E-BEAM IRRADIATION AND ACTIVATED SLUDGE SYSTEM FOR TREATMENT OF TEXTILES AND FOOD BASE INDUSTRIAL WASTEWATER.

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Abstract

The combination of irradiation and biological technique was chosen to study COD, BOD_5 and colour removal from textiles effluent in the presence of food industry wastewater. Two biological treatments, the first consisting a mix of non irradiated textile and food industry wastewater and the second a mix of irradiated textiles wastewater and food industry wastewater were operated in parallel. Reduction percentage of COD in textiles wastewater increased from 29.4% after radiation only to 62.4% after further undergoing biological treatment. After irradiation the BOD_5 of textiles wastewater reduced by 22.1%, but reverts to the original value of 36mg/l after undergoing biological treatment. Colour had decreased from 899.5 ADMI to 379.3 ADMI after irradiation and continued to decrease to 109.3 ADMI after passing through biological treatment.

Abstrak

Gabungan kaedah sinaran dan biologi digunakan untuk melihat kesan penyingkiran COD, BOD_5 dan warna dalam kumbahan tektils dengan kehadiran kumbahan dari industri makanan. Dua sistem biologi dijalankan serentak , sistem satu mengandungi campuran kumbahan tektil yang telah dirawat menggunakan sinaran dan kumbahan dari kilang makanan, sistem dua mengandungi campuran kumbahan tektil dan kumbahan dari industri makanan. Peratus penyingkiran COD kumbahan tektils meningkat dari 29.4% selepas disinarkan kepada 62.4% selepas melalui rawatan biologi. Sementara BOD_5 menurun sebanyak 22.1% selepas disinarkan, tetapi selepas melalui sistem biologi nilainya meningkat kepada 36mg/l. Selepas sinaran, warna kumbahan tektil menurun dari 899.5 ADMI kepada 379.3 ADMI dan terus menurun kepada 109.3 ADMI selepas melalui rawatan biologi.

INTRODUCTION

Textile industries consume large amounts of water and their effluents contained wide range of contaminants. Water is used for dyeing, bleaching, washing and for many flushing steps during the whole production. Contaminants in textiles effluents mean suspended solids, BOD, COD, strong colour and high pH value. Increased public concern and environment awareness, as well as stricter legislative control of effluent discharge in the recent year, has led to increased interest in method of decolourisation. Many studies had shown that radiation caused significant effect on the COD, colour and BOD removal. Absorbed dose ranging between 1- 9 kGy can degrade COD and colour of direct dye (Ali et al., 2010). Azo dye degrade and decolourized by gamma radiation (Chen et., al 2008). Studies on treatment of simulated textiles effluent by biological treatment had shown that 90% colour removal was obtained with sludge retention time of 15 days (N.D.et.,al 2001). Treatment of textile effluent by combination treatment were conducted in various approach and technique such as Fenton's and biological (Nilesh et.,al 2006), photo-Fenton with sequencing batch reactor (Julia et. Al 2006) and ozonation in a semi-batch bubble column reactor (Kadir et., al, 2009).

In this study, textiles effluent was treated with radiation before further treating it in biological treatment together with food industry wastewater. For this work, the textiles wastewater was collected from Siang Poh Knitting Sdn. Bhd. at Rawang Industrial Estate, Selangor. The company manufactures garment, which involve processes such as weaving or fabric production and finishing. Food industry wastewater in this study was obtained from a factory in Bangi that manufacturing of frozen food. Food base waste water act as carbon source to microbe for degradation textiles wastewater and at the same time its also degraded.

1.1. Characteristics of textile and food industry wastewater.

Composite textiles and food industry wastewater were characterized mainly by measurement of chemical oxygen demand (COD), biological demand (BOD) and colour. Typical characteristics of both wastewater are presented in Table 1.

Table 1. Composite textile and food industry wastewater characteristics.

Samples	COD(mg/l)	BOD(mg/l)	Color(ADMI)
Textiles industry wastewater	900-3000	100-150	Above1000
Food industry wastewater.	530-1000	200-400	50 - 100

MATERIAL AND METHOD

Radiation process.

The electron (EB) irradiation was carried out under the EPS 3000 electron beam machine. The energy and current of electron beams were 1 MeV and 30mA, respectively. The textiles effluent was irradiated in the tray using 100 kGy. Samples treatments were conducted at room temperature.

Biological Treatment

The Lab scale activated sludge system made of acryl was used as biological treatment. It consisted of equalization tank(10L), aeration tank(4L) and clarifier(4L). Wastewater was fed into aeration tank and transferred into clarifier with a peristaltic pump. The water was aerated with diffusers which was connected to small aquarium pump to maintain a dissolved oxygen (DO) concentration above 4mg/l in the aeration tank. The dissolved oxygen was monitored daily by a DO meter in the aeration tank. Parameters such as pH, and mix liquor suspended solid were control in this system to ensure the system work. To study the effect of radiation on the biological treatment process, two systems were operated in parallel, firstly treatment for the mixture of non-irradiated textiles and food industry wastewater and secondly, treatment for the mixture of irradiated textiles and food industry wastewater. Lab scale biological treatment is shown in Figure 1.

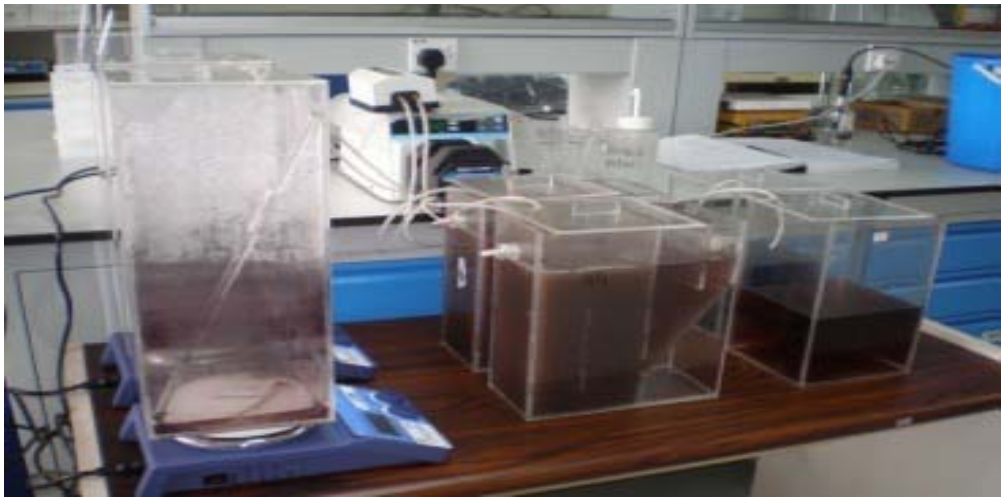

Figure 1. Biological treatment (activated sludge system) used in this project.

Analysis.

Samples were analysed before and after irradiation. COD is equivalent to the amount of oxygen required to chemically oxidize the organic matter contained in wastewater. To determine the COD sample was first digested using dichromate (HR range plus) in Hach reactor and COD value was determine by Hach-2400 spectrophotometer. BOD measures the rate of oxygen uptake by micro-organism in a sample of wastewater and was measured at temperature 20^0C over an elapsed period of five days in the dark incubator. It is not precise quantitative test, but used widely as an indicator to measure water quality. pH of the sample was analyzed using pH meter (WTW Multi 340i). Hach DR 5000 spectrophotometer were used for colour measurement.

RESULT AND DISCUSSION

Effect of Radiation to the COD, BOD and colour of textiles wastewater.

COD represents the content of all organic compound in wastewater. The changes of COD, BOD and colour for textiles effluent with initial concentration of 428mg/l, 36mg/l and 899.5 ADMI respectively, subjected to electron beam irradiation are shown in table 2. COD, BOD and colour removal percentage are 29.4%, 22.2% and 57.8% respectively. The COD and BOD removal showed similar trend of decolouration. The result shows that decolouration is much easier than COD and BOD removal. Decolouration result provides information about breaking down of the structure of dye molecules. It would cause generating small and middle organic compounds at the beginning of irradiation. But the degree of COD and BOD depend on the mineralization of the newly formed compounds. The final product from mineralization of organic compounds are H_2O, CO_2, N_2 or nitrogen oxides.

Table 2. The changes of COD,BOD_5 and colour after radiation.

Textiles Effluent	COD(mg/l)	BOD(mg/l)	Color(ADMI)
Non irradiated	428.0	36.0	899.5
Irradiated	302.0	28.0	379.3

Effect of electron beam radiation on the biodegradability of textiles wastewater

The BOD_5 and COD of raw textiles wastewater before and after electron beam radiation were calculated. The biodegradability of textiles wastewater was evaluated through calculation of the BOD_5/COD. The average biodegradability value of the non irradiated textiles wastewater are about 0.088 and those of the electron beam irradiated sample up to 0.092. The higher value of the biodegradability means that degradation of pollutant become easier in biological reaction. It can be inferred that radiation treatment can break down the molecule structure of organic compound and convert it into biodegradable compound.

Effect of the biodegradability on the removal of COD and BOD textiles wastewater in biological treatment.

Fig. 2 and 3 show that, COD and BOD_5 of irradiated textiles wastewater was continuously reduce in the biological treatment. The biodegradability of 0.092 for irradiated textiles wastewater caused higher removal of COD and BOD_5 as compared to non irradiated textiles wastewater with lower the biodegradability value (0.088). With higher biodegradability value biological activity becomes easier. The COD removal efficiencies were higher for irradiated textiles wastewater (around 62%) than for the non irradiated textiles wastewater (around 25%).

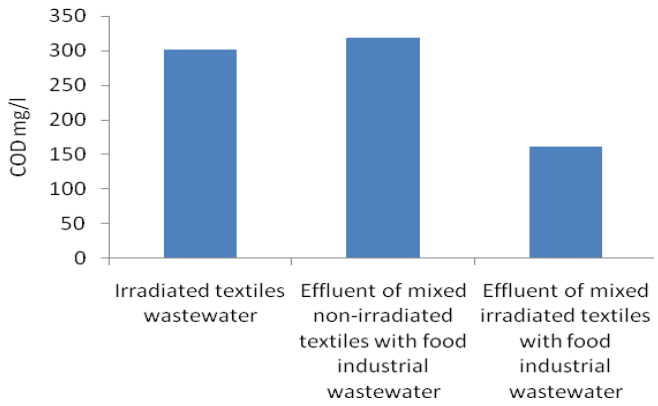

Fig 2: Effect of electron beam radiation on the removal of COD in biological treatment

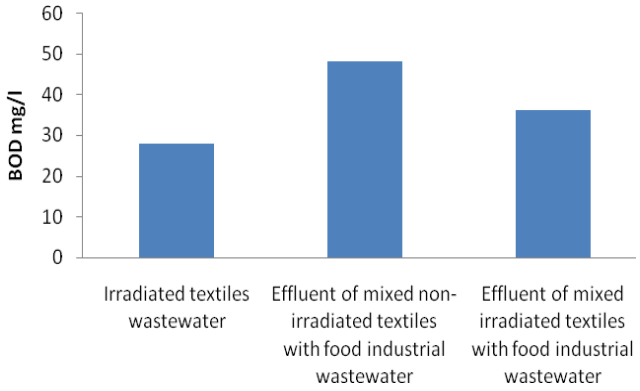

Fig 3: Effect of electron beam radiation on the removal of BOD textiles wastewater in biological treatment

Effect of irradiated and non irradiated textiles wastewater on the removal of COD and BOD_5 of food base wastewater in biological treatment.

The average value of COD and BOD_5 of the food base wastewater at the beginning were 530mg/l and 140mg/l respectively (figure 4). COD removal (%) percentage for mixture of food base and irradiated textiles wastewater was relatively higher (69.6%) compare to mixture of food base and non-irradiated textiles wastewater. While BOD_5 removal showed little difference between mixture of food base and irradiated textiles wastewater and mixture of food base and non-irradiated textiles wastewater, 74.0% and 65.7% respectively. These result indicate that presence of textiles wastewater did not interferes with the degradation of food base wastewater in the biological treatment.

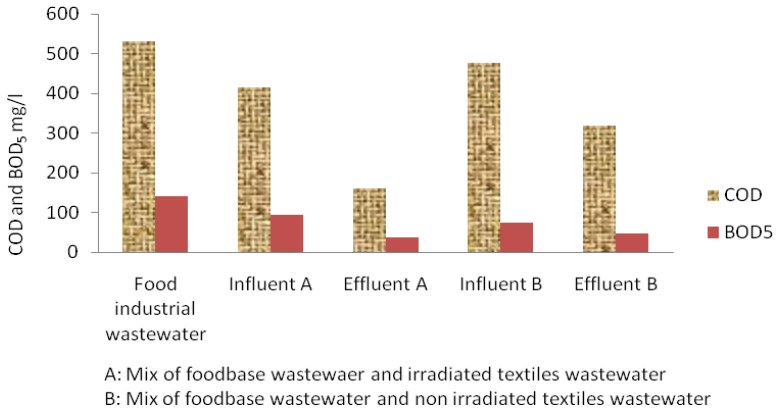

Figure 4: Effect of irradiated and non irradiated textiles wastewater on BOD5 and COD of food base wastewater in biological treatment

CONCLUSION

It can be concluded that the integrated system consisting of electron beam radiation and biological treatment for textiles wastewater in the presence of food industry wastewater can be applied. The radiation can convert refractory organic compounds into easily biodegradable product, then mix with other

wastewater which can act as carbon source for microbe activity in the biological treatment. Furthermore, this combination process is able to treat two or more suitable wastewater in the biological treatment.

ACKNOWLEDGMENT

The author wishes to thank Siti Aiasah Hashim and her team at the Alurtron EB-Irradiation Centre for their assistance during the experimental work and preparation of this paper.

REFERENCES

1. Ali Vahdat, S.H Bahrami, M.Arami, A.Motahari., (2010) "Decomposition and decoloration of a direct dye by electron beam radiation" Radiation Physics and Chemistry 79 (2010) 33-35.

2. You-Peng Chen, Shao-Yang Liu, Han-Qing Yu, Hao Yin, Qian-Rong Li. (2008) `` Radiation Induced Degradation of methyl Orange in aqueous solution", Chemosphere 72(2008)532-536.

3. N.D.Lourenco, J.M Novais, H.M. Pinheiro (2001)``Effect of some operational parameters on textile dye biodegradation in a sequential batch reactor'' Biotechnology 89 (2001) 163-174.

4. Nilesh P. Tantak, Sanjeev Chaudhari.` (2006) `Degradation of azo dyes by Sequential Fenton's oxidation and aerobic biological treatment'', Hazardous Materials, 136, 698-705.

5. Julia Garcia Montano,Francesc Torrades, Jose A. Garcia-Hortal, Xavier Domenech, Jose Peral,(2006)``Degradation of Procion Red H-E7B reactive dye by coupling a photo-Fenton System with a sequencing batch reactor,'' Harzardous material,l B134, 220-229.