludge for the treatment of 40 to 60% mixture of textile finishing mill waste and sewage.

VI) Tertiary Treatment -

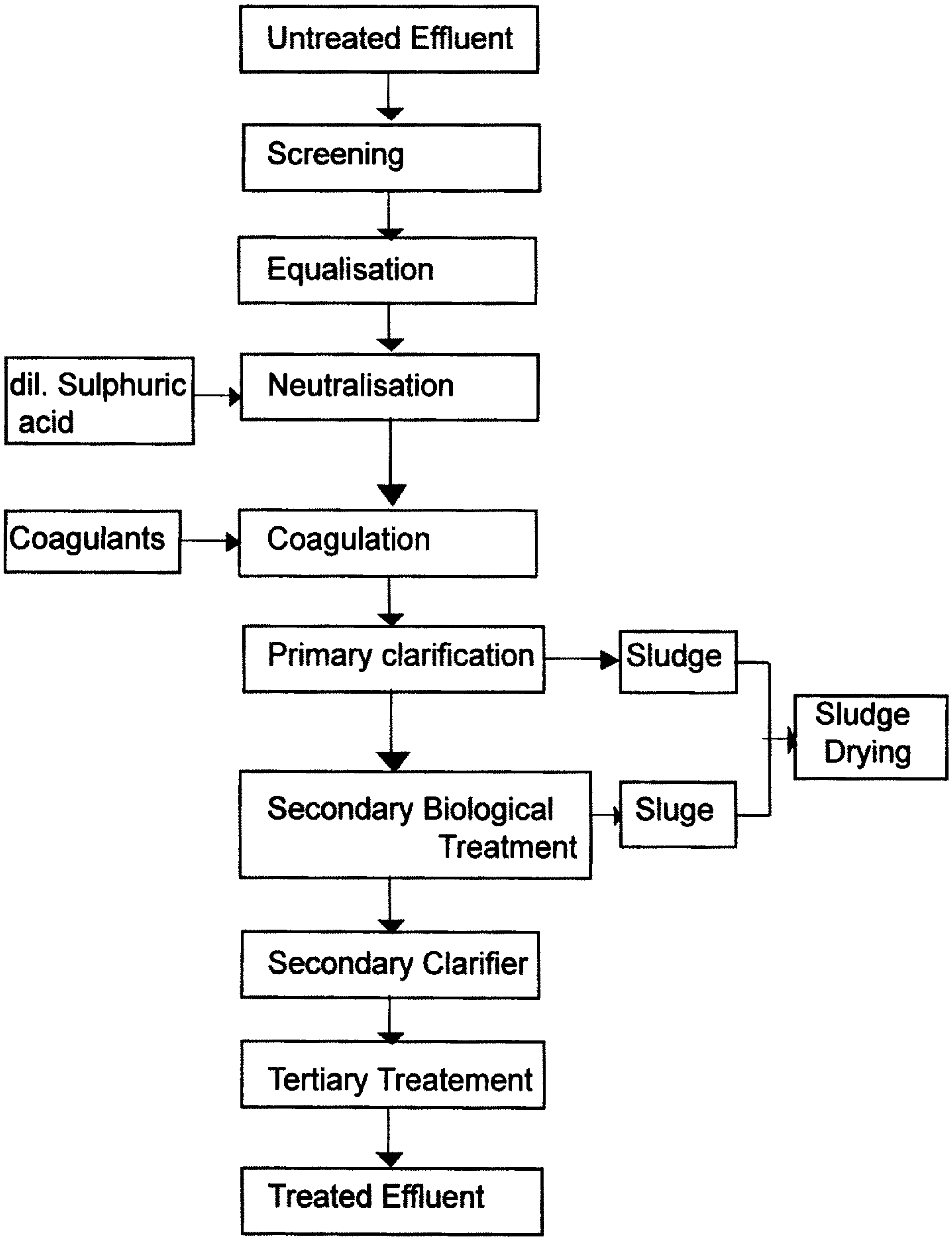
Reverse osmosisi process results in excellent colour removal and high degree of removal of the residual BOD and COD. Reverse osmosis works on the principle that when a liquid waste containing much dissolved solids is passed over the surface of a semipermeable membrane at a pressure of the feed waste, the water in the effluent passes through the membrane leaving.a concentrated liquor on the surface. Thus when dye house wastes are passed through such membranes, a concentrated dye solution is left over. The recovered water also has a great potential of reuse in the process. This process is reported to be excellent for colour removal and in the reduction in BOD and COD.

Activated catbon adsorption is used for removal of organic materials like soluble dyes. When the textile waste water containing a mixture of organic constituents such as organic dye and a solvent is applied through a bed of activated carbon, the dye would be more readily adsorbed by the carbon molecular structure. There are four basic adsorption systems 1) Moving beds 2) Fixed beds in series 3) Fixed beds in parallel 4) Expanded beds.

Moving bed adsorbers operate on a counter current basis. Water flows from the bottom through the bed and leaves at the top. Maximum utilization of carbon is achieved in fixed beds in series system by valve arrangements. A major advantage with this system is the capability of handling suspended solids unlike moving beds. Fixed beds in parallel are often employed because they are capable of removing suspended solids in addition to dissolved solids. Expanded beds are employed in order to overcome the difficulty of plugging due to suspended solids. When the activated carbon has become exhausted, it can be reactivated thermally and reused. Treatment with activateed carbon seems to be a promising method due to its lower cost and simplicity in operation.

Ion exchange process appears to be preferrable when judged from the point of view of its long term applicability and the cost of treatment is also low when compared to the cost of raw water itself. This method is suitable for treatment of highly alkaline waste stream. Both cationic and anionic exchange resins are employed for the treatmentof liquid wastes containing chromium. By ion exchange, it is possible to recover chromium in the form of sodium chromate or chromic acid. The filtered waste water is first passed through a cationic exchanger of H^+ form. Hence trivalent chromium ions form the liquid stream are adsorbed on the resin. The liquid stream are adsorbed on the resin. The liquid containing hexavalent chromium passes on to an anionic exchanger of OH^- form. The chromate gets adsorbed and its ions are replaced by hydroxyl ions. The outgoing stream is devoid of chromium and can be reused. The anion exchange resin is regenerated by passing 10% sodium hydroxide solution. The outgoing sodium chromatic solution is then passed through the cationic exchanger where sodium ions get replaced by H^+ forming chromic acid. The cation exchange resin can be regenerated by a dilute five percent solution of sulphuric acid. Two ion exchange columns are operated in series in the progressive mode. This system of ion exchange recovery seems to be feasible both technically and economically.

FLOW CHART INDICATING THE TREATMENT SEQUENCES OF TEXTILE PROCESSING.



III) CONCLUSION

Thus, though the textile industry has been developed all over the country the small textile processing unit which are scattered all over the country have been neglected from research point of view. In recent years, the industry has undergone modernization to a large extent and incorporates the latest developments in textile technology. The manufacture of textile fabrics from cotton blended with man made fibre constitutes a major development. Textile industry earns foreign exchange for our country but various chemicals and dyes used in bleaching, dyeing and other processes give rise to a toxic effluent. Most of these effluents with a number of toxic metals are discharged into the riverine system. The problems associated with biodegradation of waste water from a textile mill arises out of the fluctuating characteristics of the waste water due to varying nature and quantity of chemicals used in the process. The manufacturing process in the textile industry aims at removing natural impurities from the cloth and imparting qualities of touch, sight and durability. The sources of polluting compounds are the natural impurities extracted from fibre and processing chemicals which are removed from the cloth and discharged as waste. The effluents of textile industry dumped into water , air and soil of its neighbourhood certainly leads to pollution and produces undersirable side effects.

The main sources of waste water from textile process industry are from desizing , scouring, bleaching, mercerizing, dyeing, printing, finishing and rinsing operations. Large quantity of water is used for carrying out all these operations. Various chemicals are used for treating the fabric as well as dyes are applied to the fabric according to the requirement of the customers. The effluents from all these operations are contaminated with unused chemicals, unused dyes impurities, fibres of cloth etc. due to which the waste water generated from the textile process industries becomes polluted. This highly coloured waste water containing harmful chemicals is disposed to the nearest streams of water or rivers. As a result, the water of entire river becomes polluted which may cause serious environmental problems.

On account of the limited water consumption by the small textile processing units, the waste water contributed by them are smaller in volume but are more concentrated than the waste water from the large textile mills.

The untreated effluents if discharged into the stream causes rapid depletion of the dissolved oxygen of waterbodies which is dangerous to the acquatic life. The waste water effluents are highly coloured due to soluble dyes present in the effluents. The solid material in the effluent redues the waterholding capacity of soil which is dangerous to the agricultural fields. The salt content in effluent affects the texture of soil. The presence of toxic chemicals in effluent deteriorates the marine life. Thus the strong colour, large amount of suspended solids, high variations in pH , temperature, BOD ,COD, all these characteristics of the waste water effluent cause serious environmental problems.

In the present study, it was observed that all the effluents are strongly coloured due to the soluble dyes present in the effluents. This coloured water is highly unacceptable. For removal of colour, process units are using Ferrous sulphate treatment. But this treatment is inadequate to remove the colour. Therefore, for complete removal of colour, some additional treatment like activated carbon adsorption is necessary. The temperature of the effluent samples recorded for various sections is below permissible level which indicates that for the selected process unit, the waste water effluent generated is not harmful wiht respect to the temperature.

From the present study, it was investigated that TS values for all the effluents form various sections are highly variable while the TDS values are under tolerable limits. These high values fo TS are because of high ion composition of cations such as Na , SO_4, Ca, Mg and anions such as Cl, SO_4 ions used during the process. The pH value of the combined effluent sample is slightly alkaline. For maintaining the pH of the effluent, lime treatement is employed in the selected process unit.

In general, it was observed that the effluents released from dyeing and bleaching sections exceeded the limits prescribed by ISI for irrigation and public usage. Among the various stages in dyeing and bleaching, the effluent characteristics of the dye bath are several folds high. The discharge of these untreated dye bath and other effluents will percolate into the soil and affect the ground water table making it unfil for agricultural purpose and drinking purpose. In the present investigation, it was observed that Na content and Cr content in the effluent is considerable which reduces the calcium and magnesium contents of soil which hardens the texture of soil. On prolonged application, sodium also exhibit deflocculation effect. For correcting sodium absorption ratio,gypsum treatment may be given to the effluent before discharge of effluents. For removal of chromium, Reverse osmosis or Ion exchange method gives satisfactory results. The heavy metals are considered to be a major pollutant in natural water and have received considerable attention because of their inherent toxicity to living organisms. The average values of Dissolved Oxygen for mercerizing and finishing sections are low while for bleaching section the DO content is comparitively higher. The depletion of Dissolved Oxygen is the most serious efflect of textile wastes. The oxygen demand that is the amount of oxygen required to correct the effluent is expressed in the form of BOD and COD. The organic matter like starches , dextrins, hydrosulphites and nitrites display immediate oxygen demand. In any attempt to achieve proper BOD / COD ratios, the quantity of type of chemical present on incoming fibre must be given serius attention. Better mechanical cleaning of natural fibre and reduction in fibre finish application should result significant decrease in traditional effluents.

The treatment processes that have demonstrated ability to remove or destroy dyes in waste water are limited. Carbon adsoption, Ozonation and massive chlorination are the standard procedures but some at them do not readily remove ever class of dyes and all are expensive. Finally in combination of anaerobic and aerobic biologival treatment system is being considered for dye removal.

Environmental legislation provides a legal tool with which activities affecting the environment are regulated. Three approaches are generally followed.

1. It is expected that the stage by stage control of pollution in different spheres would ultimately form parts of a compreshensive policy. A proper coordination of different activities and the laws governing them is important.

2. The second approach to environmental protection is comprehensive and deals with all types of pollution like water, air , land, noise etc. The laws based on this have to be massive and the organizations implementing them have necessarily to be big ones.

3. The third approach envisages integration of environmental protection wiht national development planning. This is the best approach as the environment as a whole is subjected to national planning. Legislative measures should have a built - in dynamic character and be in a position to direct the activites of the country. So as to prevent them from becoming detrimental to the environment.

Environmental legislations should be supported by an adequate scientific and technial base sothat the objectives set fourth are achived with minimum cost to the society. Implementation of pollution control laws should be more techno-legally oriented instead of only legally. It is therefore necessary for implementing authority to provide basis for the plans and programmes intended for pollution control.

The object of the water (Prevention and Control of Pollution) Act. 1974 is to control pollution of water and to maintain and restore, whenever necessary, the wholesomeness of water. The purpose of the law is not to restore water to its pristine quality but to make the best use of water for development activities and still preserve its wholesomeness for other uses. The programmes have therefore to be evolved for maintaining and restoring the quality of water for its best use as well as to determine the degree of pollution control necessary before waste water is let out.

While concluding the present dissertation on **Characterization And Treatment Of Waste Water Effluents From Textile Process Industry.**, it should be mentioned that practically all the objectives with which the present work was taken up, have been fulfilled.

The present investigation opens up several avenues for further research on textile process waste water pollution. Some ideas for such future work are in brief listed below.

1) The present work has been carried out only in one selected textile process unit. A detailed study of environmental scenario of the process industry with a view of the various occupational hazards will give a better picture regarding the health status and occupational hazards in the process industry if the research work will be carried out in this area.

2) India is only next to the USA and Japan as the biggest textile producer in the world. So far, only a limited number of studies have been constructed to evaluate waste water pollution problem in textile process industry. A good Combination of research workers and textile process owners will lead a satisfactory solution for the control of water pollution due to textile process industry.

3) In the present study, the physico-chemical parameters are studied in detail but it will also be interesting to focus on the study of

health status of the textile process industry workers , if the research work will be carried out in the biological point of view by studying the biological parameters like MPN etc.

4) A comparative study for the different process units can be done by applying only some selected parameters which are directly to related to drinking water problems.

5) To get a clear insight into the problem of water pollution of the city, it is essential to study the effect of polluted water on animal life. This can be done by comparitive study of biological parameters combinely for all the process units in the city which are responsible for water pollution.

6) A recent trend is the study of occupational health concerned with the investigation of controlled effects of environmental factors. The combined effects of these factors is determined by their interaction. Therefore it will be interesting to study combinely the characterization and health effects regarding long term disposals of waste water effluents in the waterbodies.

Textile industry has undertaken the making of fabrics which is one of the oldest and most fundamental crafts of a civilized community. India is regarded as one of the largest textile producing countries in the world. The textile industry in India is widely spread throughout the country. Ichalkaranji is one such place where the textile process industry is well established. It is well known for its assocation with textile industry. The process units in Ichalkaranji is a source of economic upliftment and is job oriented. It generates employment while providing an essential commodity to the population. Thousand of workers have abondoned their ancestral homes and have migrated to Ichalkaranji to fulfill the clothing requirement of nation at the cost of their health and lives. The water pollution control act has provisions only for controlling pollution caused by industries or communities. It provides only for prohibitive and restrictive measures and doesnot empower the regulating agencies to instruct development authorities to reduce pollution. The major sources of pollution of water are the community wastes generated by industrialized cities and towns. Only one third of the class I towns have been provided sewage treatment facilities, other towns in India donot have sewage collection and/or treatment facilities especially where the population is relatively smaller. The main reason for this state of affairs is the scarcity of funds with local bodies. It becomes necessary therefore, for the state central and other funding agencies to provide adequate finanical help to local bodies so the local bodies can incarporate the necessary collection, treatment and disposal facilities. The provision of sewage treatment facilities has the following distinct advantages.

1. Industrial liquid effluents can be treated at a small extra cost.
2. Downstream water quality will improve.
3. Reuse of water can be planned in a big way especially for agriculture.
4. Financial help from industries towards operating costs would be forthcomng.

It is necessary to take genuine measures for the health protection of the workers and waste water pollution control of textile process industry. This will be possible only if one undertakes the extensive research in this important sector of textile industry. The work in this line is in progress in our laboratory.