Dye binding properties from Textile effluents

Lecture-36
Mounting pressure on the textile industry to treat dyehouse effluents has led to a host of new and old technologies competing to provide cost-effective solutions.

Among the oldest of methods for treatment of wastewater is the use of adsorbents derived from biological matter, or biomass.

Because of its low cost and widespread availability, biomass has often been investigated, with some promising results, but apparently failing the ultimate test of commercial viability.
Decolorization effect

- In this lecture an overview of the recent developments in the use of biomass for decolorization of dyehouse wastewater—specifically, for removal of acidic dyes and other dyes have been mentioned.

- Biomass decolorizes textile wastewater by adsorption and ion exchange mechanisms.

- A description of the performance characteristics of an ideal acidic-dye adsorbent would be for it to have high capacity and rapid binding kinetics, to be easily and inexpensively regenerated, and to have binding properties which are insensitive to dyebath electrolytes, other additives, and pH.
Requisites for a biomass

• It is a given that the biomass should be abundantly available and very inexpensive.

• Apart from these latter two qualities, however, biomass sources lack many of these performance attributes unless subjected to some kind of chemical modification.

• As it will be shown herein, some simple chemical alterations can dramatically improve the dye-binding characteristics of biomass substrates.
Binding capacity of biomass

• The binding capacity of a biomass substrate will depend on the size and charge of the dye.

• Conditions which can influence dye binding, and thus the apparent dye binding capacity, such as solution pH and salt content, are often very crucial.

• It is assumed that capacities would be determined under optimal conditions and sufficient time would be allowed to achieve equilibrium.
Non uniformity of binding capacity

• Also, binding capacity is not reported in a uniform manner

• The binding capacities for a particular dye in terms of moles of dye bound per Kg of dry biomass (mol/Kg).

• The charge of the dye is identified when known. With substrates for which ion exchange clearly is the binding mechanism, capacity is presented in terms of milliequivalents per Kg of dry biomass (eq/Kg).
• Many industrially useful fungi contain chitin and chitosan in their cell walls.

• Hence, the fungal biomass by products of industrial fermentation processes can serve as an alternative to crustacea as a source of chitin-based dye adsorbents.

• The cell wall of *Myrothecium verrucaria* was shown to bind azo dyes, including Acid Orange II and Acid Red 114 (a divalent anion).

• Dye binding to the fungal material was moderately slow, requiring 4-6 h to reach equilibrium.
Chemical modifications for Biomass

• The biomass types discussed, their capacities for various dyes, for utilization as absorbents for dyes in textile wastewater.

• Only the crosslinked chitosan fibers and the quaternized cellulose and lignocellulose materials have adequate dye binding capacity and rapid equilibrium kinetics, and are easily regenerated.

• And of these, only quaternized (ligno)cellulose is insensitive to dyebath pH.

• Therefore, based on performance, the quaternized lignocellulose substrates seem to offer the best potential for the treatment of acid dye-containing effluents.

• However, some form of crosslinked chitosan also appears promising because of its superior capacity.
Chemically-modified cellulose and lignocellulose

- In much the same way that chemical modification of chitin improves its dye adsorption characteristics, derivatization of cellulose or ligno-cellulosic biomass can dramatically improve their dye binding properties.

Hwang and Chen describe the grafting of polyamide-epichlorohydrin (PAE) polymer onto cellulose. This material, composed of 10-30% cellulose, has a high adsorption capacity for acidic dyes. The adsorption capacity for Direct Blue 86 (a divalent anion) of the PAE-cellulose (25% cellulose) material is 1.0 mol/Kg.

Unfortunately, the rate of dye adsorption is very slow, requiring three days at 30°C to reach equilibrium.

The apparent absorption capacity of PAE-cellulose is pH dependent (similar to chitosan). It is not known to what extent dyebath electrolytes influence dye binding, nor whether PAE-cellulose can be regenerated.