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A NOVEL INVESTIGATION IN NATURAL MEDIA BY USING MBBR REACTOR

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ABSTRACT

Giant Sequoia cone seed is studied by using in MBBR reactor method that investigates the dosage of bio-sorbent, contact time and initial concentration of the solution to the BOD, COD and color removal. Temperature is the main parameter to be maintained in oxidation process. It is tested in low (10'c) and high (65'c) temperature. So the process of oxidation with attached growth biofilm method conducted for different temperature of thermophilic and psychrophilic condition. Samples were analysed using UV Visible Spectrophotometer (UV-Vis), It was observed that treated Giant Sequoia cone seed able to achieve 50.72%,
68.25 % of color removal efficiency at psychrophilic and thermophilic temperature condition where pH is 6-8, contact time is 180-240 minutes and acts as Media for the MBBR with excellent organic load reduction at low retention time. This research also observed that treated Giant Sequoia cone seed results in an alternative for removing color and natural media for MBBR that shows a good reduction of colored wastewater.
Key words: MBBR, thermophilic and psychrophilic condition, alternative media

INTRODUCTION

1.1 GENERAL

1.1.1 Membrane Biofilm Reactor

MBBR is measured as a fast physical process to reduce the organic load which can help to reduce the color also with in short time. The binding of metal ions by natural materials may possibly take place through two types of bio-sorption process which are physical (electrostatic interaction and van der Waals forces) or chemical (ion exchange) process. According to the researchers, the composition of the cell wall is of great significance to the bio-sorption process with MBBR system gives better result for the treatment of effluent.

1.1.2 Process

Biological waste water treatment is designed to degrade pollutants dissolved in effluent by the action of micro-organisms. The micro-organisms utilize these substances to live and reproduce. Prerequisite for such degradation activity, however, is that the pollutants are soluble in water and non-toxic. Aerobic micro-organisms require oxygen to support their metabolic activity. In effluent treatment, oxygen is supplied to the effluent in the form of air by special aeration equipment. Aerobic treatment allows fully biological degradation of tannery effluent from the leather tannery industry. Aerobically operated plant exhibit higher plant stability and are less sensitive to fluctuations in effluent and plant parameters.

There is currently growing interest in the MBR process in municipal and industrial wastewater treatment. MBR is used in the leather tannery industries as end-of-pipe technology as well as process integrated measure for the reduction of the concentration of detrimental substances in the water circuit. Especially in terms of effluent quality and economical aspects a MBR is a sustainable technology for the industrial wastewater treatment.

Water is one of the basic necessities of life. Wastewater has to be treated efficiently. The capacity and effluent quality of treatment plants must improve in order to meet the increased wastewater load, caused by growing populations. In addition to this, treatment plants often need to be compact, odor-free and almost invisible incorporated into the city environment. In the recent year, the treatment of water is considered to be very essential before its discharge to the environment, as it needs public health protection from water borne diseases, environmental protection of out land and water. Hence the organic solids and inorganic solids are to be removed by suitable treatment technologies.

1.1.3 Purpose of MBBR

MBBR is a highly effective biological treatment process based on a combination of conventional activated sludge process and biofilm media. The MBBR process utilized floating High Capacity Microorganism Biochips media within the aeration and anoxic tanks. The microorganisms consume organic material. The media provides increased surface area for the biological microorganisms to attach and grow. The increased surface area reduced the footprint of the tanks required to treat the wastewater. The treatment process can be aerobic and/or anaerobic and operates at high volume loads.

1.2 IMPACT AND CONTROL OF TANNERY EFFLUENT ON ENVIRONMENT

- Tannery transforms raw hides and skins into leather for manufacturing articles like shoes, bag, suitcase, belt, wallet and jacket.
- **Soil profiles :** Soil is crucial for most plants and animals life as a growth substrate for their continual growth and development. The contamination of soils with heavy metals or micronutrients in phytotoxic concentrations generates adverse effects not only on plants but also poses risks to human health.
- **Water profiles :** Tannery effluents are of large scales environment concern because they color and

diminish the quality of water bodies into which they are released. Tannery waste also include biodegradable organic matter which have the main problem on depression of dissolved oxygen content in stream water caused by microbial decomposition.

- **Plant and vegetables growth :** Tannery wastewater produces phytotoxic effects, and high accumulation of heavy metals resulting in stress for plants and greatly affect the process of respiration, photosynthesis, shorten germ sprouting and mitotic activities and also increases the production of reactive oxygen species**.** Tannery sludge is a combination of hair, fleshing, shaving, splits, skin trimmings, leather trimmings, buffing dust and wastewater treatment sludge.
- **Atmospheric system :** The air we breathe is an essential ingredient for our well being and healthy life. Chromium present in the atmosphere originates from anthropogenic sources, as well as from natural sources, industrial activities still remain the major source of pollution to the atmospheric systems.
- **Humans and animal health :** Most micro-organisms are sensitive to Cr toxicity but some groups possess resistance mechanisms to Cr and can tolerate high level by converting from toxic Cr(VI) to essential Cr (III) form. Chromic exposure of tannery workers from a period of five months to fourteen years represents a relevant risk factor for the development of diseases associate with genetic damage.
- **Chromium impact on the biota :** chromium is an essential metal that is involved in the metabolism of glucose in human and animal, but its Cr(VI) for is toxic, mutagenic and carcinogenic. Cr(VI) is highly mobile in most environments, mainly due to its soluble nature and in negatively affects the environment due to its eminent solubility, mobility and responsiveness.
- **Effluent Physico – Chemical Parameters :** Based on different researcher there were different output physical-chemical parameters of tannery sewage in water soil and vegetables contaminated by untreated sewage discharging at different times in various areas. The characteristic of tannery effluent varies between read and black soil type both under controlled ad different concentrated effluent.

1.3 TREATMENT METHODS OF TANNERY EFFLUENT

Tannery wastewater is generally treated by various physic-chemical and biological methods and by a combination of both Physical and chemical processes. In general there are many different phase treatment methods.

- **Preliminary treatment :** In the case of common effluent treatment plants for examining tannery clusters often found in developing countries to remove large particles, sand/grid and grease, but also to significantly reduce the content of chrome and sulphides before the effluent is discharged into the collection tank.
- **Physical – Chemical treatment (primary) :** A method basically used for then removal of settle able organic and inorganic solids by sedimentation, and the removal of material that will float by skimming appox.. 25-50% of BOD, 50-70% of TS and 65% of the oil and grease , are removed during primary treatment the effluent and sludge from primary sedimentation are referred to as primary effluent and sludge.

- **Biological treatment (secondary) :** Used for the removal biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes by aerobic micro-organisms that metabolize the organic matter in the wastewater, thereby producing more micro-organic and inorganic end products.
- **Advanced treatment (tertiary) :** is employed to reduce residual COD load and/or when specific wastewater constituents are not removed by previous treatment stages.
- **Sludge handling and disposal :** effluent treatment plants produce treated, "cleaned " effluent and sludge because inherently the primary aim of waste water treatment is the removal of solids and some potentially hazardous substances from the wastewater. Biologically degradable organic substances are converted into bacterial cells, and the latter are removed from the wastewater.

1.4 COMPOUNDS OF WASTEWATER

Tannery wastewater are basin have a dark brown and have a high content of organic substances that vary according to the chemical used. Important pollutants associated with the tanning industry include chlorine, tanneries, chromium, sulphate and sulphides as addition to trade organic chemical and increasing use of synthetic chemicals such as pesticides, dyes and finishing agents, as well as from the use of newer processing chemical solvent. These substances are frequently toxic and persistent, affect both human health and the environment, tannery effluent is among one of the hazardous pollutants of industry.

Major problems are due to wastewater containing heavy metal, toxic chemicals, chlorine, lime with high dissolved and suspended salt and other pollutants. Many conventional processes were carried out to treatment wastewater from tannery industry such as biological process and chemical process. Among these, physical and chemical method are considered very expensive in terms of energy and reagents consumption. Various microorganisms are capable of reducing the content of pollutants significantly by utilizing them as energy and nutrient source in the present or absences of oxygen.

1.5 CHARACTERISTICS OF WASTEWATER

The characteristics of tannery wastewater vary considerably from tannery to tannery depending upon the size of the tannery, chemical used for a specific process, amount of water used and type of final product produced by a tannery. Tannery wastewater is characterized mainly by measurement of BOD, COD, color, TDS, TSS.

Table no 1.1 characteristics and water disposal

SI.NO	PARAMETER	WASTEWATER	PERMISSIBLE LIMIT
1	Ph	8.3	5.5-9
2	TDS	21300	2100
3	TSS	1250	600
4	COD	12840	250

5	BOD	4460	30
6	Color	40pt/co	250pt/co

1.6 GIANT SEQUOIA CONE SEED

The giant sequoia regenerates by seed . The seed cones are 4–7 cm (1 ½–3 in) long and mature in 18–20 months, though they typically remain green and closed for as long as 20 years. Each cone has 30–50 spirally arranged scales, with several seeds on each scale, giving an average of 230 seeds per cone. Seeds are dark brown, 4–5 mm (0.16–0.20 in) long, and 1 mm (0.04 in) broad, with a 1-millimeter (0.04 in) wide, yellow-brown wing along each side. Some seeds shed when the cone scales shrink during hot weather in late summer, but most are liberated by insect damage or when the cone dries from the heat of fire. Young trees start to bear cones after 12 years.

1.7 AIM OF THE STUDY

The scope of the study is to be specific MBBR with natural media in thermophilic and psychrophilic temperature condition to treat tannery wastewater. The biofilm carriers used in these experiments were giant sequoia cone seed.

The reason that giant sequoia cone seed carrier was selected to be used in this experiment over other media was the advantages of tine, distribution and smooth biomass growth on their surface. The result were compared and evaluated in terms of and COD, biochemical oxygen demand removal efficiency to determine the optimal FLR, OLR, HRT and sequence batch reactor.

1.8 OBJECTIVE OF THE STUDY

- To remove the COD BOD and Color from the effluent by oxidation process in psycro phillic and thermophilic condition.
- To finding the performance of natural media in different temperature condition
- To reduce the pollution and health problems caused by organic content from the leather tannery industry.

MATERIALS AND METHODS

2.1 MATERIALS

2.1.1 Natural Media

Giant sequoia specimens are the most massive individual trees in the world. They grow to an average height of 50–85 m (164–279 ft) with trunk diameters ranging from 6–8 m (20–26 ft). Record trees have been measured at 94.8 m (311 ft) tall. The specimen known to have the greatest diameter at breast height is the General Grant tree at 8.8 m (28.9 ft). Between 2014 and 2016, specimens of coast redwood were found to have greater trunk diameters than all known giant sequoias. The trunks of coast redwoods taper at lower heights than those of giant sequoias which have more columnar trunks that maintain larger diameters to greater heights.

The oldest known giant sequoia cone is 3,200–3,266 years old based on dendrochronology. Giant sequoias are among the oldest living organisms on Earth. The sap contains tannic acid, which provides significant protection from fire damage. The leaves are evergreen, awl-shaped, 3–6 mm ($\frac{1}{8}$–$\frac{1}{4}$ in) long, and arranged spirally on the shoots. The giant sequoia regenerates by seed. The seed cones are 4–7 cm (1 $\frac{1}{2}$–3 in) long and mature in 18–20 months, though they typically remain green and closed for as long as 20 years. Each cone has 30–50 spirally arranged scales, with several seeds on each scale, giving an average of 230 seeds per cone. Seeds are dark brown, 4–5 mm (0.16–0.20 in) long, and 1 mm (0.04 in) broad, with a 1-millimeter (0.04 in) wide, yellow-brown wing along each side. Some seeds shed when the cone scales shrink during hot weather in late summer, but most are liberated by insect damage or when the cone dries from the heat of fire. Young trees start to bear cones after 12 years.

Figure 3.1 giant sequoia cone seed

A large tree may have as many as 11,000 cones. Cone production is greatest in the upper portion of the canopy. A mature giant sequoia disperses an estimated 300–400 thousand seeds annually. The winged seeds may fly as far as 180 m (590 ft) from the parent tree.

2.1.2 Artificial groves

In 1974, a group of giant sequoias was planted by the United States Forest Service in the San Jacinto Mountains of Southern California in the immediate aftermath of a wildfire that left the landscape barren. The giant sequoias were rediscovered in 2008 by botanist Rudolf Schmid and his daughter Mena Schmidt while hiking on Black Mountain Trail through Hall Canyon. Black Mountain Grove is home to over 150 giant sequoias, some of which stand over 6.1 m (20 ft) tall. This grove is not to be confused with the Black Mountain Grove in the southern Sierra. The two groves are located approximately 175 mi (282 km) southeast of the southernmost naturally occurring giant sequoia grove, Deer Creek Grove.

2.1.3 Citric acid for media activation

Citric acid was first isolated in 1784 by the chemist Carl Wilhelm Scheele, who crystallized it from lemon juice. It can exist either in an anhydrous form or as a monohydrate. The anhydrous form crystallizes from hot water, while the monohydrate forms when citric acid is crystallized from cold water. The monohydrate can be converted to the anhydrous form at about 78°C. Citric acid also dissolves in absolute ethanol (76 parts of citric acid per 100 parts of ethanol) at 15°C. It decomposes with loss of carbon dioxide above about 175°C.

Citric acid is normally considered to be a tribasic acid, with pKa values, extrapolated to zero ionic strength, of 2.92, 4.28, and 5.21 at 25 °C. The pKa of the hydroxyl group has been found, by means of C NMR spectroscopy, to be 14.4. The speciation diagram shows that solutions of citric acid are buffer solutions between about pH 2 and pH 8. In biological systems around pH 7, the two species present are the citrate ion and mono - hydrogen citrate ion. The SSC 20X hybridization buffer is an example in common use. On the other hand, the pH of a 1 M solution of citric acid will be about 3.2. The pH of fruit juices from citrus fruits like oranges and lemons depends on the citric acid concentration, being lower for higher acid concentration and conversely.

2.1.4 Spectro photometer for analysis of colour

Spectrophotometry is the quantitative measurement of the reflection or transmission properties of a material as a function of wavelength. It is more specific than the general term electromagnetic spectroscopy in that spectrophotometry deals with visible light, near-ultraviolet, and near-infrared, but does not cover time-resolved spectroscopic techniques.

2.1.5 MBBR system with air supply system

The moving bed bio film reactor is a biological wastewater treatment process in which microorganisms grow as biofilm on suspended carriers. This keeps check of BOD, COD, pH and many other parameters that would affect the quality of wastewater. The waste water contains about 99.7% to 99.9 % liquid waste and 0.1 % to 0.3 %of solid waste and millions of microorganisms. The organic solid which can be undergo decomposition by micro-organism will fix the characteristics of the sewage and measured in term of BOD.

2.2 MEDIA PREPARATION

Giant sequoia cone seed was used as bio-sorbent to remove color from aqueous solution and used as media for biological growth in MBBR. Giant sequoia cone seed were collected at rural area near by ETP plant. Upon collection, the seed were washed and dried for better media action with distilled water for few times to remove dust and impurities. The fruits were soaked with citric acid solution of 1% and dried normal temperature for some hours until it is free from color and moisture. Then Giant sequoia cone seed were kept in less moisture interactive area for further use.

2.3 EFFLUENT SAMPLE COLLECTION

In other words, a contaminant identified by one test in one category can also be identified in another test in a separate category. For example, the organics in a wastewater sample represented by BOD will also be represented in the spectrum of solids, either as TSS or TDS particulates. For most people a complete understanding of the standard methods required to accurately complete critical wastewater analytical tests are not necessary.

Analytical tests aimed at establishing the concentration (typically in mg/L or ppm) of organic (i.e., carbon-containing) matter have traditionally been used to determine the relative "strength" of a wastewater sample. Today there are four common laboratory tests used to determine the gross amount of organic matter (i.e., concentrations > 1.0 mg/L) in wastewater:1. BOD 2. COD 3. Total Organic Carbon)4. O&G (oil and grease)

The sample of colored wastewater coming from tanning industry. Pre-treatment of effluent will be the equalisation, neutralisation and primary settling process (DAF).After the treatment of effluent having greenish colour with following Effluent characteristics.

Table 3.1 MBBR Feed effluent characteristics.

SL.NO	PARAMETER	READING
1	**pH**	**8.9**
2	**TDS**	**5250 ppm**
3	**TSS**	**3150 ppm**
4	**COD**	**6734 ppm**
5	**BOD**	**1650 ppm**
6	**Color**	**1250 pt/co**

2.4 ADSORPTION STUDIES

Three important parameters were going to study in this project for untreated and treated CE fruits which are pH, TDS, TSS, Color, COD and BOD, Temperature of process, contact time of bio sorbents with the effluent. All of these parameters are impotent in treatment process. The ultraviolet visible spectro photometer used to find out the colour value. The percentage of colour removal for each of parameters studied was calculated using the equation below:

$$\text{Percentage of colour removal} = [(\text{Cinital} - \text{Cexit}) / (\text{Cinitial})] \times 100.$$

2.5 EXPERIMENTAL SET-UP

The moving bed biofilm reactor (MBBR) technology is an attached growth biological treatment process based on a continuously operating, non-clogging biofilm reactor with low head loss, a high specific biofilm surface area, and no requirement for backwashing. MBBR is often designed as aerobic system. Sample will be coming from pulp plant which is located in outside of ETP area and its parameters will be evaluated prior to treatment. Dimension of tank is 3.5*4*3 m. The proposed moving bed biofilm

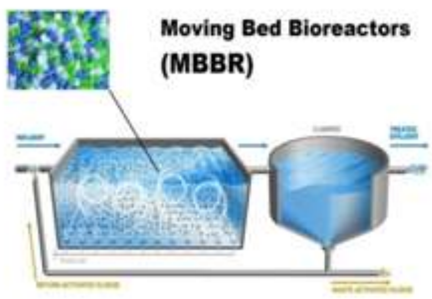

Figure 2.2 Model MBBR system

Figure 2.3 Original MBBR Systems

2.6 PROCESS DESCRIPTION

Here we have carried out an experiment in MBBR to treat waste water of a pulp plant. Experimental area of MBBR media (carrier) were placed into suspended state, maintained by continuous aeration flow. HRT of 4hrs and 12hrs was maintained to treat the water. The MBBR process uses floating natural carriers within the aeration tank to increase the amount of microorganism to treat the wastewater. This microorganism consumes organic material the carrier provides increased surface area for biological microorganisms to grow in the aeration tank. The media will be in continuous suspension from the aeration system that adds oxygen at the bottom of the aeration tank. After treatment final treated effluent will be taken outside through outlet.

3.1 RESULT AND DISCUSSION

The performances evolution of MBBR was studied for the different HRT values 4hrs and 12hrs. While evaluating the performance BOD parameter were analysed. The micro-organisms present in the wastewater used the atmospheric oxygen for their survival. The lack of oxygen leads to the decrease in the removal efficiency. The BOD removal efficiencies under constant aeration flow rate for the retention time 4hrs. and 12 hrs. is seen up to respectively.

The contaminated water collected from equalization water. Which contains more contaminants like pH, TDS, Turbidity, TSS, COD, BOD, color etc., removed by MBBR system by maintaining the proper microbes growing parameters. The DO of system has been maintaining by air blower in MBBR system and the MLSS, SV 30 will be maintained by sludge recirculation from secondary clarifier. Secondary clarifier has separates the sludge and the clear water by gravitational force. The sludge volume in the MBBR system is 450-650ml/l maintained. Which is measured by standard measuring cylinder.

Figure 3.1 Sample after MBBR process at normal temperature condition

Figure 3.2 sample of after clarification system

The treated water color and clarity of effluent treated by MBBR system by using natural media of giant sequoia seed. The color value of the inlet effluent is 1067pt/co units. Which is more color compared to textile waste water. But it consumes more power and time to remove by the ion exchange system. The giant sequoia seed are comfortable to remove the color with acting as media in MBBR system has been successfully found from this process. The final end colour value of the effluent is 267pt/co is good result.

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Table 3.1 comparison of influent and effluent

SL.NO	PARAMETER	AFTER PRE TREATMENT INFLUENT	EFFLUENT at 35'c	EFFLUENT at 10'C	EFFLUENT at 60'C
1	Ph	7.45	7.45	7.45	7.45
2	TDS(ppm)	5270 ppm	5310 ppm	5310 ppm	5310 ppm
3	TSS (ppm)	265 ppm	35 ppm	35 ppm	35 ppm
4	COD(ppm)	5649 ppm	265 ppm	2102 ppm	223 ppm
5	BOD (ppm)	1423 ppm	93 ppm	1008 ppm	83 ppm
6	COLOR (pt/co)	1067 pt/co	267 pt/co	753 pt/co	241 pt/co

Table 3.2 Effluent COD reduction based on retention time

SL.NO	RETENSION TIME (Hr)	COD (ppm)	COD (ppm) at 10'c	COD (ppm) at 60'c
1	0	5649	5649	5649
2	1	4762	5267	4456
3	2	3550	4653	3412
4	3	2161	4031	2105
5	4	1080	3578	1010
6	5	265	2102	223

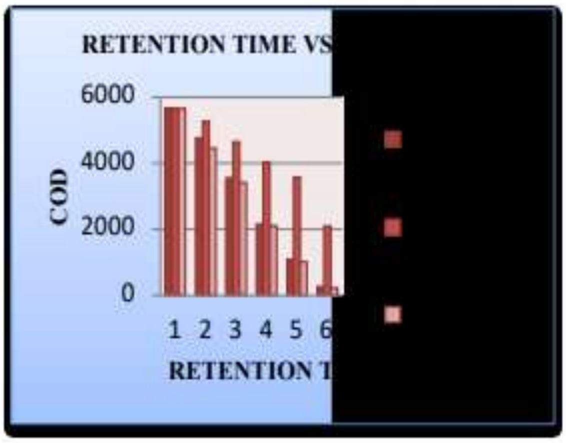

Figure 3.3 Retention time vs COD value

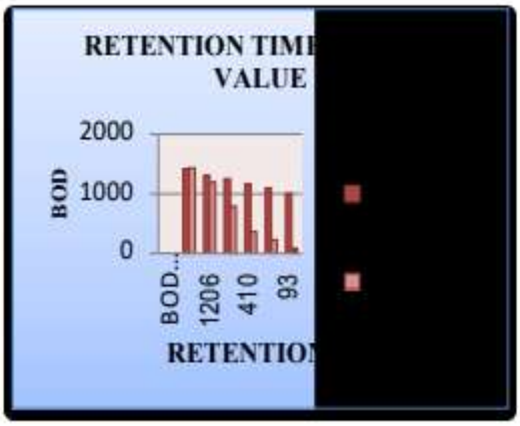

Figure 3.4 reduction time vs BOD value

Table 3.3 Reduction time with respect to BOD value

SL.NO	RETENSION TIME (Hr)	BOD (ppm)	BOD(ppm) at 10'c	BOD(ppm) at 60'c
1	0	1423	1423	1432
2	1	1206	1309	1193
3	2	815	1252	789
4	3	410	1162	363
5	4	256	1094	227
6	5	93	1008	83

Table 3.4 Color value with respect to retention time

SL.NO	RETENSION TIME (Hr)	COLOR VALUE	COLOR VALUE at 10'c	COLOR VALUE at 60'c
1	0	1067	1067	1067
2	1	945	1004	926
3	2	770	961	753
4	3	492	874	456
5	4	329	803	315
6	5	267	753	241

Table 3.5 COD Reduction percentage with respect to retention time

SL.NO	RETENSION TIME (Hr)	COD REDUCTION (%)	COD REDUCTION (%) at 10'c	COD REDUCTION (%) at 60'c
1	0	0	0	0
2	1	15.70	6.78	21.11
3	2	25.45	11.65	23.42
4	3	39.12	13.36	38.30
5	4	50.02	11.23	51.87
6	5	75.46	41.25	77.92

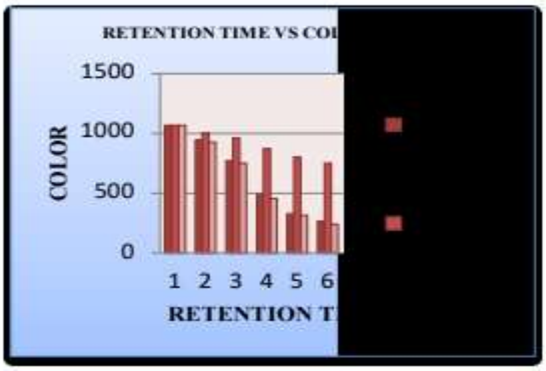

Figure 3.5 Reduction time vs color value

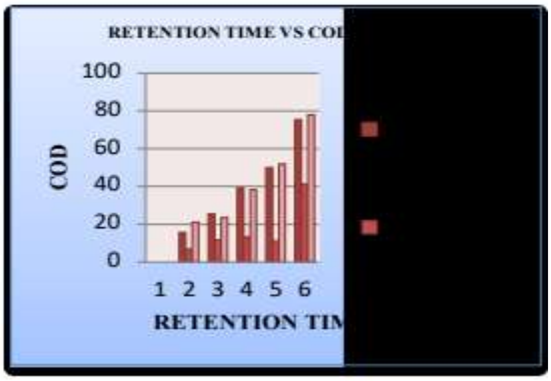

Figure 3.6 Reduction time vs COD Reduction %

Table 3.6 BOD reduction percentage with respect to time

SL.NO	RETENSION TIME (Hr)	BOD REDUCTION (%)	BOD REDUCTION (%)	BOD REDUCTION (%)
1	0	0	0	0
2	1	15.24	8.01	16.68
3	2	32.42	4.35	33.86
4	3	49.69	7.18	53.99
5	4	37.56	5.85	37.46
6	5	63.67	7.86	63.43

Table no 3.7 Color reduction percentage with respect to time

SL.NO	RETENSION TIME (Hr)	COLOR REDUCTION (%)	COLOR REDUCTION (%) at 10'c	COLOR REDUCTION (%) at 60'c
1	0	0	0	0
2	1	15.18	5.9	13.21
3	2	18.51	4.28	18.68
4	3	36.10	9.05	39.44
5	4	33.13	8.12	30.92
6	5	18.84	6.22	23.49

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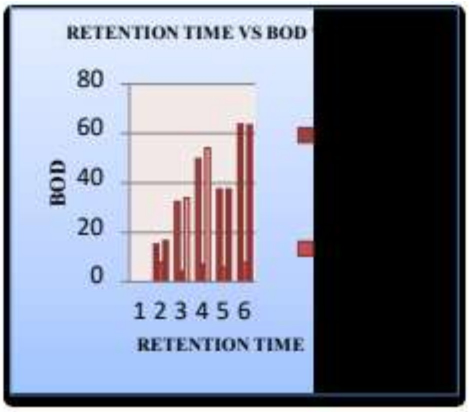

Figure 3.7 Reduction time vs BOD Reduction %

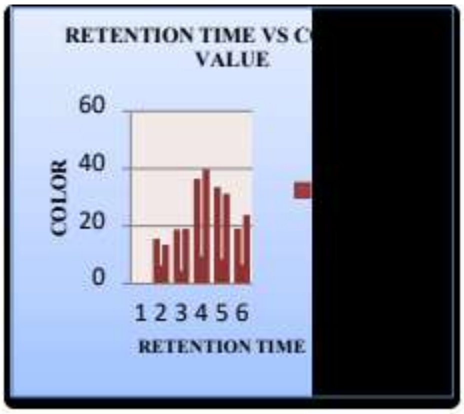

Figure 3.8 Reduction time vs color reduction %

4.1 CONCLUSION

The wastewater of the collected leather tannery effluent from the tannery industry have been tested based on their characteristics. By observing the values of the various tested characteristics, the wastewater has a potential treat to pollute the water body if disposal without a proper treatment. The research study highlights the performance of natural media in MBBR reactor.

Giant Sequoia cone seed that using in MBBR reactor as a natural media investigated the dosage of bio-sorbent, contact time and initial concentration of the solution to the BOD, COD and color. It reduces the BOD, COD and Color with the percentage of 63.67%, 75.46%, 18.84% at 35'c; 7.86%, 41.25%, 6.22% at 10'c and 63.43%, 77.92%, 23.49% at 60'c from the Retention time of 5hrs. The carrier circulation is affected due to flow rate. As retention time decreases the flow rate increases which lead to rapid circulation of carriers.

1. The MBBR technique gives the more efficiency than other conventional method. Color removal also done simultaneously.

2. The overall organic load reduction at low temperature condition is 41.72% only but the high temperature condition is 77.25%.

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