Comparison of sequential and batch bioreactor for colour removal of distillery effluent

Radhika Agarwal*, Dr. Sneh Lata† and Dr. Meera Gupta‡

1Dept. of Chemistry, Ideal Institute of Tech., Govindpuram -201301, Ghaziabad, India
2Dept. of Botany, M.M.H. Post Graduate College, Ghaziabad- 201001, India
3Dept. of Chemistry, JSS Academy of Technical Education, Noida - 201301, India
*e-mail: raradhikaagarwal9@gmail.com

(Received: June 28, 2010; Revised received: October 20, 2010; Accepted: November 08, 2010)

Abstract: The main objective of this study is to evaluate the colour removal efficiency of the microbes with the help of bioreactor in which undiluted distillery effluent is used. This reactor is arranged in laboratory scale using glass columns. The lower portion of the bioreactor contained a layer of gravel (100g), followed by sand (50g) and finally by a soil layer (50g). The three layers were used for immobilization of the strains. The performance of bioreactor was analyzed in terms of colour removal over 14 days of operation. The sequential bioreactor was more efficient in comparison to batch bioreactor. The maximum colour removal was found when we used fungus and bacteria both in sequential bioreactor that was 89.91% but in case of batch bioreactor it was 82.92%.

Key words: Bioreactor, Colour, Fungus, Bacteria

Introduction

Distilleries and fermentation industries released waste waters are the major source of soil and aquatic pollution due to the presence of water soluble recalcitrant colouring compounds called melanoidin (Evershed et al., 1997). Hence, these waste waters require pretreatment before its safe disposal into the environment. In recent years bioreactor technology has gained popularity in waste water treatment. In the presence of proper aeration bacteria and fungus is utilized for degradation and decolourisation of effluent. Degradation and decolourisation of these waste water by chemical methods (Chandra and Singh, 1999), flocculation treatment and physico-chemical treatment such as ozonation (Kim et al., 1988) and activated carbon adsorption have been accomplished, but these methods are not economically feasible on large scale due to cost limitation where as biological decolourisation by using fungus and bacteria have been successfully achieved (Kumar et al., 1997; Kumar and Chandra, 2006; Aoshima et al., 1985).

Materials and Methods

The principle of bioreactor analysis and designed used in laboratory scale using glass columns was a very simplified technique.

Designing of the bioreactor: The bioreactor was arranged in laboratory scale with an inlet and an outlet. The inlet present in the uppermost part of the reactor was providing with two openings for aeration and inoculation of strains. Sterile air was passed into the reaction in order to provide oxygen to the microorganisms present. For this purpose compressed air from the aeration pump was made pass through a sintered glass filter. The lower portion of the reaction had an outlet for collection of effluent sample above which the reactor contained a layer of gravel (100g), followed by sand (50g) and finally by a soil layer (50g). With the help of plastic tubes this outlet was connected with another bioreactor, which was inoculated with strain. These bioreactors also have two openings one for aeration and other of inlet, which works for outlet for above bioreactors. This bioreactor also has one outlet for sampling of effluent.

Loading of bioreactor with the effluent sample: The effluent collected from distillery mill was placed in 10-litre bottle on top. This bottle was connected with the columns (bioreactors) with plastic tubes. The effluent (2-litre) was loaded in each of the four columns. The first bioreactor was taken as a control i.e. neither fungus nor bacteria were used for treatment of effluent. In the second bioreactor after one day treatment by bacterial strain i.e. distillery bacterial1 (DB1) the effluent was transferred in lower bioreactor that was inoculated with another bacterial strain i.e. distillery bacterial5 (DB5). In third and fourth bioreactors after one day treatment by fungal strain i.e. distillery fungal2 (DF2) the effluent was transferred in lower bioreactors that were previously inoculated with bacterial strain (DB4 & DB5).

Inoculation of strain: Before inoculation of fungal strain they were revived in potato dextrose broth for 3 days. The development of mycelium shows the growth of the fungus then the strain was transferred into bioreactors. The strain (DF2) was used in two different bioreactors. After one day treatment of effluent, the effluent was transferred into lower bioreactors. In lower bioreactors, two different bacterial strains (DB1 and DB5) were inoculated. Before inoculation the strains were grown in nutrient broth overnight. Then the strains were transferred to columns (bioreactor) which acting as the treated sample for Biotreatment purpose.

Batch arrangement: In this type of arrangement, column was filled with known (1800 ml) quantity of effluent. Fungal strain (DF2) (200 ml) was inoculated in to the effluent. The effluent was transferred in another reactor connected by polypropylene tube. The bacterium (DB1 and DB5) was inoculated in second reactor. The treated effluent was removed after 1, 3, 7 and 14 days from both the reactors. The change in colour was determined.
Fig. 1: Comparison of both bioreactors on decolourization of distillery effluent in upper columns

Fig. 2: Comparison of both bioreactors on decolourization of distillery effluent in lower columns
Sequential arrangement: In this type of bioreactor column was filled with industrial effluent (1800 ml) and inoculated with fungal strain. The column was connected with another reactor with sequential way and incubated with bacterial strain. The continuous supply of effluent was maintained with flow rate of 20 ml/h. the sample was removed after 1, 3, 7 and 14 days from bioreactor treated with both fungi and bacteria. Change in pollution load was determined.

Results and Discussion

From the fig 1, it is evident that in batch bioreactor the colour degradation is less in comparison to sequential bioreactor. From fig 2, it is evident that in batch bioreactor the maximum decolourization was found in case of treatment with fungus i.e. 67% on 7th day but sequential bioreactor it was found 80.12%. On 14th day this decolourization was decreased upto 50.12% in case of batch bioreactor and 68.41% in case of sequential bioreactor. In case of treatment of effluent with fungus and then with bacteria (DB1) in batch bioreactor the maximum result was found 74.99% but in case of sequential bioreactor it was 89.91%. This is because in sequential bioreactor we maintain the biomass of the bacteria as well as flow rate of the effluent.

As the results show that in comparison to sequential bioreactor in batch bioreactor there is less removal of colour, this is because in sequential bioreactor we maintain the bio mass of the micro-organism as well as flow rate of the effluent. As the results show that on 14th day the reduction in colour was decrease in case of both batch and sequential bioreactor, this is due to the release of colour in effluents which was absorbed by fungus mycelia on 7th day. Sirianuntapiboon et al. (1995) reported that decolourization of effluents is done by adsorption mechanism. The melanoidin pigment which is the major cause of colour of distillery effluents was accumulated in the cytoplasm and around the cell membrane as melanoidin complex, which was gradually decolourize by intracellular enzyme. The larger molecular weight fractions of melanoidin were decolorized rapidly, while the small molecular weight fractions remained in the solution for longer time (Agarwal et al., 2010) and this small molecular weight compound again released into the effluent when the experiment is used to run for longer period of time. It was suggested that decolourization by fungi takes place due to the destruction of coloured molecules and partially because of sorption phenomena (Chandra et al., 2008).

Acknowledgement

The authors are highly thankful to principal of MMH Post Graduate College for conducting him the research work.

References