Cleaner Technology Concept Through Micro Particle - To Control Pitch/ Stickies, Retention/Drainage Aid And Effluent Treatment

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ABSTRACT

To achieve the sustainability, many Paper mills are shifting from pollution control to pollution prevention through cleaner technology - recycling / reuse water and solid waste and thus reducing pollutants and also to save the energy.

Cleaner technology concept starts from pulp mill/deinking plant by controlling pitch/stickies, paper machine to control colloidal, dissolved materials and TOC (Total organic compounds) and finally the effluent treatment.

Typical bentonite based technology is adopted to control pitch and stickies, mainly in pulp mill, deinking and recycled pulp, as retention and drainage aid in paper machine and as scavenger in effluent treatment.

Introduction

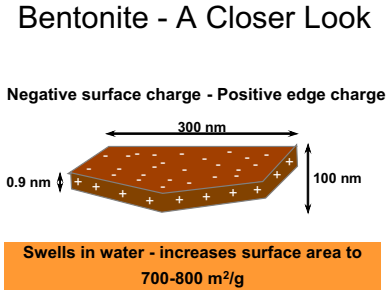
Increased use of recycled fibers and reduced usage of fresh water in the paper mills has lead to decreased additive efficiency, lower paper quality and poorer machine runnability. Increased interfering substances in papermaking furnish, such as pitch in mechanical pulp, stickies from recycled coated paper and deinked waste paper cause major runnability problems resulting in loss in production and profit to the mill. Bentonite, swellable clay with high surface area, is a very effective mineral to adsorb micro stickies and either assists these materials to exit the plant or incorporates the material in harmless form into the paper.

Due to stringent environmental restrictions many mills are planning to close the process water loop to conserve the water and lesser discharge as effluent. In the process of closure of water loop there will be a build up of colloidal and dissolved solids which will have an impact on machine runnability and productivity. The use of bentonite-based retention/drainage systems using a micro flocculation structure is able to adsorb colloidal and dissolved materials from the white water circuit and it is retained in the sheet thus helping in removing the water soluble trash. We are trying to clarify the chemical interaction in wet end focusing on retention of fines, fillers & essential chemicals in paper machines.

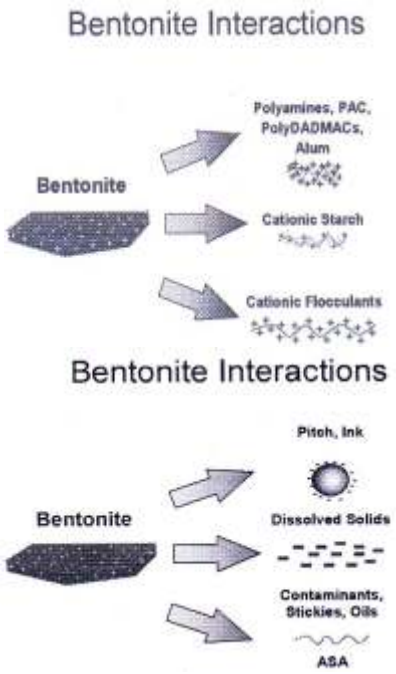
Effluent treatment is becoming compulsory for paper mills to separate water from unwanted colloidal, dissolved solids & to discharge the color free water with lesser COD & BOD as per the specifications. We are explaining how Bentonite along with Anionic Polyacrylamide helps to improve the removal of color ,colloidal & dissolved solids.

Bentonite - An Inoraganic Micro Particle

Bentonite is a natural product originated from settled volcanic dust that under given physical and chemical conditions formed bentonite rock. Colour is related to Fe content. Montmorillonite is the active component which is typical of smectite. Bentonite is a generic term.



The below figures clearly indicate that how effectively bentonite interacts with interfering substances and other cationic polymers. This property of bentonite helps to absorb and adsorb dissolved and colloidal materials from the waste water and white water circuit. By acting as a microscopic sponge and being highly retained in the paper sheet,



Characteristics	Bentonite
Microstructure	Hydrous Aluminium Silicate (Swellable Clay)
Layer Loading	Anionic, Hydrophilic, with cationic edges
Specific surface	700 m^2 / gr. (swollen)
Fiber adhesion	Good H - bridges
Surface energy	700 mJ/m^2
Addition rate	0.4% gives 2,800,000 available adsorption surface

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a significant proportion of the process water's soluble trash is removed.

Bentonite For Controlling Pitch And Stickies

Pitch

Natural wood pitch is hydrophobic, Anionic material encapsulated in the fiber or present as colloidal particles in the fibrous suspension. (0.2-2.0 Microns).In these forms pitch is no problem to the Pulp and papermaker. Agglomerated pitch can lead to deposits which are difficult to remove and troublesome to the papermaker. The unsaponifiable components such as Waxes, Fatty alcohols, Sterols, and Terpene Alcohols are likely to form deposits on wires, felts, rolls and cylinders. Besides causing production interruptions due to sheet breaks, frequent cleaning and maintenance, pitch/stickies reduce wire, felt and blade life. Dewatering and formation decrease contribute to further reduction of the machine efficiency.

Pitch amount and quality variations

Pitch amounts natural variations are related to the type of wood, seasoning, time of the year, storage time. The pulping process, the used additives, the washing and bleaching efficiency are mechanical and chemical factors impacting the amount of pitch. Washing and bleaching stages are good removal points for colloidal pitch.

Occurrence of a Pitch problem

Pitch is present in the system as an unstable colloid. Sudden agglomeration can take place when following conditions change: pH drop, temperature drop, pitch concentration, hydrodynamic shear or water hardness. Especially high levels of calcium need to be avoided because calcium can precipitate pitch.

Pitch removal at the pulp mill

Generally, all sewer positions give the opportunity to remove pitch.

The best strategy is to reduce the amount of pitch before it reaches the paper machine. Complete removal of pitch is hardly possible therefore a combination of below mentioned chemistries is applied to remove the pitch, avoid agglomeration or reduce the tackiness. (See table)

Stickies

Stickies is the general naming for all organic synthetic detrimental substances entering the paper stream. The major sources of stickies are from recycled fibers such as office waste, old News Print, Coated Broke and Old Corrugated. Housekeeping issues can introduce stickies in a non recycling paper mill in form of e.g. plastics from splicing tapes, core caps etc.

The range of stickies chemistries is wide, varying from contact adhesives components such as SBR, vinyl acrylilates, polysoprene, polybutadiene, from hotmelts, EVA, polyethylene, tackifiers and wax. Ink and Coating binder components complete the chemical mixture.

In all the above differentiation, they share common properties as most of the components are:

* Hydrophobic
* Anionic
* Have various shapes
* Have variable surface area.
* Are removed by size, shape and density.

Sticky removal at a recycling plant-

Stickies are classified as Micro stickies which are smaller than 150 microns and Macro stickies which are larger than 150 microns. The latter can be removed by screening and cleaning while the Micro stickies can be removed by washing, flotation or with chemical mineral de-tackification. The following chemistries explains how stickies can be controlled.

Bentonite As Retention And Drainage Aid

The paper industry is started conserving fresh water than it did a decade ago. The environmental leap is due to closing water systems: Cleaning and reusing water.

Bentonite Case studies Stickies

Mill	Problem	Application	Result
Mill no 1 Copy paper	Pitch removal Dusting Landfill	Replaced 8-10 kg talc with 1.5-2 kg Bentonite at fast mixer of pulp	Pitch no problem No dusting Reduced landfill
Mill no 2 Colored paper	Pitch	Bentonite 2 kg/t after bleaching tower. Bentonite 1.5 kg and Flocculent 200 PPM in return water after second Kemi-washer.	Pitch no longer a problem.
Mill no 3 Coated fine paper	Runnability of the PM's affected by pitch	Bentonite 2 kg/t in virgin pulp chest (SF) and 3 kg/t in LF chest.	No pitch related runnability problems on machine.
Mill no 4 Coated fine paper	Runnability	Trial stage	Runnability improved

Chemistry	Function
Bentonite/ Talc	Absorption, de-tackifying and removal. Retention of Talc is needed.
Surfacetants	Avoiding agglomeration by hydrophilic layering. (water solube)
Alum, Sodium Aluminates, PAC	Avoid encapsulated pitch to detach from fiber and coagulates pitch to fiber and fines.
Dispersants	Decrease and avoids agglomeration of pitch particles by increasing the anionic charges of the particle.
Organic coagulants	Mostly used in paper machine area. High cationic low molecular weight polymer to attach pitch particles to fiber

Bentonite Case studies

Mill	Problem	Application	Result
Mill no 5 Copy paper	Calander deposits	Bentonite 2 kg/t in ground wood before refining & 2 kg/t in DIP	Significant reduction of calander deposits.
Mill no 6	High speck count	Bentonite 2 kg/t in DIP before bleaching.	Significant reduction of specks.
Mill no 7 Newprint	Runnability	Bentonite 1.5 - 3 kg/t in TMP	Improved runnability.

The goal is to use zero fresh water but it may be tough for many mills. After such a thorough purification process, most mills end up with less waste water but find it is more saturated in anionic trash and inorganic material. If this is not controlled, this would increase TOC (Total Organic compounds) and conductivity levels, both may create problem in machine runnability. One of the most proven micro particles to counteract this problem is bentonite.

The main emphasis of this discussion is the use of a powerful retention/drainage system in the wet end to guarantee effective retention of fibre, fillers, fines and any functional additives.

The main chemical difference between an open and closed white water sytems is the quantity of dissolved substances that accumulate due to the concentration effect of the various process water loops.

In a typical process behavior during water closure of a mill using 100 % recycled fibre,it is observed that, the gradual increase in TDS (Total dissolved solids) occurs once the fresh water consumption reduces. The new equilibrium takes several months to stabilize.

Typical bentonite based reactions

Bentonite Mechanism

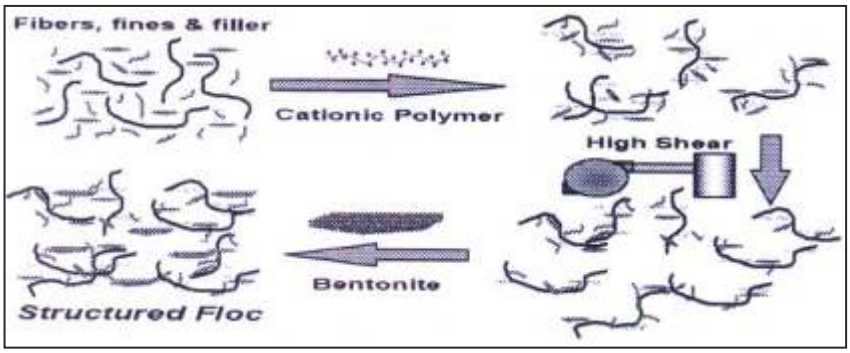

Figure shows a simplified reaction mechanism of the basic two-components micro particle system using bentonite as the microparticle.the first component, a cationic polymer, with a higher molecular wt. reacts directly with the stock components & form a large microfloc structure through bridging .under shear , these flocs break up & form microfloc about ten times smaller than the original structure . The bentonite is added after the screen and the microfloc are brought together by electrostatic forces, creating a porous, malleable, tight floc structure. This super coagulated structure can deform without loosing its strength, enabling high retentions and good sheet formation. There are other microparticle systems that have a similar mechanism but hydrated bentonite has a unique characteristic, making it superior in the paper & paper board mills with closed white water system. Due to the small particle size & contains micro pores with an amphoteric charge structure helps for the retention of colloid & complex dissolved solids as well as fiber, fines and minerals.

Benonite case studies as Retention and drainage aid

Mill no 1 was suffering from poor runnability and poor formation due to poor drainage. After implementing the dual component with micro particle bentonite things have been changed and mill can improve its productivity. The details are as under:

1-100% hardwood based, producing the copy paper.

2- A 100% agri-residue based mill running with single component polymer base retention aid program. On introducing the bentonite as second component with Cationic flocculant, the system could enable to bring equilibrium by reducing the head box & white water consistency considerably improved the runnability and productivity and reduction in chemical consumption.

Apart from above case studies bentonite along with coagulant or/ and Flocculent proved to be an excellent dewatering agent and assists in improving formation and ash retention.

Bentonite Based Effluent Treatment Program:

Positive	Effect and Change	Remark
Retention	■ FPR improved from 82 to 91%. FPAR improved from 43 to 50%) ■ Slice opened from 21.6 to 28.5 mm. ■ HB and WW consistencies decreased.	Almost 11% increase. Slice 32 % more open
Drainage	■ From 18 sec. to between 8 and 11 sec. (sec/500ml) ■ Water line moved in total ca 175 cm closer to HB. ■ RPM Fan-pump increased from 368 to between 491 & 463 RPM at trial end to 371 RPM.	Increase 8.6 %
Productivity	■ Speed increase in total 40 m/min from 462 to 502 m/min.	Almost 10-13% increase.
Savings	■ Steam consumption reduced from 1.58 t/t to a minimum of 1.45 t/t.	

The generation of wastewater and the characteristics of pulp and paper mill effluent depend upon the type of manufacturing process adopted. Hence, the treatments of the waste waters from different mills become complicated because no two paper mills discharges are identical due to different combination of unit processes involved in the manufacturing of pulp and paper. Wastewater from pulp and paper mills constitutes a major source of aquatic pollution since it contains high organic substances causing high biochemical oxygen demand (BOD) and chemical oxygen demand (COD), extractives

Parameters	Effect and Change	Remark
Retention	■ FPR improved from 73 to 80%. FPAR improved from 38 to 48%)	Almost 7% increase in FPR and 12 % in FPAR
Drainage (Dewatering)	■ Dewatering improved from 390 ml to 480 ml/ 30s. ■ W/W consistency got reduced from 0.33 to 0.14%, H box cy got reduced from 0.9% to 0.74%	Better drainage and improved formation
Machine runnabiliy and productivity	■ Machine runnability improved by reducing no of breaks 15 - 20 to 4 - 5 ■ Production increased from 190 tpd to 240 tpd.	Breaks reduced by 80 % Production increased by 25%
Savings in additives	■ AKD consumption reduced from 18 kg/t to 12 kg/t.	AKD consumption reduced by 30-35%

(resin acids), suspended solids, metals, fatty acids, tannins, lignin and its derivatives, etc.

Lignin and its derivatives can form highly toxic and recalcitrant compounds and are responsible for the high BOD and COD. The effluent is toxic to aquatic organisms and exhibits strong mutagenic effects and physiological impairment. Varieties of responses were reported in fish populations living downstream of bleached Kraft pulp mills. Consequently, a new approach in the wastewater treatment technology should be developed to face more stringent environmental regulations on the quality of the effluent entering receiving waters. Many studies have been carried out on the treatment of pulp and paper mills wastewater by biological method such as conventional aerobic and anaerobic treatment methods. The advantage of polymeric flocculants is their ability to produce large, dense, compact and stronger flocs with good settling characteristic compared to those obtained by coagulation. It can also reduce the sludge volume. Furthermore, the polymer performance is less dependent on pH. There are no residual or metal ions added such as Al3+ and Fe3+, and the alkalinity is maintained. The flocculation performance of flocculants primarily lies on the type of flocculent and its molecular weight, ionic nature and content, on the suspension content in the waste water and the type of wastewater .The use of polymeric flocculants or polyelectrolyte, especially those of high molecular weight, has resulted in tremendous performance improvement for industrial separation processes, a good flocculation is observed when microparticle is used in conjunction with cationic and nonionic PAMs(Polyacrylamides) but a synergetic effect is observed in conjunction with anionic PAM.

When bentonite used with anionic A-PAM (anionic polyacrylamides) will help in absorbing colloidal particles and flocculated and nasties are cleaned out. However, small amount of more solid waste is being generated due to bentonite.

Primary clarification with dual component micro particle & Polyacrylamide-

Case 1- Mill was using alum and anionic PAM for primary treatment of effluent and mill couldn't achieve the required TSS and colour removal for further treatment. When A-PAM and bentonite was introduced to treat the effluent there was considerable improvement in TSS (Total suspended solids) outlet and colour. The following data explains how the combination of Bentonite and anionic PAM is effective in primary effluent treatment.

Apart from the above application the bentonite can also be used to treat the waste water.

The following cases explain how bentonite is effective in waste water treatment.

Parameters	Inlet water	After primary cl.	After secondary cl.
TSS, ppm	400-500	<100	<100
Color, Pt- Co units	750-850	600-650	350-450
Total COD, ppm	1300-1400	950-1050	350-400

Bentonite for waste water treatment

Mill	Problem	Application	Result
Mill no 7 waste water	High TOC (total organic compounds)	Bentonite 1 - 2 kg in waste water inlet to effluent.	Reduced TOC
Mill no 6	High TOC , Mn and Fe	Bentonite 1 - 2 kg inlet waste water Krofta	Reduced TOC, Mn, and Fe in waste water.

Conclusion

Bentonite, an inorganic micro particle plays an important role in controlling pitch and stickies, can be effectively used as a retention and drainage aid and can also be used for primary treatment of effluent to reduce TSS, colour and COD in combination in with polyacrylamide.

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