Evaluation on Ecological Stability and Biodegradation of Dyeing Wastewater pre-Treated by Electron Beam

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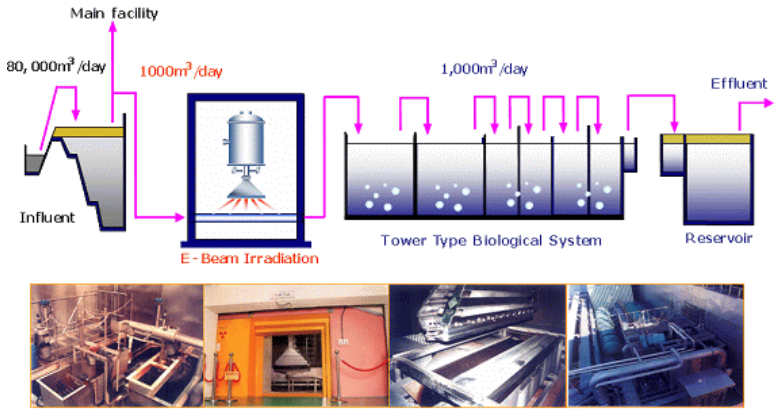
Backgrounds

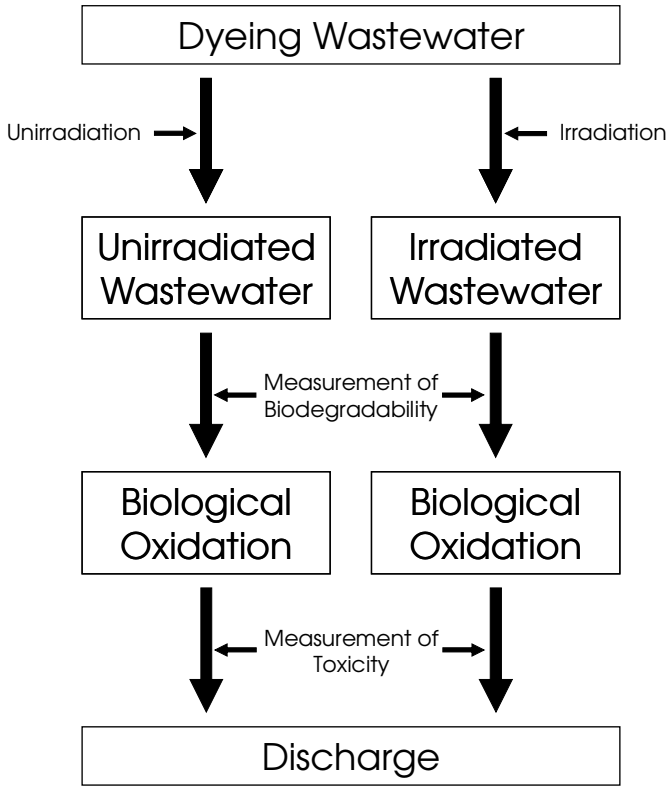
- Construction of dyeing wastewater treatment facility
  (10,000m3/day)
- Effect of EB on biodegrability of dyeing wastewater
  - Activity of microorganisms
- Public acceptance
  - Toxicity
    Ecological stability of treated wastewater by EB and microorganisms



Objectives

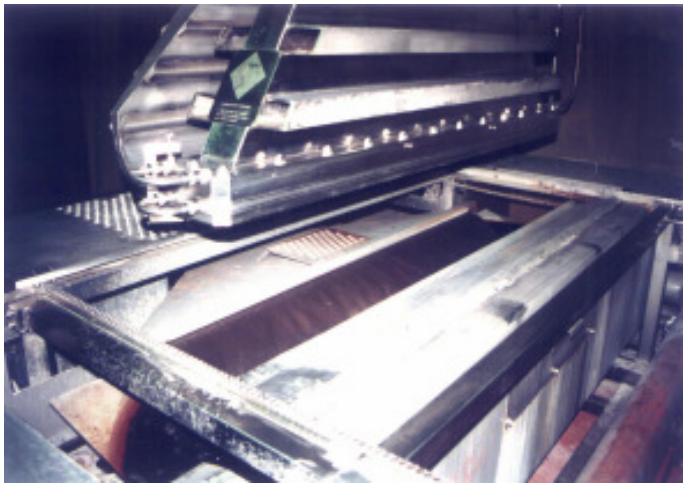
- Biodegradation of dyeing wastewater pre-treated by electron beams
- Consideration on ecological stability of biological effluent pre-treated by electron beams in terms of public acceptance

Experimental- Experimental procedure



- Measurement of biodegradability
- Measurement of toxicity
- Detection of by-products
- Observation of microorganisms

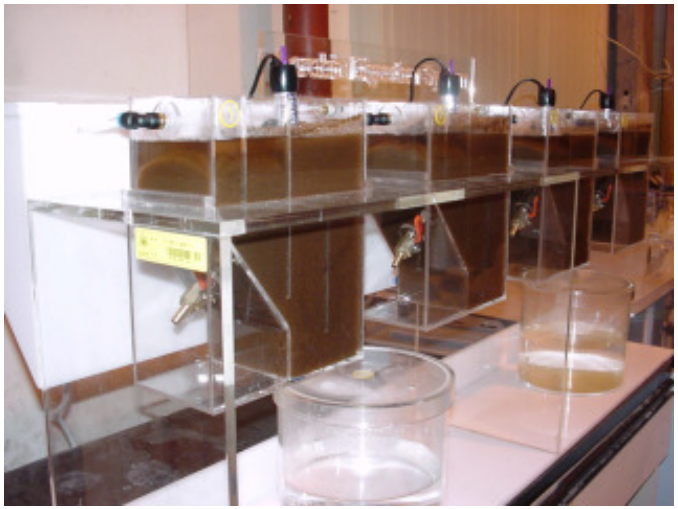
Experimental -EB Irradiation



A view of irradiation of dyeing wastewater

- Electron accelerator(EB-Tech) of 1 MeV, 40kWwith the dose of 1.0 kGy
- The dyeing wastewater is placed in storage vessel, which serves as saturator-equalizer.
- Dyeing wastewater from the vessel was moved with controlled consumption by pump to jet nozzle
- The dyeing wastewater injected was directed in horizontal plane; their flight length was equal to ~1.5 m (at the initial rate 3m/s).
- The dyeing wastewater injected along horizontal part of their flight was treated by electron beam.
- Irradiated dyeing wastewater was collected into the container in order to be treated by subsequent biological process.

Experimental - Biological oxidation



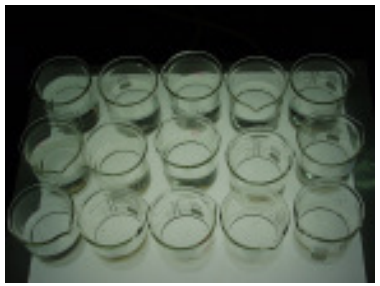
Biological reactor

- Four simple type of standard activated sludge reactors with dimention (205w x 265h x 100w)
- Irradiated and unirradiated dyeing wastewater were treated in according to fixed hydraulic retention time (HRT) with 24hr, 30hr, 36hr and 48hr, respectively.
- Effluent was analyzed by BOD_5, COD_{Mn}, CODcr

Experimental - Toxicity

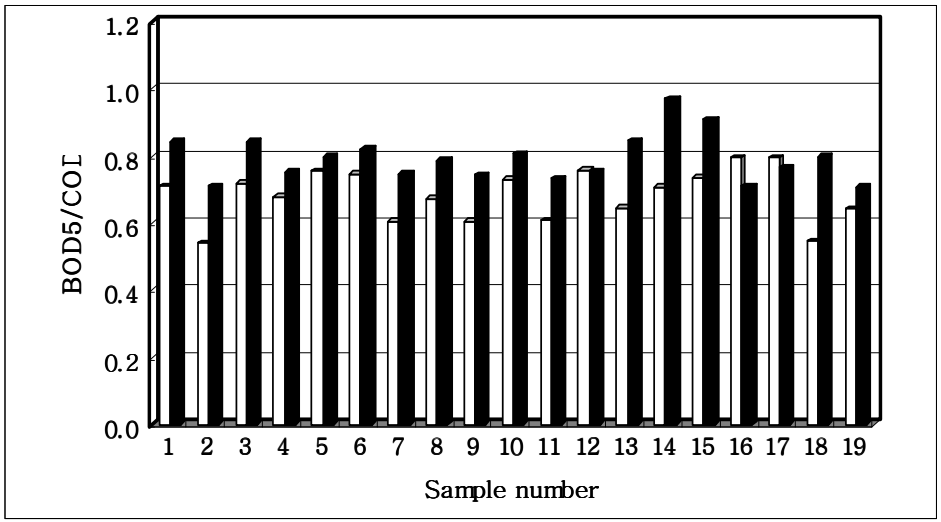
Daphina magna used in toxicity test

Counting of survived daphnia magna



- Samples were obtained from sedimentation zone of biological reactor.
- Daphina magna was cultivated and stored in the incubator before using
- Five samples with control and different dilution factors were prepared for different HRT.
- Counting on survival number of Daphina magna was performed after 24 hours for samples with different HRT, respectively

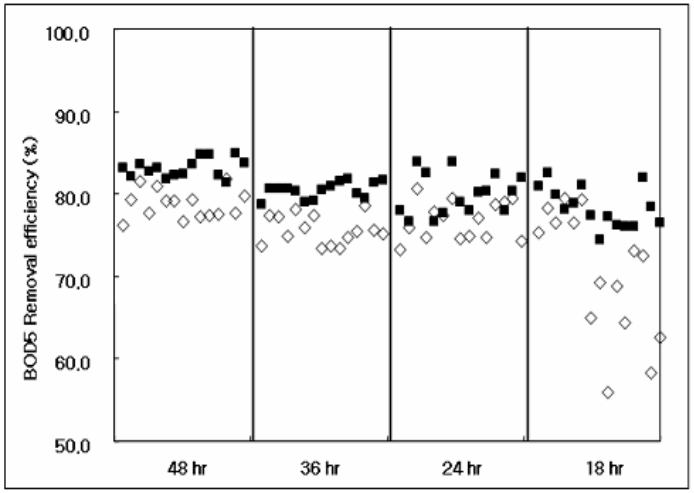
Results – Biodegradability(I)



Comparison of biodegradability based on BOD5/COD for dyeing wastewater by irradiation (□ 0 kGy, ■ 1 kGy)

- The biodegradability of the dyeing wastewater irradiated was increased to higher 0.1-0.3

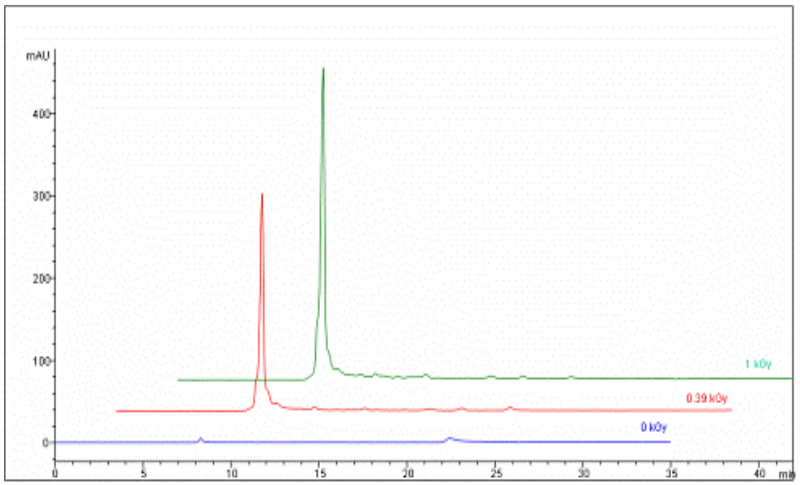
Results – Biodegradability(II)



BOD5 Removal efficiency in accordance with irradiation and HRT(◇ 0 kGy, ■ 1 kGy)

- BOD removal efficiency of irradiated dyeing wastewater was improved and stabilized regardless of HRT
- BOD removal efficiency of unirradiated dyeing wastewater with HRT of 18 hrs was decreased suddenly
- The improvement of biodegradability was assumed by transformation of high molecule compounds into low molecule compounds by irradiation

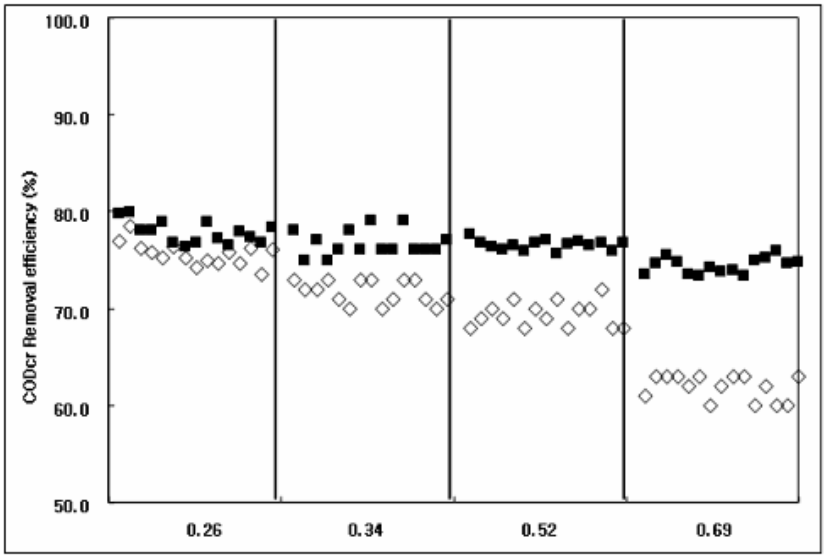
Results – Biodegradability(III)



Appearance of low molecule organic acid peak in according to irradiation dose

- Low molecule organic acid was produced in accordance with irradiation
- Relatively low molecule organic acids can be easily oxidized by microorganisms.

Results – COD Load

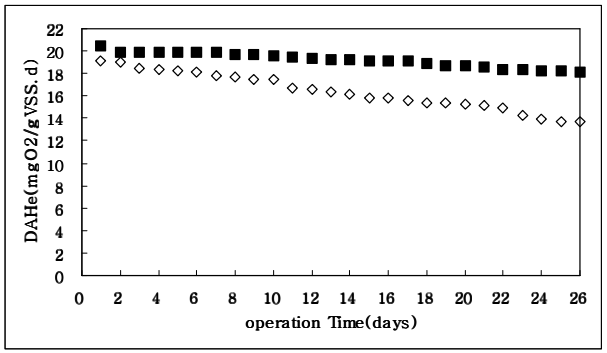


CODcr removal efficiency according to F/M ratio(◇ 0 kGy, ■ 1 kGy)

- COD removal efficiency with irradiated dyeing w/w was not changed and stabled regardless of increased COD load
- COD removal efficiency with unirradiated dyeing w/w was decreased with COD load
- Considering that the F/M ratio of a standard activated sludge process is about 0.25, the biological treatment process connected with electron beam irradiation looks effective although when F/M ratio is high

Results – Activity of microorganisms

Vorticella observed from biological treatment reactor connected with irradiation and high F/M ratio



The change of DHA (Dehydrogenase activity) by INT in tbiological reactor at HRT 24(◇ 0 kGy, ■ 1 kGy)

- Large number of *vorticella* could be observed in the biological reactor connected with irradiation.
- The appearance of *vorticella* in the biological reactor means that biological reactor is well operated.,
- DHA by INT in the biological reactor connected with irradiation was not decreased while it was slowly decreased according to time in the biological reactor without irradiation.
- This means that activity of microorganisms becomes more weaken.

* INT : 2-(p-iodophenyl)-3-(pnotrophenyl)-5-phenyltetrazolium chloride

Results – Toxicity

List of toxicity on effluent from biological oxidation process of irradiated and unirradiated dyeing wastewater by electron beam

Reaction condition / Analysis condition		EBX RW	EBO RW	18Hr EBX	18Hr EBO	24Hr EBX	24Hr EBO	36Hr EBX	36Hr EBO	48Hr EBX	48Hr EBO
Concentration (%)	Number Exposed	Mortalities		Mortalities		Mortalities		Mortalities		Mortalities	
100%	20	20	20	10	0	2	0	2	1	2	0
50%	20	7	11	2	0	0	0	0	0	1	0
25%	20	5	1	0	0	0	0	0	0	0	0
12.5%	20	4	0	0	0	0	0	0	0	0	0
0%	20	0	0	0	0	0	0	0	0	0	0
EC_{50}(%)		40.16	46.27	99.16	>100	>100	>100	>100	>100	>100	>100
Toxic Unit		2.49	2.16	1.01	<1	<1	<1	<1	<1	<1	<1

1) EBX RW : Unirradiated dyeing wastewater 2) EBO RW : Irradiated dyeing wastewater

The toxicity on the Daphnia magna of wastewater was decreased from 2.49 to 2.16. In case that an electron beam irradiation was not applied, the effluent from biological treatment with HRT of 18hr was toxic to the Daphnia magna. However, the effluent from a biological treatment connected with an electron beam irradiation was not toxic regardless of HRT.

Conclusions

- Biodegradation of dyeing wastewater pre-treated by electron beam was enhanced compared to unirradiated one.
- In the initial stage of biological oxidation regardless of different HRT, dyeing wastewater pre-treated by electron beam could be oxidized easily compare to unirradiated one.
- More larger number of survived daphnia magna could be observed in the biological effluent pre-treated by electron beam.
- Biological effluent pre-treated by electron beam can be said “ it is safe on the ecological system”.