

Development of membrane-based biological treatment process for textile dye wastewater

FAISAL IBNEY HAI

JSPS postdoctoral fellow

Environmental Science Center, University of Tokyo

The 11th RECWET symposium: "Water environment control by membrane treatment technology"

December 2, 2008

Background	Textile processing: steps and discharged chemicals
Desizing	Sizing agent (Starch, Polyvinyl alcohol etc.), detergent, oxidizing agent etc.
Scouring	Grease, wax, detergent, caustic soda, caustic ash etc.
Bleaching	Hypochlorite, peroxide , caustic soda, caustic ash etc.
Mercerizing	Concentrated caustic, detergent etc.
Wet reduction	Organic acid etc.
Dyeing and rinsing	Dye , dyeing auxiliaries such as electrolyte , dispersing agent, surfactants etc. polyacrylates, phosphonates, sequestering agents (e.g. EDTA), deflocculation agents (lignin or naphthalenesulfonates), antistatic agents, fixing agents,
Oiling	Olive oil, mineral oil, non-ionic emulsifier etc.
Fulling	Detergent, caustic, sequestering agent etc.
Carbonizing	Concentrated acid etc.
Printing and rinsing	Similar to dyeing and rinsing
Finishing	Finishing auxiliaries like preservatives (substituted phenol), chemicals used for fire-, moth-, and water-proofing etc.

Background

Dye wastewater: Environmental concerns

Dye: a 'hard-to-treat' pollutant

- **striking visibility** in recipients, influence photosynthetic activity of aquatic lives
- **persistent**, and recalcitrant to microbial degradation, [Hydrolyzed reactive blue 19, Half life=46 yrs. (pH=7, 25°C)]
- their accumulation in certain forms of aquatic life may lead to **toxic** products. [Basic violet 1, LC₅₀=0.05mg/l (single cell green algae)]

Scale of the problem

- More than **100,000** commercially available dyes
- Estimated annual production of over **7 x10⁵** tons
- **15%** lost during the dyeing process
- The textile industry accounts for the **two-thirds** of the total dyestuff market


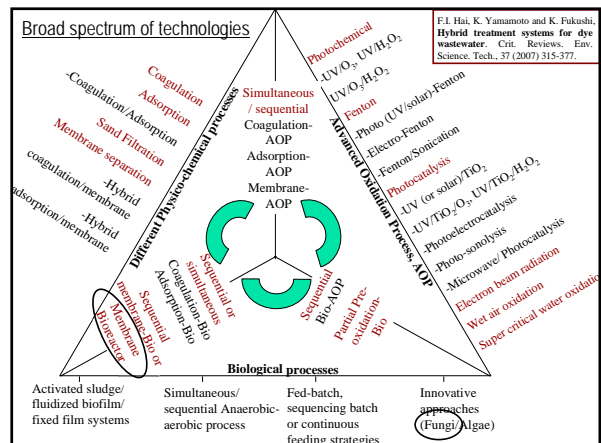
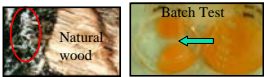


Photo source: 1. www.fbs.leeds.ac.uk/staff/profile.php?tag=Knapp 2,3. www.china.org.cn/english/environment/189819.htm 4. www.ago.net/www/picture.three/bartynsky.jpg



Background

Special dye-degrading microorganism: White-rot fungi
 Extracellular secretion of non-specific oxidative enzymes



Limitations of conventional fungal reactor

- Excessive growth and reactor clogging
- Sensitivity to agitation
- Long HRT requirement
- Worse performance in continuous reactors
- Bacterial contamination destabilizing performance

Previously developed system

ELSEVIER
 Desalination 192 (2006) 315–322
 www.elsevier.com/locate/desal

DESALINATION

Development of a submerged membrane fungi reactor for textile wastewater treatment
 Faisal Ibney Hai^a, Kazuo Yamamoto^b, Kensuke Fukushi^b

Special dye-degrading microorganism: White-rot fungi
 Extracellular secretion of non-specific oxidative enzymes as a secondary metabolic activity.

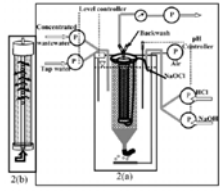
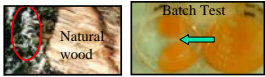



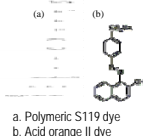
Fig. 2. Schematic of the proposed bioreactor system.
 (a) Membrane within a mesh cage inside the reactor.
 (b) Close-up of backwashing of the core of fiber bundle.

Journal of Membrane Science 121 (2006) 165–169
 Contents lists available at ScienceDirect
 Journal of Membrane Science
 journal homepage: www.elsevier.com/locate/jmemsci

Removal of structurally different dyes in submerged membrane fungi reactor—Biosorption/PAC-adsorption, membrane retention and biodegradation
 Faisal Ibney Hai^{a,*}, Kazuo Yamamoto^b, Fumiyuki Nakajima^a, Kensuke Fukushi^b

Synthetic wastewater and the reactor

Dye = 0.1 g/L
 Starch = 2 g/L
 Urea = 0.1 g/L
 Other nutrients



a. Polymeric S119 dye
 b. Acid orange II dye

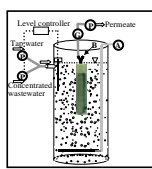


Fig. Schematic of laboratory setup
 (A: Air pump, B: Backwash, G: Vacuum gauge, P: Pump)

