INTRODUCING CASUARINA FRUIT AS NATURAL MEDIA IN MBBR AND FINDING ITS PERFORMANCE IN DIFFERENT TEMPERATURE

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ABSTRACT

Casuarina Equisetifolia fruit 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 colour removal. Temperature is the main parameter to be maintained in oxidation process. 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 Casuarina Equisetifolia fruits able to achieve 52.72%, 78.25 % of colour 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 Casuarina Equisetifolia fruits results in an alternative for removing colour and natural media for MBBR that shows a good reduction of coloured wastewater.

***Keywords*: MBBR, thermophilic and psychrophilic condition, alternative media**

I. INTRODUCTION

MBBR is measured as a fast physical process to reduce the organic load which can help to reduce the colour 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 pulp effluent.

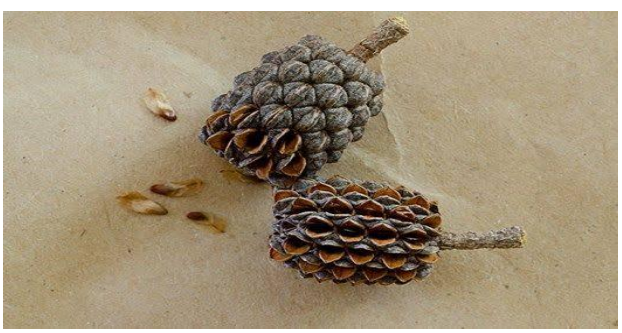
Biological waste water treatment is designed to degrade pollutants dissolved in effluents by the action of micro-organisms. The micro-organisms utilize these substances to live and reproduce. Pollutants are used as nutrients. Prerequisite for such degradation activity, however, is that the pollutants 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 paper mill effluents. Aerobically operated plants exhibit higher plant stability and are less sensitive to fluctuations in effluent and plant parameters.

There is currently growing interest in the MBR (membrane bioreactor) process in municipal and industrial wastewater treatment. MBR is used in the paper industry 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.

II. EXPERIMENTAL INVESTIGATION

MBBR is a highly effective biological treatment process based on a combination of conventional activated sludge process and biofilm media. The MBBR process utilizes 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 reduces 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.

2.1 Material Collection



2.1: Casuarina fruit

Casuarina equisetifolia is an evergreen, dioeciously or monoecious tree 635 (60) m tall, with a finely branched crown. Crown shape initially conical but tends to flatten with age. Trunk straight, cylindrical, usually branchless for up to 10 m, up to 100 (max. 150) cm in diameter, occasionally with buttresses. Bark light greyish-brown, smooth on young trunks, rough, thick, furrowed and flaking into oblong pieces on older trees; inner bark reddish or deep dirty brown, astringent. The branchlets are deciduous, drooping, needle like, terete but with prominent angular ribs, 23-38 cm x 0.5-1 mm, greyish-green, articles 5-8 mm long, globous to densely pubescent, dimorphic, either deciduous or persistent. Twigs deciduous, entirely green or green only at their tips.

2.2. Reagents

2.2.1 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 (water-free) 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 (anhydrous) 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 pK_a 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. Tables compiled for biochemical studies are available.

2.3. Preparation of Adsorbent Material

CE fruit was used as bio sorbent to remove colour from aqueous solution and used as media for biological growth in MBBR. CE fruits were collected at rural area nearby ETP plant. Upon collection, the fruits 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 colour and moisture. Then CE fruits were kept in less moisture interactive area for further use.

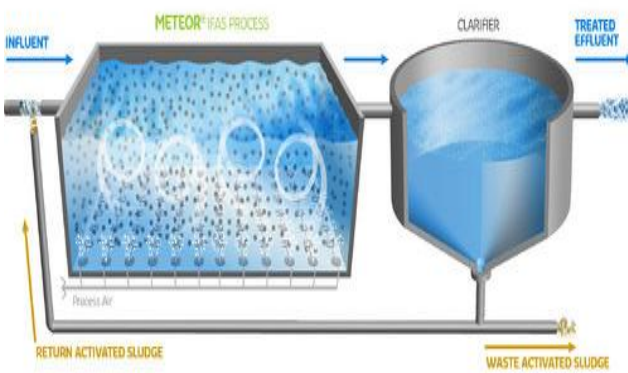
III. MBBR PROCESS

MBBR process can be used effectively to treat water from lower concentration to higher concentration. This process promotes suspended growth as well as attached growth. Carriers are used here that helps bio-degradation of organic matter in wastewater, with the help of microbial bio-film that grows on its surface. Aeration system is used for continuous suspension of carriers. This process uses carriers of different size and shapes, covering different surface area, having different potential to form bio-film. Over last few years there has been a growing interest in biofilm process of wastewater treatment. There are several reasons for the fact that biofilm process more and more often is being favoured such as:

- The treatment plant requires less space.
- The final treatment result is less dependent on biomass separation since the biomass concentration to be separated is at least 10 times lower.
- The attached biomass become more specialized (high concentration of relevant organism) at a given point in the process train, because there is no sludge return.

The desired objective of this paper is to investigate the reactor performance with respect to different size and shape of the carrier and HRT, i.e. 4hrs and 12hrs.

Each time a sample was taken out of the being treated solution, it was filtered using a Whiteman's filter paper No.44 and the absorbance of the filtrate was measured by photo colorimeter at 420 nm.



3.1: Model MBBR system

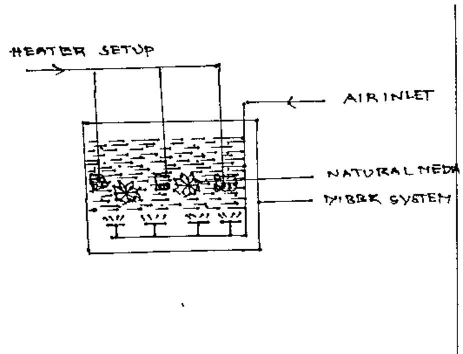
3.2: Original MBBR System

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. Dimension of tank is 3.5*4*3 m. The proposed moving bed biofilm can be shown in figure 3.2.

For high temperature study MBBR system updated for maintaining high temperature with help for electrical heater in laboratory scale process. The effluent collected from paper mill containing lot of organic load and chemicals.

The components of MBBR system is:

- Laboratory scale container.
- Natural media
- Heater setup with temperature controller
- Effluent with MLSS

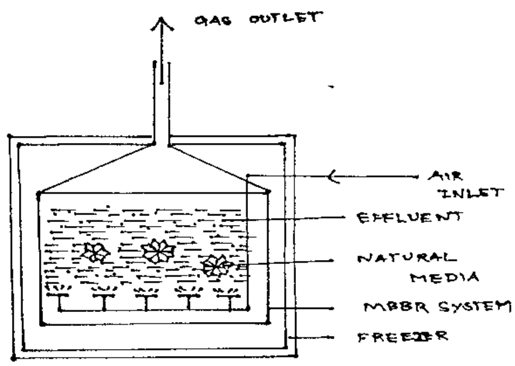


3.3: Diagram of MBBR System for High temperature study

For low temperature study MBBR system updated for maintaining low temperature with help for electrical freezer in laboratory scale process. The process experimented in a batch scale manner for better result of organic load reduction.

The components of MBBR system is:

- Laboratory scale container.
- Natural media
- Freezer setup with temperature controller
- Effluent with MLSS



3.4: Diagram of MBBR System for low temperature study

Here we have carried out experiments 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.

Following the process of checking its parameter carried out for knowing the character of reduction of effluent. The following parameters are checked purposively like pH, TDS, Colour, COD and BOD.

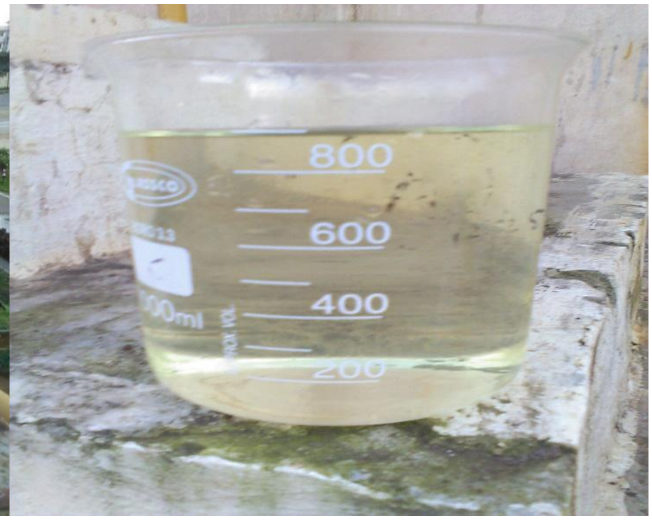
IV. RESULTS AND DISCUSSION

The performance evolution of MBBR was studied for the different HRT values i.e. 4hrs and 12hrs. While evaluating the performance BOD parameter were analysed. The micro-organisms present in the wastewater uses 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 of 4 hrs and 12 hrs is seen up to 69.82% and 77.29% respectively. The BOD removal efficiency is shown as below.

4.1: Inlet effluent

Figure no 4.1 shows the contaminated water collected from equalisation water. Which contains more contaminants like pH, TDS, Turbidity, TSS, COD, BOD; Colour etc. this contaminates may be easily removed by MBBR system by maintaining the proper microbes growing parameters like DO, MLSS, SV30, MLVSS, NO_2, NO_3 etc. 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 has shown in figure.



4.2: Sample after MBBR process at normal temperature condition.

4.3: Sample of after clarification system

Figure no 4.3 shows the treated water colour and clarity of effluent treated by MBBR system by using natural media of casuarinas fruit. The colour value of the inlet effluent is 250pt/co units. Which is more colour compared to textile waste water. But it consumes more power and time to remove by the ion exchange system. The casuarinas frits are comfortable to remove the colour with acting as media in MBBR system has been successfully found from this process. The final end colour value of the effluent is 16 pt/co is good result.

Table No 4.1: Comparison of influent and effluent at 35 degrees Celsius

SL.NO	PARAMETERS	INFLUENT	EFFLUENT	REMOVAL EFFLICIENCY
1	pH	7.8	7.86	
2	TDS (ppm)	2250	2350	
3	TSS (ppm)	150	36	
4	COD(ppm)	3450	516	85.0
5	BOD(ppm)	1250	234	81.3
6	COLOUR(pt/co)	250	16	92.6

Table No 4.2: Inlet and outlet characters of effluent at low temperatureat 10 degrees Celsius

SL.NO	PARAMETERS	INFLUENT	EFFLUENT	REMOVAL EFFLICIENCY
1	pH	7.8	7.86	
2	TDS (ppm)	2250	2350	
3	TSS (ppm)	150	36	
4	COD(ppm)	3450	1865	45.9
5	BOD(ppm)	1250	868	30.6
6	COLOUR(pt/co)	250	163	34.8

The Moving Bed Bio-film reactor (MBBR) process uses floating casuarina carriers (media) within the aeration tank to increase the amount of microorganisms available to treat the wastewater compared to conventional secondary treatment. The microorganisms consume organic material.

Table No 4.3: Inlet and outlet characters of effluent at high temperature at 60 degrees Celsius

SL.NO	PARAMETERS	INFLUENT	EFFLUENT	REMOVAL EFFLICIENCY
1	pH	7.8	7.86	
2	TDS (ppm)	2250	2350	
3	TSS (ppm)	150	36	
4	COD(ppm)	3450	258	92.5
5	BOD(ppm)	1250	216	82.7
6	COLOUR(pt/co)	250	16	93.6

The media provides increased surface area for the biological microorganisms to attach to and grow in the aeration tanks. The increased surface area reduces the footprint of the tanks required to treat the wastewater. The media will be continuously agitated by bubbles from the aeration system that adds oxygen at the bottom of the compartment of the aeration tank. The microorganisms consume organic material. After treatment, final treated effluent will be taken outside through outlet.

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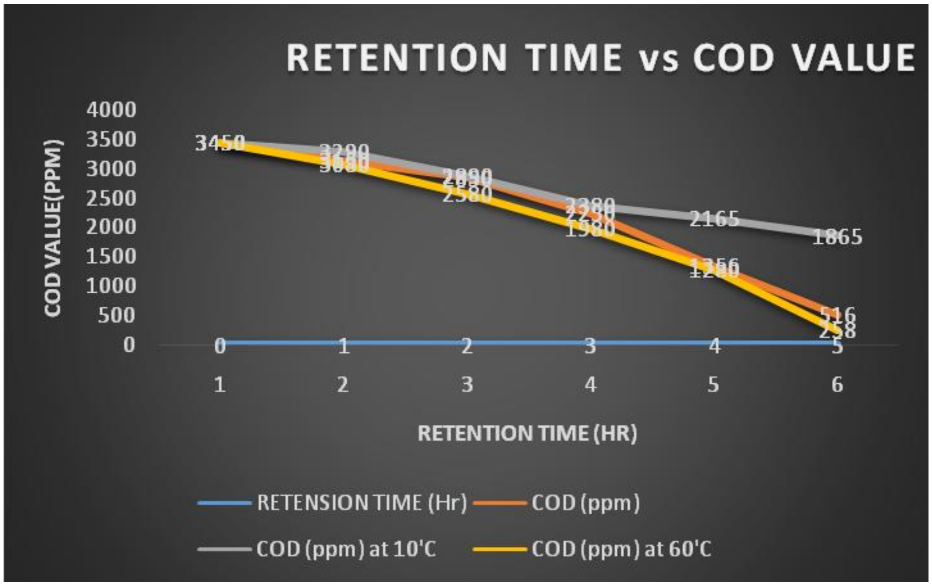
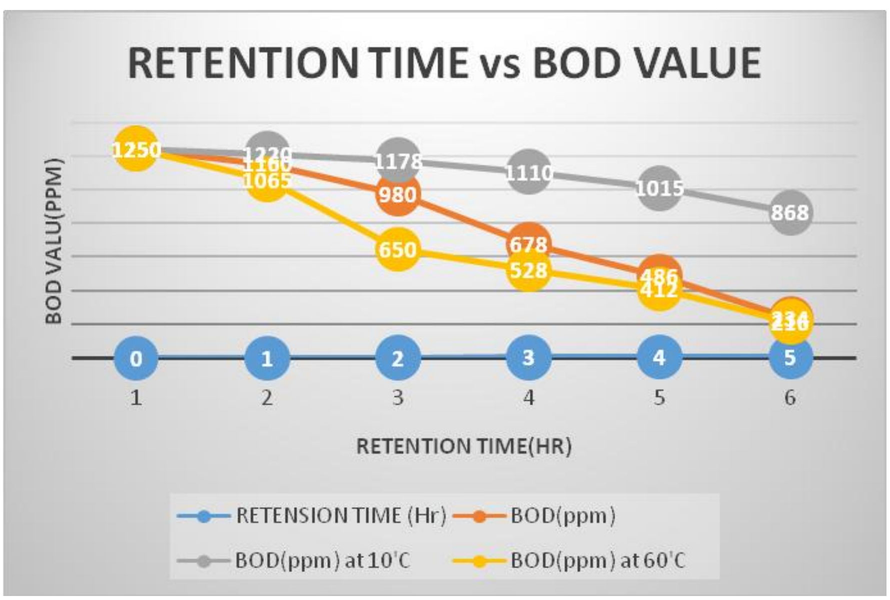


4.4: Retention time vs COD value

Figure no 4.4 show the retention time based performance of the casuarina frits to removes the COD value as a carrier in MBBR system. High surface area containing carriers only removes the fast reduction of OD in MBBR system.



4.5: Retention time vs BOD value

Figure no 4.5 show the performance of the casuarina fruits to removes the BOD value with respect to the retention time. The retention time of the MBBR system helpful to remove the organic contaminants. Also the high

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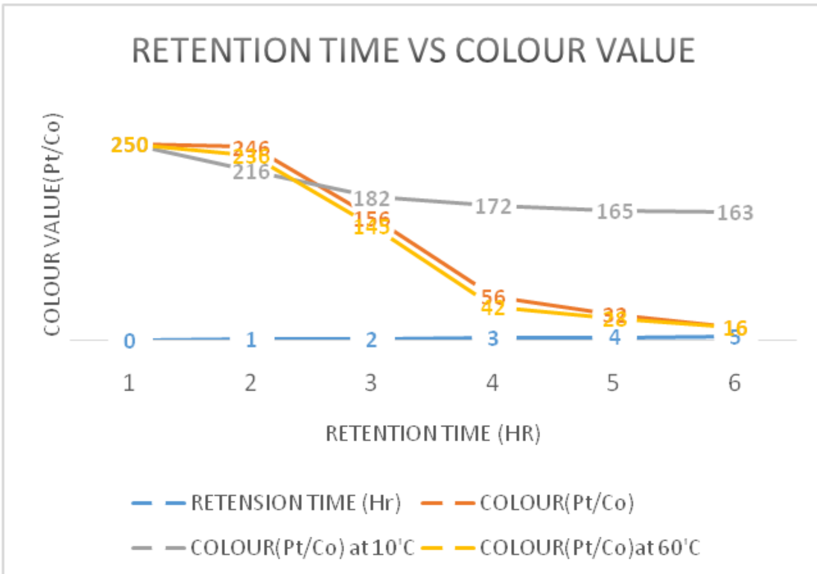
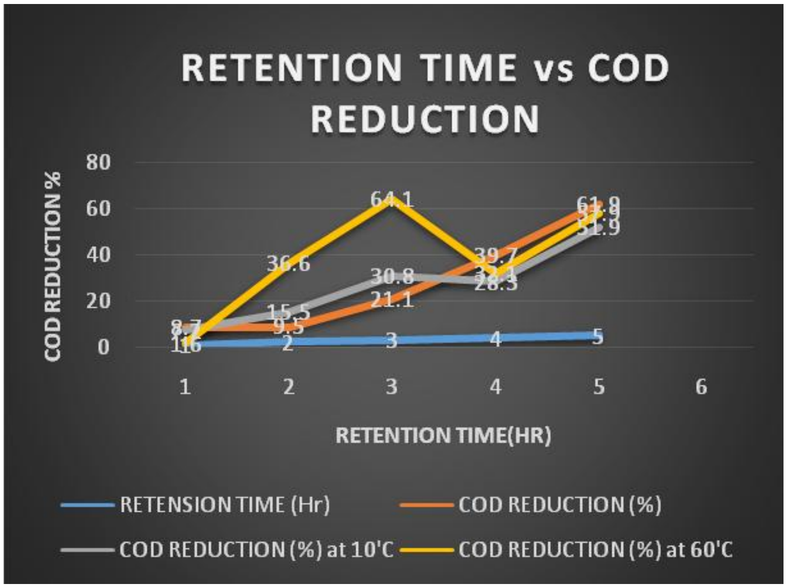
surface area containing carriers gives the appropriate helps to the microorganisms to oxidize the effluent contaminants.

Then the color value of the effluent also not removed by MBBR systems completely. The adsorption process of the casuarina fruits is helpful to remove the colour. Starting time of the process colour removal occurs slowly due to contact of effluent with the carriers because of the strife surface of the carriers. After that one hour of the retention time which is easily removes the colour value the perfect reaction time of casuarina frits is 1-3 hours of retention time.

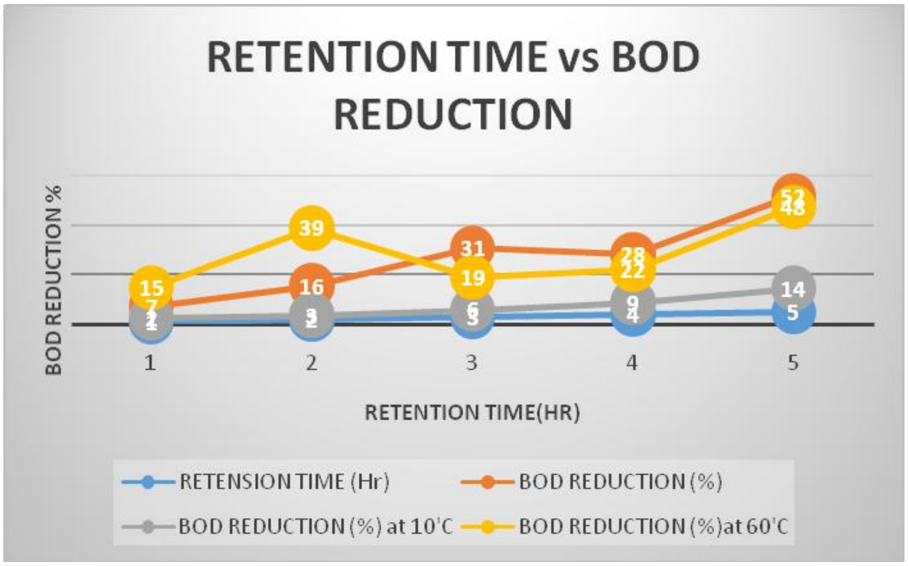


4.6: Retention time vs Colour value

Figure no 4.6 show the percentage of COD removal based of the retention time of natural media of casuarina fruits. Because of the high surface area of casuarina fruits helps to removes the COD from effluent. All the carriers not get good surface are the important one about the casuarina fruits.



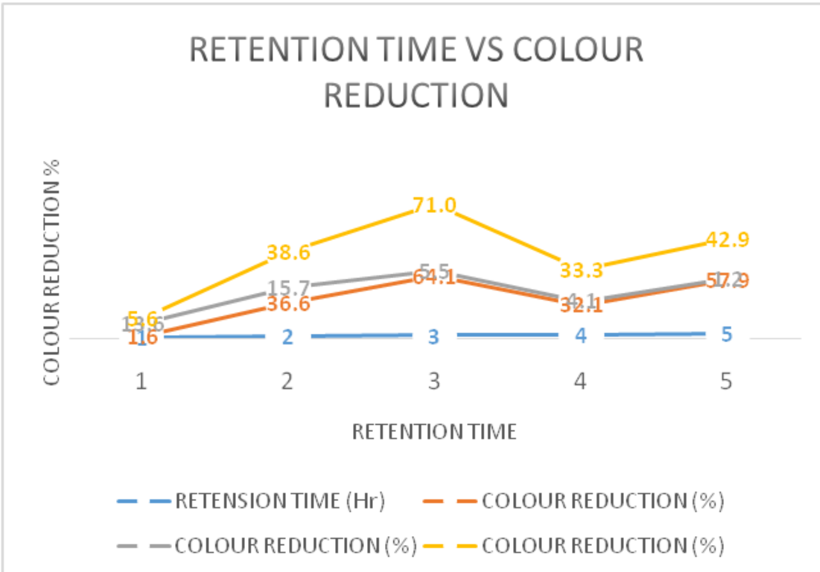
4.7: Retention time vs COD reduction percentage



4.8: Retention time vs BOD reduction percentage

Above figure gives the results of body reduction percentage based on the retention time of effluent in the MBBR system. Starting time of the process BOD reduction percentage low due to the microbial adoption in MBBR system with natural media. Then the BOD reduction percentage getting rises up to 2-3 hours of working of carriers in MBBR system. Then the below figure gives the results of adsorption of carriers that is colour removal percentage by casuarina frits. The starting time of the adsorption gets slow.

Due to the contact of the effluent with the carrier's surface area after the 1-hour time of operation the process will be more. Then the end parts of graph show the adsorption ending stage of process.



4.9: Retention time vs colour reduction percentage

V SUMMERY AND CONCLUSION

The characteristics of the wastewater of have been obtained from the test plant. According to the observed value of various characteristics, it is seen that the wastewater has potential to pollute the water body considerably if disposal without treatment. It is essential to reduce the pollutant contains of wastewater for its safe disposal to water body under permissible limits specified by BIS.

The research study highlights the performance of natural media in MBBR reactor. There are two parameters are studied to achieve the desired objectives suggested as per the standards. It is seen that the HRT has the greater impact on the cost of operation as well as maintenance. 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 is suitable for the BOD removal efficiently. Hence we achieved the colour removal with MBBR system.
2. The MBBR technique gives the more efficiency than other conventional method. Colour removal also done simultaneously.
3. The overall organic load reduction at low temperature condition is 52.72% only but the high temperature condition is 78.25%.

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