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E-BEAM IRRADIATION AND ACTIVATED SLUDGE SYSTEM FOR TREATMENT OF MIXED 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 to 62.4% after further undergoing biological treatment. After irradiation, the BOD_5 of textiles wastewater was reduced by 22.1%, but reverted 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.

Keywords: biological treatment, BOD, COD, irradiation, waste water

INTRODUCTION

Textile industries consume large amount 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 refer to suspended solids, BOD, COD, strong colour and high pH value. Increased public concern and environmental 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 irradiation of dye (Vahdat, et al., 2010). Azo dye degrades 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 (Lourenco 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 (Montano et al., 2006) and ozonation in a semi-batch bubble column reactor (Turhan and Turgut, 2009).

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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 A textile industry at Rawang Industrial Estate, Selangor. The company manufactures garment, which involve processes such as weaving or fabric production and finishing. Food industry wastewater was obtained from a factory in Bangi that manufacture frozen food. Food based waste water act as carbon source to microbe for degradation of textiles wastewater and at the same time it was also degraded.

CHARACTERISTICS OF TEXTILE AND FOOD INDUSTRY WASTEWATER

The textiles and food industry wastewater were characterized mainly by measurement of chemical oxygen demand (COD), biological demand (BOD_5) and colour. Characteristics of both wastewater are measured as shown in Table 1. Typical characteristics of both wastewaters are presented in Table 1.

Table 1: Textile and food industry wastewater characteristics

Samples	COD(mg/l)	BOD_5(mg/l)	Colour(ADMI)
Textiles industry wastewater	900-3000	100-150	Above1000
Food industry wastewater.	530-1000	200-400	50 - 100

MATERIAL AND METHOD

Irradiation of wastewater

The electron beam (EB) irradiation was carried out using the EPS 3000 electron beam machine. The energy and current of electron beams were set at 1 MeV and 30mA, respectively. The textile wastewater was placed in a tray and irradiated at 100 kGy 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 the aeration tank and transferred into the clarifier using a peristaltic pump. The wastewater was aerated with a diffuser which was connected to a small aquarium pump, to maintain 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 controlled 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 irradiated textiles and food industry wastewater (Effluent A) and secondly, treatment for the mixture of non irradiated textiles and food industry wastewater (Effluent B). Lab scale biological treatment is shown in Figure 1.

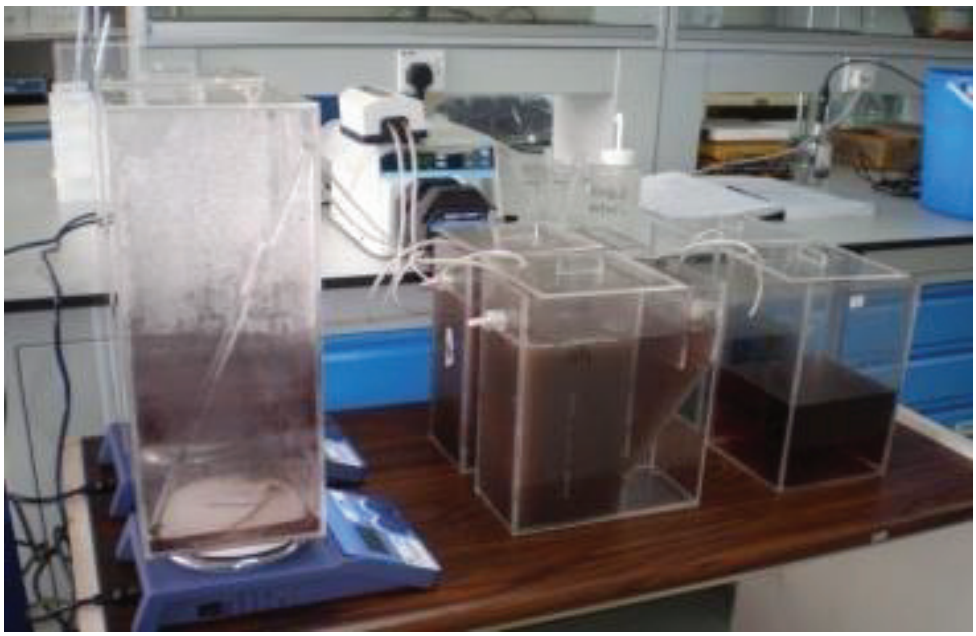

Fig. 1: Biological treatment (activated sludge system) used in this project

Analysis of Treated Wastewater

Wastewater 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, the 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 a dark incubator. It is not a 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.

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RESULT AND DISCUSSION

Effect of Radiation to the COD, BOD and Colour of Textiles Wastewater

COD value indicates the amount of aggregate organic compounds found in the samples. E-beam caused the COD, BOD_5 and colour of textiles effluent changeas shown in Table 2. COD, BOD_5 and colour removal percentage are 29.4%, 22.2% and 57.8% respectively. The COD and BOD_5 removal showed similar trend of decolouration. The result shows that decolouration is much easier than COD and BOD_5 removal. Decolouration result provides information about breaking down of the structure of the dye molecules. It would cause generating small and middle organic compounds at the beginning of irradiation. But the degree of COD and BOD_5 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 (Flödváry and Wojnárovits 2009).

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

Textiles Effluent	COD(mg/l)	BOD(mg/l)	Colour(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 measured. 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 molecular structure of organic compound and convert it into biodegradable compound.

Effect of the Biodegradability on COD and BOD_5 of Textiles Wastewater in Biological Treatment System

Fig. 2 and 3 show that, COD and BOD_5 of irradiated textiles wastewater were continuously reduced 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%).

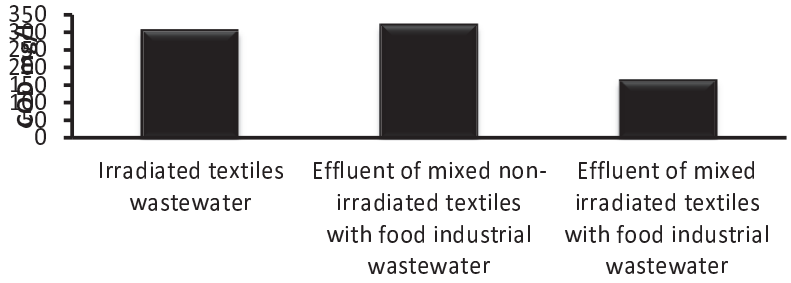

Fig. 2: Effect of electron beam radiation on COD textiles wastewater in biological treatment

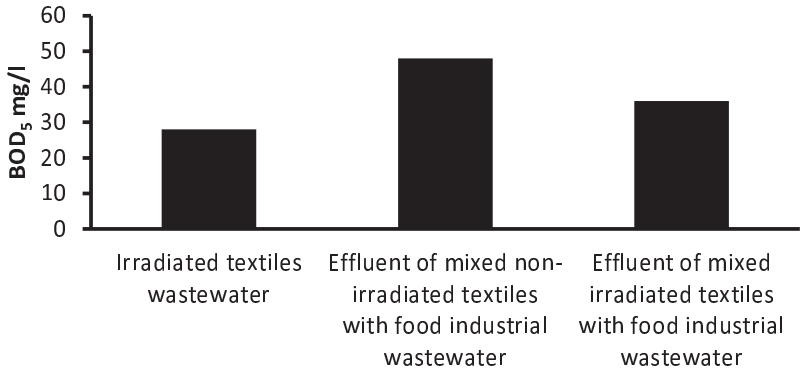

Fig. 3: Effect of electron beam radiation BOD textiles wastewater in biological treatment

Effect of Irradiated and Non Irradiated Textiles Wastewater on 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 as shown in figure 4. It can be seen from the figure that COD of mixture of food base and irradiated textile wastewater (Effluent A) was decreased about 69.6% after underwent biological treatment while the mixture of food base and non-irradiated textile wastewater (Effluent B) was decreased about 40%. The results show that degradation of food base wastewater was improved with addition of irradiated textile wastewater. While reduction of BOD_5 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 results indicate that presence of textiles wastewater did not interferes with the degradation of food base wastewater in the biological treatment.

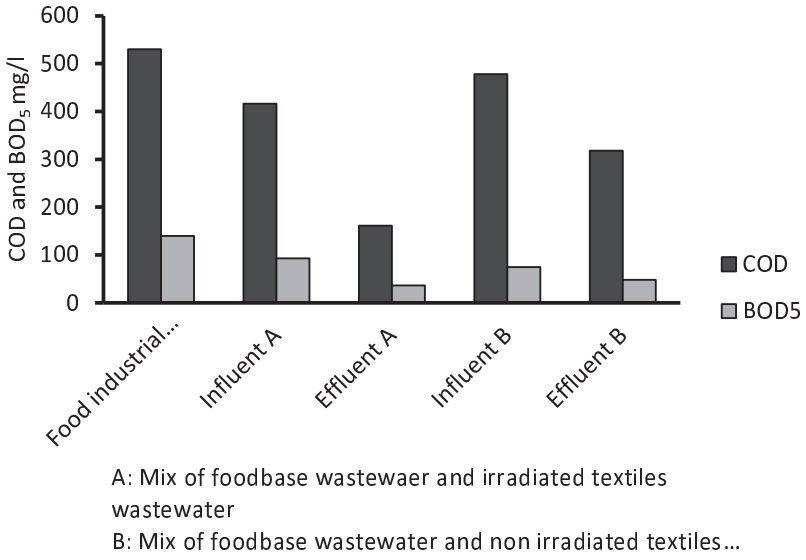

Fig. 4: Effect of irradiated and non irradiated textiles wastewater on BOD_5 and COD of food base wastewater in biological treatment

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 appropriate wastewater in the biological treatment.

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