# Utilization of Specialized Activated Alumina for Decolorization

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Specialized activated alumina were designed for the purification of the bark and needles of Pacific Yew trees harvested for taxane compounds clinically important in the treatment of breast and ovarian tumors. Taxanes include paclitaxel (Taxol) and docetaxel (Paclitaxel). In order to obtain maximum yield of the taxane drugs, it was necessary to remove the color pigments. Therefore modifications were made to the pore size, the particle distribution and the pH of this designed alumina. Through extensive trial the best activated alumina for taxane isolation and purification was found to be a wide pore material with an average dp50 particle distribution of 50 microns.

The result has been that this same specialized activated alumina, originally developed for purifying taxane materials used for the treatment of cancer provides the textile industry with a superior decolorizing agent for the removal of dyes and other colored waste materials in water effluents. Dyes are chemicals, which on binding provide materials with color. Dyes are ionic, aromatic organic compounds with structures including aryl rings possessing delocalized electron systems. Dyes used by the textile industry are largely synthetic and are derived from coal tar and petroleum based intermediates. The color of a dye is provided by the presence of a chromophore group, which is a radical configuration consisting of conjugated double bonds containing delocalized electrons.

The primary classification of dyes is based on the fibers to which they can be applied and the chemical nature of each dye determines the fibers for which the dye has affinity. Acid dyes are water soluble anionic compounds applied to nylon, wool, silk and some modified acrylic textiles in an acidic medium. They have one or more sulfonic or carboxylic acid groups in their molecular structure. The dye fiber affinity is the result of ionic bonds between the sulfonic acid part of the dye and the basic amino groups in the wool, silk and nylon fibers. There are more than 100,000 commercially available dyes, with over 7 x 105 tons of dyes produced annually. The release of large quantities of dyes into water by textile industries is a major environmental waste issue. It has been estimated that about 9% of the total amount (450,000 tons) of dyestuffs produced in the world are discharged in textile wastewater. Untreated or partially treated effluents from other industries such as paper, plastic leather, cosmetic, woolen and carpet industries also contribute a heavy pollution burden.

Reactive dyes are water soluble, anionic dyes requiring relatively simple dyeing methods. Reactive dyes have largely replaced direct, azoic and vat dyes and are the largest dye class in the United States. The most common class of dyes and pigments are azo and anthraquinone colorants, and represent about 90% of all organic colorants. The dyes form covalent bonds with the fiber and become part of the fiber.

The greatest environmental impact from discharged dyes lies in their adsorption and reflection of sunlight. Dyes placed into wastewater effluent interfere with the growth of bacteria which biologically degrade the dyes, and then hinder photosynthesis in aquatic plants. Furthermore the anaerobic breakdown of some dyes leads to the production of toxic amines. Add to this the fact that at concentrations as low as 0.005 parts per million dyes can be visible in water and one has a major environmental problem. Indeed it is the presence of color which is the telltale sign alerting to this environmental issue.

Adsorption has become the most effective method for the decolorization of textile wastewater. Traditionally, activated carbon was the most commonly used adsorbent. Activated alumina has a major advantage over carbon, in that it can be reactivated at a temperature of 400 C and reused. As such activated alumina has recently become the adsorbent of choice for the textile industry.

Variables which can affect the degree of adsorption include the molecular volume of the dye, its planarity and its ability to bind to the adsorbent. The mechanism of color removal can be described in four steps

1. migration of the dye molecules from the solution to the film around the particle
2. diffusion through the liquid film to the surface
3. intraparticle diffusion

4. adsorption on an active site

The adsorption of dyes is influenced by many factors including the dye/adsorbent interaction, initial dye concentration, sorbent surface area, particle size, temperature, pH and contact time.

Physical adsorption occurs when weak interparticle bonds exist between the adsorbate and adsorbent. Such bonds include van de Wall, hydrogen and dipole-dipole forces. Chemical adsorption is based upon strong interparticle bonds which occur due to the exchange of electrons such as with covalent and ionic bonds.

The advantage for using activated alumina to bind and decolorize dyes lies in the amphoteric properties of alumina. Both acid and basic dyes are able to bind onto the same particle. This unique property of our decolorization alumina provides a benefit which makes this special activated alumina unheralded in its ability to decolorize materials.

The use of this activated decolorization alumina and adsorption for decolorization of dyes and cleanup of textile wastewater discharge has in a very short time moved from curiosity to manufacturing guideline.