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Studies on Biological Treatment of Textile Effluent from CETP

K.Anbarasi [1], D.Dhanaraja[2] and G.Selvabharathi [3]

1Department of Petrochemical Technology, Anna University, BIT Campus, Trichy - 620 024.

2Department of Chemical Engineering, King Khalid University, Kingdom Saudi Arabia

3Department of Civil Engineering, SSM Institute of Engineering and Technology, Dindigul – 624005

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ABSTRACT

Synthetic dyes are indispensable to the textile and dyeing industries. Among all synthetic dyes, azo dyes are the most common, being used up to 90 percent of the tonnage, as they are versatile and easy to synthesize. Yet many azo dyes are toxic and cause genetic mutations. Even a very low concentration of these dyes in industrial effluents is enough to do great damage to the environment. Textile effluent is known to contain strong color, large amount of suspended and dissolved solids, and high BOD and COD concentration. Because of these characteristics, treatment of textile effluent has been a rather difficult task. Several processes have been attempted and reported in literature for removal of dyes present in the textile effluents such as adsorption, membrane separation and biological treatment etc. Among this biological treatment method are found to be cost effective and gives high efficiency over other methods for the removal of dye compounds present in the textile effluent and hence in this present work an attempt is made to reduce the BOD, COD, TDS and TSS using biological method.

Introduction

Water is essential to all forms of life. The role of water in various phases of life processes and in industrial circles is a well-known factor. From the point of view of human existence, the requirement of water has been increased several folds to maintain health and hygiene. It is a primary duty of an individual to think about the recycling / reuse of industrial effluents as far as possible. India is developing in many sectors. Industries play a vital role in economic development. One among them is textile. The Indian textile industry is one of the largest segments of the Indian economy accounting for over one-fifth of the total industrial production. It occupies a unique place in our country and is one of the earliest to come into existence in India, it accounts for 14% of the total Industrial production, contributes to nearly 30% of the total exports and is the second largest employment generator after agriculture. It is a group of related industries, which uses a variety of natural (cotton, wool, etc.) and/or synthetic fibers to produce fabric. It is a significant contribute or to many national economies, encompassing both small and large-scale operations worldwide. A large proportion of the environmental issues are related to the use and discharge of water. The operations like dyeing in textile industries require large amount of water and the water coming out from such units is highly turbid and colorful. Effluents are generally hot, alkaline, and strong smelling and colored by chemicals used in dyeing processes. Some of the chemicals discharged are toxic. From the industry 80% of the input water will come out as effluent. This effluent is highly colored in nature with Chemical Oxygen Demand (COD), dye concentration. It has also contains surfactants, metal, salts solids, oil and possibly toxic organics, including phenols from dyeing and finishing and halogenated organics from processes such as bleaching. If such industrial effluents are discharged without proper treatment into the natural water bodies, the whole water will get polluted and loose it's aesthetic significance. The main sources of effluents generated by the textile processing industry originate from the washing and bleaching of natural fibers and from the dyeing and finishing steps. All these processes generate considerable volumes of effluents, which contain such chemical substances as dyes, alkalis, chromium, phenol, oils and waxes. The great variety of fibers, dyes, process acids and finishing products in use, these processes generate wastewater of great chemical complexity and diversity. The persistent compounds present in textile effluents belong to very diverse chemical classes, each used in relatively small amounts, such as polyacrylates, phosphonates, sequestering agents, deflocculation agents, antistatic agents for synthetic fibers, carriers in disperse dyeing of polyester, fixing agents in direct dyeing of cotton, preservatives and a large number of finishing axillaries used for fire and water proofing. A particular case of persistence in the wash effluent of raw wool consisting of an emulsion of detergents [26]. The main problem when treating industrial wastewater is the removal of dyes, BOD, COD, TDS, TSS, sulphides, chlorides etc. Physical, Chemical and Biological processes may carry out the removal of these constituents. Biological treatment is a suitable process for the removal of the bulk of organic load. COD, BOD, TDS, TSS etc are studied for treatment of wastewater. Textile wastewater is characterized mainly by measurement of Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Suspended solids (SS) and dissolved oxygen (DS). Typical characteristics of textile industry wastewater are represented in table1. Results in table1 show a large extent of variation from plant to plant and sample to sample. As presented in sample1 COD values of wastewater are extremely high compared to other parameter. In most cases BOD/COD ratio of the wastewater is around 0.25 that implies that the WW contains large amount of non-biodegradable organic matter [27].

Tele:
E-mail address: skanbarasi@gmail.com

Table.1 Textile industry wastewater characteristics

Parameters	Values
PH	7.0 – 9.0
BOD (mg/l)	80 - 6000
COD (mg/l)	150 – 12,000
TSS (mg/l)	15 – 8,000
TDS (mg/l)	2900 - 3100
Color (pt – co)	50 – 2500

Treating textile effluent is normally one of the last waste water management options to be considered. This is due to the high costs involved and to uncertainty about the treatment level achievable. The treatment of textile effluents should be considered where all other wastewater management measures fail to guarantee safe disposal or where it is financially attractive. Various treatment options are available for treatment of textile effluents before disposal. The methods are:

A physical process usually treats suspended, rather than dissolved pollutants. It may be a passive process, such as simply allowing suspended pollutants to settle out or float to the top naturally – depending on whether they are more or less dense than water. Absorption on activated charcoal is a physical process which can remove dissolved chemicals. Chemical flocculants may also be added to produce larger particles. To aid floatation process, dissolved air under pressure may be added to cause the formation of tiny bubbles which will attach to particles. Filtration through a medium such as sand as a final treatment stage can result in a very clear water. Membrane separation is another process available for the treatment purpose. A semi permeable membrane has been used for the separation of organic compounds out of that Reverse Osmosis (RO) is the suitable one for the treatment of dye effluent. Reverse osmosis process involves the passage of molecules through a semi permeable membrane. The driving force is pressure, selectivity and separation accomplished by characteristics of the membrane in general smaller molecules and lower valance materials are the more difficult to separate from the water. Biological method is widely used for treating soluble organic chemicals dissolved in water. Bacteria, fungi and other microorganisms convert soluble organic compound into bacterial cells and inorganic compounds. The biological treatment of textile wastewater depends on the preliminary technological processing of wastewater, which in turn facilitates the most important procedure, i.e. the biochemical adaptation of pollution in the final stage. Biological treatment plants are more commonly used to treat domestic or combined domestic and industrial effluent from a municipality. They use basically the same processes that would occur naturally in the receiving water, but give them a place to happen under controlled conditions, so that the cleansing reactions are completed before the water is discharged into the environment. The main objective of biological treatment of effluent is to remove the non-settable colloidal solids and to degrade other organic matter or to reduce the concentration of organic and inorganic compounds in the effluent. It is one of the most widely used removal methods for complete stabilization of biologically degradable substances in wastewater. This treatment processes involves the removal of biodegradable dissolved and colloidal organic matter. This is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_3, and H_2O). Several aerobic biological processes are used for secondary treatment differing primarily in the manner in which oxygen is supplied to the microorganisms and in the rate at which organisms metabolize the organic matter. High-rate biological processes are characterized by relatively small reactor volumes and high concentrations of microorganisms compared with low rate processes. Consequently, the growth rate of new organisms is much greater in high-rate systems because of the well controlled environment. The microorganisms must be separated from the treated effluent by sedimentation to produce clarified secondary effluent. The sedimentation tanks used in secondary treatment, often referred to as secondary clarifiers, operate in the same basic manner as the primary clarifiers described previously. The biological solids removed during secondary sedimentation, called secondary or biological sludge, are normally combined with primary sludge for sludge processing. Common high-rate processes include the activated sludge processes, trickling filters or biofilters, oxidation ditches, and rotating biological contactors (RBC). A combination of two of these processes in series (e.g., biofilter followed by activated sludge) is sometimes used to treat municipal wastewater containing a high concentration of organic material from industrial sources. A biological treatment method are found to be cost effective and gives high efficiency over other methods for the removal of dye compounds present in the textile effluent and hence in this present paper an attempt is made to reduce the BOD, COD, TDS and TSS using biological methods and the variables which influence the degradation are also optimized. Biological method uses microorganisms to catalyze the degradation of or transformation of various toxic chemicals to less harmful forms. The studies on the metabolism of organic contaminants are performed with bacteria. Bacteria generally are easier to culture and they grow more quickly than fungi. They are able to metabolize chlorinated and other organic contaminants. Microorganisms are ubiquitous. They are found in soil, air, water, food, sewage and on body surfaces. In short, every area of our environment is replete with them. A variety of microorganisms like Bacteria, Fungi , Algae and Viruses are found in nature. Bacteria are uni-cellular organisms which grow rapidly under warmth and moisture. Some specific types of bacteria are pathogenic and cause cross infection. Fungi, molds are complex organisms with slow growth rate. They live in natural habitats in which their growth is affected by interactions with populations of other microbes, as well as by the physical and chemical characteristics of their environment. Understanding the ecological interactions in microbial communities is extremely important to determine the role of microbes in nature. It is difficult to study microbes in nature; therefore, most of what we know about microbes has been learned from pure cultures. Microorganisms are cultured in the laboratory and it is used for this process. So that the above problems can be eradicated and also looking out for other new techniques. Degradation of textile effluents remains an environmental problem still satisfactorily unsolved. Wide ranges of pH, salt concentrations and chemical structures often add to the complication. Among the most economically viable choices available for effluent treatment and the most practical in terms of manpower requirements and running expenses to adopt and develop, appear to be the biological systems [25] Bacteria decolourisation is a promising alternative to replace or supplement present treatment processes. The future will probably bring the development of even more complex methods based on this process. Currently, ongoing efforts are now focused on the selection of new possibilities and its application for detoxification of other recalcitrant compounds.

More concerted efforts are still required to establish biological systems [23]. Of all the technologies investigated in waste cleaning. Biological method has emerged the most desirable approach for cleaning up many environmental pollutants. Biological method uses microorganisms to catalyze the degradation of or transformation of various toxic chemicals to less harmful forms. The studies on the metabolism of organic contaminants are performed with bacteria. Bacteria generally are easier to culture and they grow more quickly than fungi. They are able to metabolize chlorinated and other organic contaminants [26] Four microorganisms were used for the degradation of textile effluents. They are:

Mycorrhiza is a Greek word that means Root - Fungus. They are colorless in nature. This can help urban trees in a biological way that fertilizers and other synthetic treatments can't. Mycorrhizae help the tree by tapping nutrient rich soil spaces that the tree roots cannot reach by themselves. They make trees healthier and more beautiful. Mychorrhiza fungi may also form conduits for nutrients between plant species. These mycorrhizal fungi produce fungal threads that coat the plant roots, even penetrating the cells in many cases, getting nutrients from the plant while providing benefits for its host at the same time. Fungi are active at the pH level of 6.5

Staphylococci are Gram-positive spherical bacteria that occur in microscopic clusters resembling grapes and the cells are about 1 micrometer in diameter. Staphylococcus aureus forms a fairly large yellow colony on rich medium. Staphylococcus aureus can grow at a temperature range of 15 to 45 degrees and at NaCl concentrations as high as 15 percent. Nearly all strains of S. aureus produce the enzyme coagulase. The catalase test is important in distinguishing streptococci (catalase-negative) from staphylococci, which are vigorous catalase-producers. The test is performed by adding 3% hydrogen peroxide to a colony on an agar plate or slant. Catalase-positive cultures produce O_2 and bubble at once. The test should not be done on blood agar because blood itself contains catalase. The optimum temperature is 37 c and optimum pH for growth is 7.0-7.5.

Escherichia coli are a bacterium that is a common, but certainly not the most abundant inhabitant of the human intestine. It also lives in the intestine of many other animals, wild as well as domestic.

Bacillus represents a genus of Gram-positive bacteria which are ubiquitous in nature. (Soil, water and airborne dust). Some species are natural flora in the human intestines. When grown on blood agar, Bacillus produces large, spreading, gray-white colonies with irregular margins

Experimental Set Up and Procedure

Various samples were collected from the CETP and the BOD, COD, TDS, TSS of those samples was determined and the readings were noted. The microorganisms which are used for the degradation of textile effluents are isolated, identified and cultured in the laboratory. Batch studies were carried out in a 250ml conical flask fitted with a shaker for agitation. The known concentration of effluent was taken and microorganisms were added to it. Thus at different intervals of time, samples were drawn out and the parameters (BOD, COD, TSS, TDS) were determined. Similarly the experiments were carried out for each and every microorganism and the effect of parameters for different microorganisms was investigated and graphs are plotted. A mixed culture of organisms is also done. All the organisms which were chosen for degradation is mixed along with the effluent and tested for degradation. Same procedure is followed for mixed culture as that of individual cultures. This mixed culture is performed in order to know the effect of microorganisms on degradation of textile effluents.

Tolerance Limits prescribed by TNPCB for the industrial effluents

The tolerance limits prescribed by TNPCB for the industrial effluents discharged into inland surface water and public sewers are given below in table

Table 2. Tolerance limits for the industrial effluents.

Characteristics	Tolerance limits for industrial effluents discharged into	
	Inland surface water IS: 2490-1974	Public sewers IS: 3306-1974
BOD (mg/l)	30	500
COD (mg/l)	250	-
pH	5.5 – 9.0	5.5 – 9.0
Total suspended solids (mg/l)	100	600
Temperature (^{o}c)	40	45
Oil and grease (mg/l)	10	100
Phenolic compounds (mg/l)	1.0	5.0
Cyanides (as CN) (mg/l)	0.2	2.0
Sulphides (as S) (mg/l)	2.0	-
Fluorides (as F) (mg/l)	2.0	-

Materials and Methods

Water samples were collected at the treatment plant and were analyzed for BOD, COD, TDS and TSS. The determination of all these parameters is shown.

Determination of Biochemical Oxygen Demand (BOD)

The BOD level is determined by comparing the Dissolved Oxygen (DO) level of a water sample taken immediately with the DO level of a water sample that has been incubated in a dark location for 5 days. The difference between the two DO levels represents the amount of oxygen required for the decomposition of the BOD level. Take 2 samples of water taken and the DO level (ppm) of one sample is determined immediately. The second water sample is placed in an incubator in complete darkness at 20^{o}C for 5 days. After 5 days, DO reading (ppm) for another sample is determined. The difference between first day and fifth day reading gives BOD level.

BOD at 20^{o}Cof the sample

((Do – D_5) x Volume of bottle / sample) – (Co – C_5)

Determination of Chemical Oxygen Demand (COD)

A 50 ml sample is placed in a 500ml refluxing flask and the blank is prepared using 50 ml of distilled water. Glass beads are added to the mixture along with 1 g of Mercuric Sulphate ($HgSO_4$), 5 ml of conc. H_2SO_4 / $AgSO_4$ solution, and $HgSO_4$.

Then 20 ml of 0.25N potassium dichromate ($K_2Cr_2O_7$) and mix. After thorough mixing, the flask is attached to the reflux condenser and refluxed for 2 hours by applying heat. The apparatus is cooled at room temperature and the condenser is washed with distilled water. 4 to 5 drops of Ferroin indicator is added to the solution and titrated against 0.1N ferrous ammonium sulphate. The end point obtained is red-brown. This is repeated for sample.

COD = (A-B) x Normality of $Fe(NH_4)_2$ (SO_4) x 8 x 1000 / Volume of sample

Quantity of Fe $(NH_4)_2$ (SO_4) added for blank = A ml

Quantity of Fe $(NH_4)_2$ (SO_4) added for sample = B ml

Determination of Total Dissolved Solids (TDS)

Total dissolved solids are determined as the residue left after evaporation and drying of the filtered sample. A clean porcelain dish is ignited in a muffle furnace and after partial cooling in the air; it is cooled in a desiccator and weighed. 100 ml of filtered sample is placed in the dish and evaporated at 100^{o}C on water bath, followed by drying in oven at 103 ^{o}C for one hour. It is then dried and cooled in the dessicator and weighed.

TDS (mg/l) = (A- B) x 1000 / V

A = Final weight of the dish (mg)

B = Initial weight of the dish (mg)

V = Volume of sample taken (ml)

Determination of Total Suspended Solids (TSS)

Total suspended solids are determined as the residue left on gooch crucible or a glass after drying in oven. TSS of a sample is determined by pouring a carefully measured volume of water through a pre-weighed filter of a specified pore size. The filter paper is weighed again after drying to remove all water. The gain in weight is a dry weight measure of the particulates present in the water sample expressed in units derived or calculated from the volume filtered.

TSS (mg/l) = (W2 – W1) x 1000 / V

W1, W2 = recorded weight in mg.

V = Volume of sample taken.

Isolation, identification and culture of microorganisms

The techniques commonly used for isolation of discrete colonies initially require that the number of organisms in the inoculum be reduced. The resulting diminution of the population size ensures that, following inoculation, individual cells will be sufficiently far apart on the surface of the agar medium to effect a separation of the different species present. The several methods are used for isolation of micro organisms. Most commonly used methods are spread plate method and streak plate method. Identification is mainly based on morphology, shape, and color. This identification can be done by the staining methods. Various types of staining methods are simple staining, differential staining (gram staining), fungal staining etc. The most commonly used staining method is simple staining. After identification the microorganisms were cultured in the laboratory. Each and every microorganism has a specific test to be undergone. Thus every microbe is identified by using the tests. For example catalase test is important in identifying streptococci. Similarly various tests were performed for other microorganisms.

Results and Discussion

The experiment is carried out with the microorganisms. First the percentage BOD, COD, TDS and TSS is calculated for various pH of the effluent and from the optimum pH we are moving towards variation of the concentration of the effluent keeping the optimum pH as the pH of the solution. Next as said above the optimum incubation time and temperature of the effluent is found.

Physio–Chemical Characteristics of Textile Effluent on Usage of Mixed Cultures

Table 3. Physico – chemical characteristics of textile effluents.

Parameters	Before treatment	After treatment
pH	11.3	6.8
Color	Dark brown	Pale color
BOD	400 – 800 mg/l	100 – 200 mg/l
COD	1860 – 3000 mg/l	400 – 600 mg/l
TDS	38,000 mg/l	8,500 mg/l
TSS	17,000 mg/l	3,750 mg/l
Turbidity	High	Low

Effect of Time on BOD removal from Textile Effluent by Using Mixed Cultures

The effect of degradation of mychorrhiza species, staphylococcus species and E.Coli and bacillus species is depicted in the Fig 3. It is seen that the percentage of reduction of BOD increases with increase in time. BOD reduction is more in mixed culture when compared to all individual cultures. The concentration of BOD has been reduced from 373ppm to 41ppm. Thus about 89% of BOD removal is found in mixed culture where as the individual culture is concerned, staphylococcus species reduces the concentration of BOD from 375ppm to 52ppm. And bacillus species reduces the concentration of BOD from 382ppm to 74ppm. Thus about 86% and 80.8% of BOD removal is found respectively.

The other two cultures namely E.Coli and mychorrhiza species reduces the concentration from 392ppm to 86ppm and 403ppm to 103ppm. Thus they contribute about 78.3% and 74.6% of BOD removal. This result shows that the contribution of bacillus species and staphylococcus species in the mixed culture only reduces the concentration of BOD and increases the % removal of BOD.

Table3.1. Effect of time on BOD reduction

EFFECT OF MICROBES ON CONCENTRATION OF BOD					
Incubation time (hrs)	**Mixed culture**	**Mychorrhiza vertoni**	**Staphylococcus aureus**	**E.Coli**	**Bacillus subtilis**
0	373	392	375	403	382
4	281	332	291	341	299
8	192	275	195	293	203
12	123	196	148	229	154
20	88	131	97	192	91
20	53	97	63	124	76
24	43	89	57	107	79
28	41	86	53	103	74
32	41	85	52	102	73

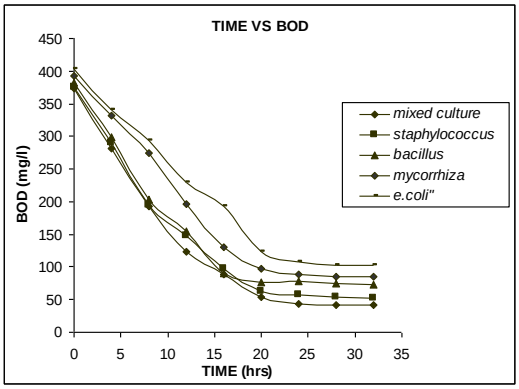

Fig 3.1. Effect of time on BOD reduction

Table 3.2 Effect of time on % removal of BOD

Incubation time (hrs)	EFFECT OF MICROBES ON % REMOVAL OF BOD				
	Mixed culture	**Mychorrhiza vertoni**	**Staphylococcus aureus**	**E.Coli**	**Bacillus subtilis**
0	24.6	15.3	22.4	15.4	21.7
4	48.5	29.8	48	27.2	46.8
8	67	49.6	60	43.1	59.6
12	76.4	66.5	74.1	52.3	76.1
20	85.7	75.2	83.2	69.2	77.4
20	88.4	77.2	84.8	73.4	79.3
24	89	78	85.8	74.4	80.6
28	89	78.3	86	74.6	80.8

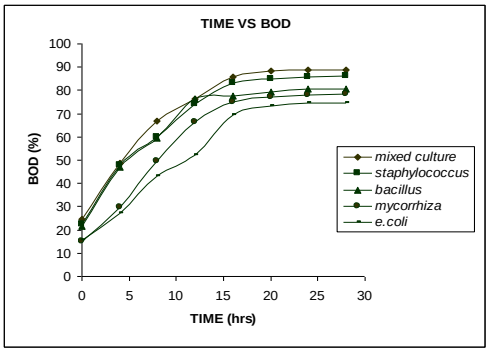

Fig 3.2. Effect of time on % removal of BOD.

Effect of Incubation Time on Cod Removal from Textile Effluent by Using Mixed Cultures

The effect of degradation of mychorrhiza species, staphylococcus species, bacillus species and E.Coli and is depicted in the Fig 3.3. It is seen that the percentage of reduction of COD increases with increase in time. COD reduction is more in mixed culture when compared to all individual cultures. The concentration of COD has been reduced from 1294ppm to 243ppm. Thus about 81.2% of BOD removal is found in mixed culture where as the individual culture is concerned, staphylococcus species reduces the concentration of COD from 1368ppm to 327ppm. And bacillus species reduces the concentration of COD from 1526ppm to 292ppm. Thus about 76% and 80.8% of COD removal is found respectively.

The bacillus species contribution is more in the % removal of COD when compared to staphylococcus species which reduces more BOD. The other two cultures namely E.Coli and mychorrhiza species reduces the concentration from 1608ppm to 408ppm and 1560ppm to 340ppm. Thus they contribute about 74.6% and 78% of COD removal. This result shows that the contribution of bacillus species and staphylococcus species in the mixed culture only reduces the concentration of COD and increases the % removal of COD.

Table 3.3 Effect of time on COD

Incubation time (hrs)	EFFECT OF MICROBES ON CONCENTRATION OF COD				
	Mixed culture	Staphylococcus aureus	Bacillus subtilis	Mychorrhiza vertoni	E.Coli
0	1294	1368	1526	1560	1608
4	1014	1126	1096	1328	1346
8	867	985	801	1003	1072
12	592	743	613	798	916
20	351	561	460	524	768
20	257	388	379	388	540
24	251	345	321	356	428
28	243	328	296	344	412
32	241	327	292	340	408

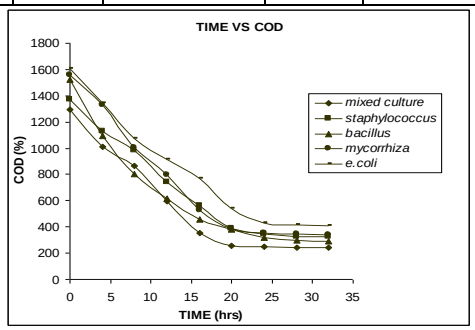

Fig 3.3. Effect of time on COD.

Table 3.4 Effect of time on % removal of COD

Incubation time (hrs)	EFFECT OF MICROBES ON % REMOVAL OF COD				
	Mixed culture	Staphylococcus aureus	Bacillus subtilis	Mychorrhiza vertoni	E.Coli
0	21.6	17.6	28.1	15	16.3
4	32.9	28	47.5	35.7	33.3
8	54.2	45.6	60	48.8	43
12	72.8	59	69.8	66.4	52.2
20	80	71.6	75.1	75.1	66.4
20	80.6	74.7	78.9	77.1	73.3
24	81.3	76	80.6	77.9	74.3
28	81.2	76	80.8	78	74.6

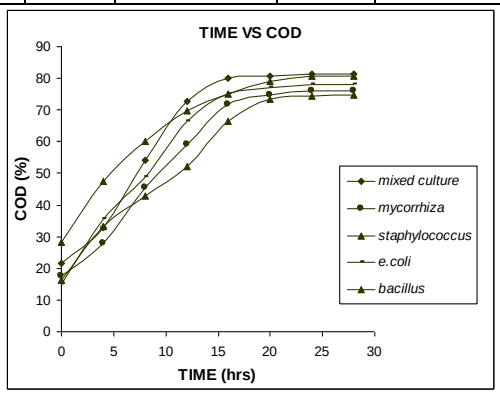

Fig 3.4. Effect of time on % removal of COD.

Effect of Incubation Time on Tds Removal from Textile Effluent By Using Mixed Cultures

The effect of degradation of mychorrhiza species, staphylococcus species, bacillus species and E.Coli and is depicted in the Fig 3.5.It is seen that the percentage of reduction of TDS increases with increase in time. TDS reduction is more in mixed culture when compared to all individual cultures. The concentration of TDS has been reduced from 20,160ppm to 8075ppm. Thus about 60.2% of TDS removal is found in mixed culture where as the individual culture is concerned, mychorrhiza species reduces the concentration of TDS from 20,142ppm to 11280ppm. And E.Coli reduces the concentration of TDS from 20,169ppm to 11324ppm. Thus about 44% and 43.8% of TDS removal is found respectively.The mychorrhiza species contribution is more in the % removal of TDS when compared to E.Coli.

The other two cultures namely staphylococcus species and bacillus species reduces the concentration from 21,020ppm to 13,020ppm and 20,984ppm to 13,100ppm. Thus they contribute about 38.1% and 38% of TDS removal. There is no much difference for this two species. Both remove equal % of TDS. This result shows that the contribution of mychorrhiza species and E.Coli In the mixed culture only reduces the concentration of TDS and increases the % removal of TDS.

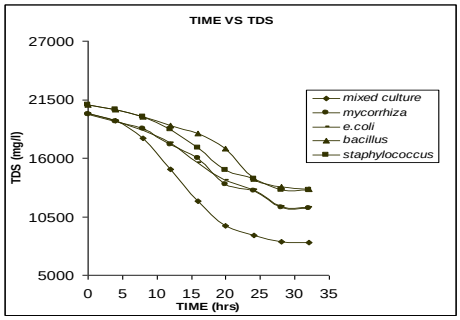

Fig 3.5 Effect of time on TDS

Table 3.5. Effect of time on TDS

Incubation time (hrs)	EFFECT OF MICROBES ON CONCENTRATION OF TDS				
	Mixed culture	Mychorrhiza vertoni	E.Coli	Bacillus subtilis	Staphylococcus aureus
0	20160	20142	20169	20984	21020
4	19504	19420	19532	20542	20589
8	17850	18763	18637	19897	19876
12	14970	17298	17429	19032	18724
20	11959	15974	15546	18286	16947
20	9631	13560	13924	16872	14844
24	8756	12897	12981	14049	14024
28	8142	11346	11466	13275	13021
32	8075	11280	11324	13100	12996

Table 3.6 Effect of time on % removal of TDS

Incubation time (hrs)	EFFECT OF MICROBES ON CONCENTRATION OF TDS				
	Mixed culture	Mychorrhiza vertoni	E.Coli	Bacillus subtilis	Staphylococcus aureus
0	3.2	3.5	3.1	2.1	2
4	11.4	6.8	7.6	5.1	5.4
8	19.9	14.1	13.5	9.3	10.9
12	40.4	20.6	21.4	12.8	19.3
20	48.2	32.6	30.9	19.5	30
20	57.4	36	35.6	33	33.2
24	60	43.6	43.1	36.7	38
28	60.2	44	43.8	38	38.1

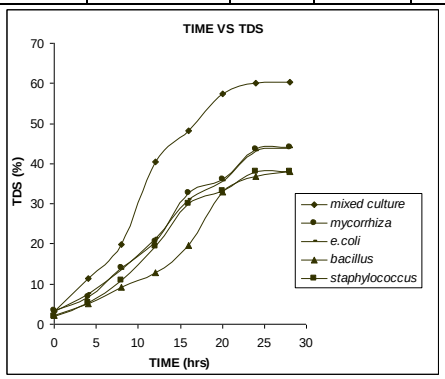

Fig 3.6 Effect of time on % removal of TDS.

Effect Of Incubation Time On Tss Removal From Textile Effluent By Using Mixed Cultures

The effect of degradation of mychorrhiza species, staphylococcus species, bacillus species and E.Coli and is depicted in the Fig 3.7. It is seen that the percentage of reduction of TSS increases with increase in time. TSS reduction is more in mixed culture when compared to all individual cultures. The concentration of TSS has been reduced from 14,280ppm to 8640ppm. Thus about 40% of TSS removal is found in mixed culture where as the individual culture is concerned, E.Coli reduces the concentration of TSS from 14,720ppm to 10,490ppm. And mychorrhiza species reduces the concentration of TSS from 16,960ppm to 11,723ppm. Thus about 30.8% and 27.8% of TSS removal is found respectively. The mychorrhiza species contribution is less in the % removal of TSS when compared to E.Coli.

The other two cultures namely staphylococcus species and bacillus species reduces the concentration from 15,076ppm to 11,524ppm and 15,874ppm to 11,892ppm. Thus they contribute about 23% and 25% of TSS removal. Thus the % removal of TSS is more in bacillus species than staphylococcus. This result shows that the contribution of mychorrhiza species and E.Coli In the mixed culture only reduces the concentration of TSS and increases the % removal of TSS.

Table 3.7 Effect of time on TSS.

Incubation time (hrs)	Effect of Microbes on Concentration of TSS				
	Mixed culture	E.Coli	Mychorrhiza vertoni	Staphylococcus aureus	Bacillus subtilis
0	14280	14720	16960	15076	15874
4	13300	14215	16460	14754	15432
8	12600	13946	15900	14290	15003
12	11440	12810	15220	13798	14786
20	10600	12130	13984	13256	13705
20	9750	11400	12746	12653	12987
24	9000	10820	12094	12013	12542
28	8690	10540	11946	11785	12048
32	8640	10490	11723	11524	11892

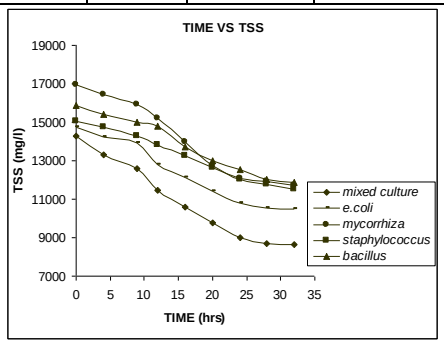

Fig 3.7 Effect of time on TSS.

Table 3.8 Effect of time on % removal of TSS.

Incubation time (hrs)	EFFECT OF MICROBES on % REMOVAL OF TSS				
	Mixed culture	E.Coli	Mychorrhiza vertoni	Staphylococcus aureus	Bacillus subtilis
0	6.8	2.9	3.4	2.1	2.7
4	10.7	6.2	5.2	5.2	5.4
8	19.8	9.1	13	8.4	8.2
12	23.3	17.5	15.5	12	13.6
20	28.5	24.8	22.5	16	
20	36.1	28.6	26.4	20.3	
24	39.3	29.5	26.9	22	
28	40	30.8	27.8	23	

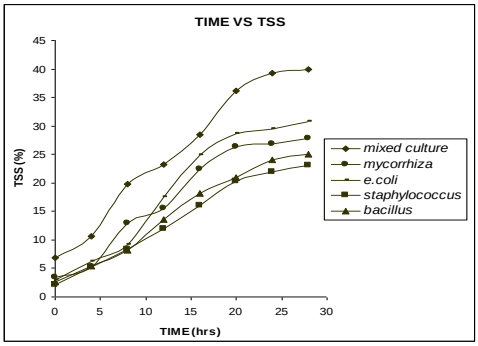

Fig 3.8. Effect of time on % removal of TSS.

Conclusion

Degradation of textile effluents remains an environmental problem still satisfactorily unsolved. Wide ranges of pH, salt concentrations and chemical structures often add to the complication. Among the most economically viable choices available for effluent treatment/decolourisation and the most practical in terms of manpower requirements and running expenses to adopt and develop, appear to be the biological systems. Bacteria decolourisation is a promising alternative to replace or supplement present treatment processes. The future will probably bring the development of even more complex methods based on this process. Currently, ongoing efforts are now focused on the selection of new possibilities and its application for detoxification of other recalcitrant compounds. More concerted efforts are still required to establish biological decolourisation systems. From the present study it may be concluded that the removal of BOD, COD, TDS and TSS from the textile effluents by biological methods has been found to control water pollution

Reference

[1] Abd El-Rahim WM, Moawad H, Khalafallah M. J Basic Microbiol (2003) "Microflora involved in textile dye waste removal", Vol. 43(3), pp. 167-74

[2] McMullan G, Meehan C, Conneely A, Kirby N, Robinson T, Nigam P, Banat IM, Marchant R, Smyth WF (2001) "Microbial Decolourisation and degradation of textile dyes", Appl Microbiology Biotechnology, Vol. 56(1-2), pp. 81-87.

[3] Martins MA, Lima N, Silvestre AJ, Queiroz MJ. (2003) "Comparative studies of fungal degradation of single or mixed bioaccessible reactive azo dyes", Chemosphere, Vol. 52(6), pp. 967-973.

[4] Amaral PF, Fernández DL, Tavares AP, Xavier AB, Chamarrota MC, Coutinho JA, Coelho MA. (2004) "Decolourisation of dyes from textile wastewater by Trametes versicolor",Environ Technology, Vol. 25(11), pp. 1313-1320.

[5] Wesenberg D, Kyriakides I, Agathos SN. Wesenberg D, Kyriakides I, Agathos SN. "White-rot fungi and their enzymes for the treatment of industrial dye effluents"

[6] M. Adosinda M. Martins, Nelson Lima, Armando J. D. Silvestre and M. João Queiroz. (2003) "Comparative studies of fungal degradation of single or mixed bioaccessible reactive azo dyes", J Basic Microbiology, Vol. 43(3), pp. 167-174

[7] Chen KC, Huang WT, Wu JY, Houng JY.(1999) "Microbial Decolourisation of azo dyes by Proteus mirabilis", J Indian Microbiol Biotechnology, Vol. 23(1), pp. 686-690

[8] Chen KC, Wu JY, Huang CC, Liang YM, Hwang SC. (2003) "Decolorization of azo dye using PVA-immobilized microorganisms", J Biotechnology, Vol. 101(3), pp. 241-52.

[9] McMullan G, Meehan C, Conneely A, Kirby N, Robinson T, Nigam P, Banat IM, Marchant R, Smyth WF, "Microbial Decolourisation and degradation of textile dyes"

[10] Nataro, James P. and James B. Kaper. (1998) "Diarrheagenic *Escherichia coli*." Clinical Microbiology Reviews, American Society for Microbiology, Vol. 11, no. 1, pp. (142-201)

[11] Blattner, Frederick R., Guy Plunkett III, Craig A. Bloch, Nicole T. Perna, Valerie Burland, Monica Riley, Julio Collado-Vides, Jeremy D. Glasner, Christopher K. Rode, George R. Mayhew, Jason Gregor, Nelson Wayne Davis, Heather A. Kirkpatrick, Michael A. Goeden, Debra J. Rose, Bob Mau, and Ying Shao. (1997) "The complete genome sequence of Escherichia coli K-12.", Science, Vol. 277, pp. 1453-1462

[12] Abbott, Sharon L., Jennifer O'Connor, Tom Robin, Barbara L. Zimmer, and J. Michael Janda. (2003) "Biochemical properties of a newly described Escherichia species, Escherichia albertii", Journal of Clinical Microbiology, American Society for Microbiology, Vol. 41, no. 1, pp. 4852-4854

[13] Choi.Y.S, J.H.Cho Environmental Technology, "Color Removal from Dye Wastewater Using Vermiculite" Vol 17 No. 11, pp. 1169 – 1180.

[14] LibraJ.A.SosathF. (2003) "Combination of biological and chemical processes for the treatment of textile waste water containing reactive dyes", J of chemical technology & biotechnology, Vol 78, pp. 1149-1156.

[15] Ugoji EO, Aboaba OO. (2005) "Biological treatment Of Textile Industrial Effluents in Lagos Metropolis, Nigeria", Environment Int.

[16] Chen KC, Huang WT, Wu JY, Houng JY. (1999) "Microbial Decolourisation of azo dyes by Proteus Mirabilis", J Indian Microbiological Biotechnology.

[17] Steffan S, Bardi L, Marzona M. (2005) "Degradation by microbial cultures immobilized in alginate beads", Environmental International.

[18] Li Y, Xi DL (2001) "Decolourisation and biodegradation of dye wastewaters by a facultative – aerobic process", Bioresearch Technology.

[19] Marek Lebiedowski "Biological removal of impurities from textile industry wastewaters: an assessment".

[20] Libra J.A., Sosath F. (2003) "Combination of biological and chemical processes for the treatment of textile wastewater containing reactive dyes", Journal of Chemical Technology & Biotechnology, Vol. 78, no.11, pp.1149-1156(8)

[21] Wamik Azmi and U. C. Banerjee. (2002) "Biological Stabilization of Textile and Dye Stuff Industrial Waste", Indian Chemical Engineer, Vol.44, No.4

[22] N. Rajamohan and C. Karthikeyan "Fungal Biodegradation of Dye house Effluent and Kinetic Modeling".

[23] Yongjie Miao "Biological remediation of dyes in textile effluent: a review on current treatment technologies".

[24] Masud Hussain SK, Ibrahim SH, Anantharaman N, Sheriffa Begum KMM. (2003) "Degradation of lignin by white-rot fungus", Eco Env Conserv, Vol. 9(1), pp. 7-14

[25] C.Lopez, I.Mielgo, M.T.Moreira, G.Feijoo, J.M. (2002) "Enzymatic membrane reactors for biodegradation of recalcitrant compounds. Application to dye decolorization", Lema Journal of Biotechnology, Vol. 9, pp. 249-257

[26] Asamudo, N.u. , A.S.Daba and O.U.Ezeronye. (2005) "Bioremediation of Textile effluent using Phanerochaete Chrysosporium", African Journal of Biotechnology Vol. 4(13), pp.1548-1453

[27] Adel-Kdasi, Azni Idris, Katayon Saed and Chuah Teong Guan.(2004) "Treatment of textile wastewater by advanced Oxidation processes- A Review", The Int. Journal, Vol 6, No 3, pp 226-234.