



TECHNICAL BULLETIN: Wastewater

Color Removal in Pulp and Paper Effluent Using Inorganic Coagulants

The pulp and paper industry uses large amounts of process water, despite significant conservation. Thousands of gallons of water must be treated for every ton of pulp or paper produced. The industry has long dealt with the issues of BOD and TSS, and more recently with issues such as Dioxins, Furans, and AOX. While the implementation of the Cluster Rules did not place regulatory limits on color, the U.S. EPA left the option open for regulatory authorities to establish permit limits on color based on the individual circumstances of each permit holder and watershed. Many pulp and paper operations already have permit limitations on color and others will likely follow.

Alternate pulping and bleaching strategies such as extended delignification and oxygen delignification have reduced pulp mill color significantly, and these load reduction strategies will continue to be a key part of any color control plan. While in some cases process modifications may be adequate to meet local requirements, other circumstances may dictate additional treatment. For example, a mill may be located near waters of limited assimilative capacity, or this capacity may have been impaired by drought, development, or a revision in regulatory approach (such as imposing a TDML that effectively tightens the permit). In these situations inorganic coagulants may be useful to achieve the most cost-effective solution.

Coagulants and Color Removal

Pulping and bleaching processes

release colored compounds into the effluent stream. Most of the color comes from removing lignin in the bleaching operation, particularly in the caustic extraction stage. The color exists in a range of physical forms, from suspensions to true solutions. Conventional treatment processes remove some color. One mill participating in the EPA's project XL cites removal through the wastewater treatment system of 38%¹. Primary and (biological) secondary treatments are not usually more effective than this in removing soluble color.

Coagulants and adsorbents can help remove colored compounds by complexing with and/or destabilizing the color bodies. A wide variety of coagulants have been examined for this purpose, including alum, ferric sulfate, lime, clay, activated carbon, polyamines and activated silica². Historically, chemical treatment was viewed as cost prohibitive^{2,3}. This situation has improved due to the generally lower color loads per ton of pulp and the competitive market for coagulants. While a large-scale color reduction program is not a trivial undertaking, it can be done on a commercially viable basis and can push color removal rates to 90% or greater.

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Treatment Techniques

Color removal with coagulants is mechanically similar to common techniques for water purification, where coagulants have been used for decades to reduce both turbidity and color. Fuller⁴ and Lind⁵ both imply conventional settling basins. However, other clarifier types may be used, including dissolved air flotation (DAF) units.

Chemically, each application needs to be screened individually, as the wastewater and the requirements for removal efficiency can vary significantly. For inorganic coagulants, pH is a very important variable for effective color removal. In the case of alum, a pH of 5-6 is usually necessary to achieve reasonable color removal. The incoming wastewater is often alkaline, so a distinction must be made between the need for acidity and actual coagulant demand. While a coagulant such as alum or an iron salt can lower the pH to the desired level, it can add to chemical sludge generation unnecessarily if the gap between acidity demand and coagulant demand is large. Aluminum and iron coagulants are available with a variety of free acid levels. These maintain the convenience of a single feed point without unnecessary additional chemical sludge generation.

Following the color removal step, it is good practice to raise the pH back to the neutral range. This minimizes soluble coagulant carryover and reduces the impact on receiving waters. Blending with a high-pH effluent stream can often accomplish this at relatively low cost.

An effective polymer program, tailored to the individual situation, will generally improve the cost effectiveness of color

removal. Polyamines are used to aid color removal, while other polymers (e.g. polyacrylamides) are used as flocculants to improve removal of the coagulated color.

Alum process residue (APR, sometimes referred to as High-Clay Alumina) is another option that can cost-effectively improve color removal.^{4,5} This material is essentially a very low cost, positively charged clay. The residual alum aids color destabilization, while the mineral core provides a surface for adsorption and floc density for settling. These benefits need to be balanced against the potential for additional sludge generation.

The sludge press filtrate is a secondary area for color reduction. Inorganic coagulant addition here reduces the color of the presstrate as well as significantly reducing the dewatering polymer demand. Ferric salt use can eliminate hydrogen sulfide issues as well. Ferric sulfate is often preferred over ferric chloride for this type of application to reduce the likelihood of chloride-enhanced press corrosion.

A mill in need of a color reduction program should consider chemical coagulation as a viable option. Because each application will have unique characteristics, screening work and system optimization are critical. The mill should take this into account during the supplier selection process.

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