Activated Carbon treatment for Textile Effluents

Lecture-26
Activated carbon

Activated carbon, also called activated charcoal or activated coal, is a generic term that includes carbon material mostly derived from charcoal.

Activated carbon is a material with an exceptionally high surface area and a high degree of micro-porosity.

The porosity is so high that just one gram of it has a surface area of approximately 500 m², as determined typically by nitrogen gas adsorption.

Sufficient activation for useful applications may come solely from the high surface area, though often, further chemical treatment is used to enhance the absorbing properties of the material.
Powdered activated carbon (PAC)

Traditionally, active carbons are made in particulate form as powders or fine granules less than 1.0 mm in size with an average diameter between 0.15 and 0.25 mm. Thus they present a large internal surface with a small diffusion distance. PAC is made up of crushed or ground carbon particles, 95 - 100% of which will pass through a designated mesh sieve. Granular activated carbon is defined as activated carbon that is retained on a 50-mesh sieve (0.297 mm). PAC material is finer material. According to ASTM standard, PAC is classified as particle size corresponding to or smaller than an 80-mesh sieve (0.177 mm). PAC is not commonly used in a dedicated vessel, owing to the high head-loss that would occur. PAC is generally added directly to other process units, such as raw water intakes, rapid mix basins, clarifiers, and gravity filters.
Granulated activated carbon

Granulated activated carbon has a relatively larger particle size compared to powdered activated carbon and consequently, presents a smaller external surface. However, in instances where diffusion of the adsorbate is a primary consideration, GAC would assume importance. They are therefore preferred for adsorption of gases and vapours as their rates of diffusion are faster.

GAC is also used for water treatment, deodorisation and separation of components of flow system. GAC can be either in the granular form or extruded.

The most popular aqueous phase carbons are the 12x40 and 8x30 sizes because they have a good balance of size, surface area, and head-loss characteristics.
Adsorption

Adsorption supports such as activated charcoal can be used as adsorbents for hydrophobic compounds, including dye molecules. The technology is simple and activated charcoal (from wastes such as wood, etc) can be obtained at a low cost. However, the desorption process is problematic and not cost-effective. Therefore, bound substances, including dyes, need to be disposed off. Coagulation, together with either flocculation or sedimentation, is often used in the textile industry. Coagulation is promoted by addition of an inorganic polyelectrolyte, e.g., polyaluminium chloride. These particles are then separated by floatation or sedimentation.
Removal of color

• Adsorption: It is the exchange of material at the interface between two immiscible phases in contact with one another. Adsorption appears to have considerable potential for the removal of colour from industrial effluents

• Owen (1978) after surveying 13 textile industries has reported that adsorption using granular activated carbon has emerged as a practical and economical process for the removal of colour from textile effluents.
Adsorption by activated carbon

- Adsorption on powdered activated carbon.

- The adsorption on activated carbon without pretreatment is impossible because the suspended solids rapidly clog the filter (Matsui et al., 2005).

- This procedure is therefore only feasible in combination with flocculation–decantation treatment or a biological treatment. The combination permits a reduction of suspended solids and organic substances, as well as a slight reduction in the color (Rozzi et al., 1999), but the cost of activated carbon is high.
Granular activated carbon-biofilm

The feasibility of using a granular activated carbon-biofilm configured packed column system in the decolorization of azo dye Acid Orange 7-containing wastewater.

The Acid Orange 7-degrading microbial from anaerobic sequencing batch reactor which treating the azo dye-containing wastewater for more than 200 d was immobilized on spent granular activated carbon (GAC) through attachment.

The GAC-biofilm configured packed column system showed the ability to decolorize 100% of the azo dye when working at high loading rate of Acid Orange 7 at 2.1 g/(L x d) with treatment time of 24 h. It was observed that the decolorization rate increased along with the increasing of initial Acid Orange 7 concentrations, until it reached an optimum point at about 0.38 g/h with initial Acid Orange 7 concentrations of 1,150 mg/L and the decolorization rate tend to be declined beyond this concentration.
Bentonite adsorption

The high chromaticity seriously hinders the reuse of reactive dye waste water.

A new method by bentonite adsorption and coagulation (PAC) is employed for removing color from synthetic dye waste water which contains reactive red K-2G, K-RN blue, K-GR blue, X-3B red, K-GN orange, KB-3G yellow, K-2BP red, K-RN yellow and K-G yellow.

Bentonite pretreated by 4% CTMAB and milled to 160 order screen is proven to the best decoloring agent. For a 100 mL reactive red K-2G sample (CODcr 400 mg/L, 25 000 chromaticity color), 0.5 g bentonite pretreated and 2.5 mL PAC is enough to decolor wastewater up to 99.92% and the sediment time is short.

Non-degradable dyes such as active red X-3B and K-GN orange are declored completely as well.
Adsorption is better

• The adsorption technique is superior to other techniques with regard to simplicity of design, initial cost, ease of operation and insensitivity to toxic substances.

• This technique uses a large number of suitable sorbents such as activated carbon, polymeric resins or various low cost adsorbents (non-modified or modified cellulose biomass, chitin, soil material, activated alumina, bacterial biomass, etc).

• Identification of a potential dye sorbent must be in good agreement with its dye-binding capacity, its regeneration properties and its requirements and limitations with respect to environmental conditions.

• Activated carbon remains the most effective and widely used adsorbent for the decolourisation of textile industry wastewater.