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Sticky Control during Pulping of Secondary Fibers

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STICKY CONTROL DURING

PULPING OF SECONDARY FIBERS

by

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ABSTRACT

The thesis experiment attempted to show the effect talc and bentonite had on reducing the reagglomeration of sticky particles, and to discover which of the 2 fillers was more effective.

Trials were made using the mechanical action of the blender and heat to break up and disperse the hot-melt adhesive. Talc or bentonite wase then added and tested to determine their effectiveness on the subsquent reagglomeration of sticky particles during mixing.

It was shown that as addition of either talc or bentonite gave a significant reduction in the reagglomeration of the hot-melt adhesive particles.

Results showed that bentonite gave better overall test results. However, these results may be misleading due to the experimental error associated with this thesis procedure.

The electron microscope was used to show the adhesion of talc and bentonite onto the surface of the hot-melt adhesive.

TABLE OF CONTENTS

THEORETICAL DISCUSSION

Increasing technology has allowed the incorporation of paperstock, secondary fibers, into the papermaking process. As a fibrous source, secondary fibers, commonly termed wastepaper, can be used to supply 100% furnish for many grades of paper and paperboard. Since secondary fiber consists of both short and long fibers it can be used as a source of raw material for many different grades.

Wastepaper, however, is seldom used as 100% furnish. In the United States approximately 43% of the corrugated boxboard made today, is made from recycled boxboard. Also 24% of the newsprint made uses furnish from recycled newsprint and 39% of all tissue made is made from various secondary fiber grades. Currently, 45% of all fibrous material used by the European paper and paperboard industry is comprised of wastepaper. In 1984, the annual consumption of recycled paper and paperboard in Europe totalled 12.8 million metric tons. The U.S. pulp and paper industry consumed a slightly higher tonnage, 14 million metric tons, however this represents only 23% of the fibrous material used.

The demand for recycled paper and paperboard in Europe, showed a modest increase between 1980 and 1985. The demand is expected to grow at an increased rate between 1985 and 1990. Although the U.S. market for recyclable paper and paperboard is not expected to increase, no drastic decrease in the market is expected.

An independent study (10), showed the economics of increasing the use of recycled fiber compared to the use of virgin pulp as a fiber source. Old corrugated containers were recycled and used as furnish to make unbleached kraft linerboard and compared the price to make the same grade with virgin pulp.

Market value of recycled corrugate containers is highly varialbe, having a reported market value of $40 to $75/ metric ton, as late as 1984. In comparision, reported market values of pulpwood appears to be more stable over time, ranging around the $40 to $50/ metric ton range (dry weight basis).

However, fiber yield from old corrugated containers can be over the 90% range, whereas the yield from a kraft mill is approximately 50%.

Using approximate values, it can be seen that the total cost for the kraft process utilizing the virgin pulpwood cost, an average of $113.7 million for a 635 metric ton/ day operation. The introduction of secondary fiber pulping process gave as average approximate cost of $15,1 million for the same size mill. This results in an average savings of $98.6 million for a 635 metric tons/ day mill.

Decreased cost from the secondary fiber process resulted from a decrease in energy requirements, less requirements for black liquor evaporators and concentrators, pulp digesters and liquid heaters, wood preparation, chemical recovery and lime kiln areas. Also, per-unit labor cost is reduced with the use of secondary fibers due to the smaller labor requirement for the kraft pulping, which includes labor for wood preparation, pulp mill, and chemical recovery.

On the negative side, the use of recycled fiber reduces proportionally the amount of black liquor and wood residue available for combustion, therefore increasing the need for auxiliary fuel, which is typically more expensive.

To seperate the wastepaper into its different constituents, a deinking mill uses the addition of caustic, to aid in the seperation process. A board mill, on the other hand, usually doesn't add any chemicals and

relies solely on the hydrapulper. The mechanical action of the hydrapulper which is simular to an ordinary kitchen blender, breaks up the wastepaper into its different constituents.

A major problem encountered when using secondary fibers as a fiber source is the introduction of contaminants into the system. These contaminants are generally referred to as 'stickies'.

Stickies are defined as the noncellulosic wastepaper contaminants that exhibit elastic and tacky characteristics (8). Stickies tend to adhere to the process equipment, cause runnability problems, and produces spots in the final product. In addition to producing spots in the final product, stickies adhering to the process equipment may cause holes in the web or cause web breaks.

Sticky particles are generally classified as 2 major types: (9)

1. Stickies- this is the term that is normally applied to the sticky conditions related to fiber recycling and usually refers to papermaking conditions created by the prescence of hot-melt adhesives, pressure sensitive adhesives, waxes, etc.

2. White Pitch- applies to white appearing sticky deposits found in paper mills recycling coated broke in which the coating binder is some form of latex such as polyvinlyacetate (PVAc) or styrene-butadine (SBR).

If left untreated and allowed to pass through the system, stickies tend to reagglomerate as they come into contact with each other. Deposits appear in a various of different areas of the process system. A few examples are stock lines, machine wires, felts, uhle boxes, pressure rolls, and calendar stacks. (2, 6, 11, 12)

The problem with stickies first appeared in the 1940's with the introduction of synthetic resins. Stickies are often produced from 2 major catagories, hot-melt adhesives and pressure sensitive adhesive. Stickies

are expected to be an increasing problem due to the increased use of hot-melt adhesives and pressure sensitive adhesives. Stickies may also orginate from such sources as styrofoam, latexes, waxes, asphalts, ink residuals, and synthetic films. These sources of sticky particles can result from recycling such items as book bindings, mailing labels for newspapers and publications, tape coated products, and any fiber source that contains one of the classes of sticky particles.

Presently, there are 3 concepts that are used to resolve the sticky contaminant problem (11). The first method presorts the wastepaper, removing all sticky material before processing the wastepaper through the system. Although this method is theoretically sound, pratical limitations are noted. Limitations result from the amount of man-hours required to presort the wastepaper with the sticky contaminants from the wastepaper containing no contamination. Also, the possibility of human error resulting from the presorting reduces the efficiency of this method.

The second method, which will have mills continueing their current practices, is to use mechanical methods to clean and remove the sticky contamination from the fiber source, Equipment, such as screens with holes and fine slots (as small as 0.008 in.) and forward and reverse hydrocyclones, are employed to minimize the flow of stickies to the paper machine. However the continued use of this type of method will require the upgrading of the process equipment involved. (6)

The third method employes the advantage of adding a chemical additive to make all sticky material repulpable and easily removable. The basic idea of this method states that a chemical additive is added to the pulp slurry and rendering the sticky particles innocous by either dispersion or removal. To render the sticky particles harmless, the chemical add-

itive will either modify the formulation of the sticky particles or modify their characteristic properties. This method can be further subdivided in to 2 major concepts, dispersion concept and an absorption concept. (13)

The dispersion concept utilizies an organic chemical additive. The chemical additive is introduced to stablize the surface charges of the sticky particles and maintaining them in a suspension to allow their passage out of the system by washing techniques. The particles are then disregarded as effluents. The main disadvantage of the dispersion concept is seen in closed water systems. Sticky particles can build up to a level were the dispersing agent will no longer be effective.

In the absorption concept, the sticky particles are absorbed onto an inert minerial surface and are carried out of the system with the final product.

Both the dispersant and the absorption concept have proven as reliable methods for the controll of sticky contaminants in the recycled process. (9)

Two of the more effective chemical additives used in the absorption concept are talc and bentonite. (9,14,16) Both of these chemical additives have been used in controlling deposits from pitch which plaqued the pulp and paper industry before the introduction of sticky contaminantion.

Stickies caused by hotmelt adhesives, although chemically different from pitch particles, they appear to act mechanically simular. They also tend to be broken up into tiny 'balls' in the hydrapulper.

Pitch is considered the sticky, tacky, resinous or gummy substance found in wood. (7) In its original form as found in wood, mostly located in the fine ray cells, pitch is a finely dispersed colloid with no in-

clination to be troublesome.

During the cooking of the wood chips some of the pitch is also cooked out. Pitch particles are cooked out of the ray cells and held in suspension under the influences of the natural dispersing agents of the wood found in the sulfite waste liquor. As we proceed to wash the liquor out of the pulp, some of the free pitch is also washed out.

Depending on the degree of washing, we have a pulp slurry that is more or less free of loose pitch particles. However, pitch is still foundin the remaining ray cells.

In every step of the pulping process, we are mechanically working the wood fibers against each other. Inevitably, we are knocking more pitch out of the ray cells and into the pulp slurry. The more mechanical agatation occuring, the more pitch that is released and the increased likelihood of trouble occurring. Washing at almost any point in the system will generally wash out some of the fine pitch particles and ray cells. However, washing will not be a cure-all if the pitch particles have reagglomerated and become so large that they are unable to pass through the mat.

If pitch 'balls' are not allowed to be washed through the mat and out of the system as effluent, problems will occur. Problems arise in a chemical pulp mill, by pitch agglomeration curtailling production when they deposit on brown stock screens, plates, or affect the quality as specks in the final bleached pulp. (7,14)

In a paper mill, agglomerated pitch deposits will appear in a various areas such as in stock lines, machine wires, felts, uhle boxes, press rolls and calender stacks. In most cases, agglomerated pitch particles will cause problems with machine runnability and product qual-

ity. These problems are simular to those associated with stickies allowed to pass through the system untreated.

Minerial fillers, such as talc and bentonite, have both hydrophilic and organophilic surfaces which allow them to be dispersed into pulp and water slurries and absorb organic matter onto their surfaces, respectively.

Results (13,16) have shown that the reduction in pitch particle concentration is inversely proportional to the addition level of the ultrafine talc. Increasing the amount of talc added will decrease the concentration of the pitch particles. Bentonite also showed a decrease in pitch spots with an increase in the addition level. The bentonite was added to the hydrapulper at a rate of 10 lbs. per 100 lbs. of fiber (10% bentonite addition based on the weight of the fiber).

Talc is a layer-lattice type of minerial composed of many platelets. A layer of magnesium hydroxide is sandwiched between and chemically bonded to layers of silica sheets. These layers are held together by weak Van der Waals forces.

The Van der Waals forces are easily broken allowing the edges of the talc particles to become hydrophilic in nature. By becoming hydrophilic, the particles are easily dispersed into water slurries, or in the case of the pulp and paper industry pulp slurries.

As a whole unit the talc particle is electrically neutral and strongly organophilic at its planar surfaces. By having the planar surfaces organophilic the talc particle will absorb organic matter from the surrounding slurry. (9,13,14)

Talc is produced from the thermal alteration of a commonly occurring mineral called dolomite. (9) The purer the form of talc, the greater

the degree of organophilic characteristics it will display; the greater the degree of organophilic surface present, the greater the efficiency of the talc at absorbing the organic matter from the surrounding pulp slurry, on a pound per pound basis.

The properties of low abrasion, non-toxic rating, high organophilic surface area, and the inert chemical nature, allows its use at any pH level. (9)

Talc controls the pitch particles by preferentially absorbing them in an aqueous medium. (14) Talc controls pitch by absorbing the particles onto its planar surface. The organophilic surface of the talc particles attracts the oleoresinous material from the pulp slurry. Talc picks up the pitch particles by random contact.

Optimal pitch control depends on the availability of the maximum amount of the talc's organophilic surface to come into contact with the pitch. To achieve this optimal level the following 2 considerations should be employeed. First, the pitch should be in the filmy, nonagglomerated state that exhibits tacky conditions. Secondly, the talc should be finely ground, highly delaminated, and posses an organophilic surface area between 15 and 17 sq. m/g. (14)

Clays produced by the devitrification of volcanic ash are geologically termed bentonites. (4) Bentonites are characterized by their ability to absorb water at a greater quantity than plastic clays.

Bentonites are classified as 2 major types:

1. Wyoming Type- absorbs large quantities of water, swelling greatly in the process and remaining in suspension in thin water dispersions.

2. Metra or Sub-bentonite- absorbs only slightly more water than ordinary plastic clays or fuller's

earths and are characterizied by rapid slaking and slight swelling when placed in water. (15)

Physical properties of bentonite is determined by the relative proportions of lime and soda. A high ratio of soda to lime indicates a swelling bentonite.

Bentonite, like talc, has a layered structure with octahedral shaped layers. Bentonite is comprised of aluminum ions that are sandwiched between sheets of linked SiO_4 tetrahedra. Also like talc, bentonite is comprised of hydrophilic and organophilic surfaces. Bentonites are generally thought as being extremely small particles with a very high surface area and having the ability of absorbing large quantities of water.

Bentonites, unlike talc, vary in color when added to water. The Wyoming type is a creamy white color when dry but becoming a light tan color when wet.

Due to the large ratio of organophilic to hydrophilic surfaces of these 2 fillers, they are especially suited for the control of organic and other tramp impurities.

As the pitch particle comes into contact with the fillers it is absorbed onto the filler's planar surface it will reduce the area that has the potential to be troublesome. As this particle comes into contact with more filler it will be absorbed onto their planar surface also. Eventually the pitch particles are surrounded by the filler and passes out of the system with the final product. The pitch particles become 'invisible' in the final product and thus pass out of the system harmlessly.

As stated earlier, stickies and pitch are chemically different but act the same mechainically. Stickies will also cause problems with de-

posits on the process equipment, cause runnability problems, and cause spots in the final product.

If sticky particles are left untreated and pass through the system they will reagglomerate and form larger deposits which will in turn lead to greater problems.

The most likely place for stickies to reagglomerate are spots of agitation. Thus it is important to add either talc or bentonite before reagglomeration is allowed to occur. Addition should take place before pumps, bends in pipes, probes of automatic consistency and flow meters, or any other place of agitation. Also, places of high shear should have the addition of filler. Shear may cause some of the filler to be shaken loose from the sticky particle and thus may result it in becoming tacky once again.

However, the most effective place to add the talc or the bentonite is at the hydrapulper. The chance of the filler particles and the sticky particles of coming into contact with each other is greatly enhanced due to the rotary action of the hydrapulper.

From this discussion it can be seen that it is better to remove the sticky particles rather than recirculating them through the system. With this in mind, it makes sense to remove contaminants, hot-melt and pressure sensitive adhesives, before reagglomeration can take place. In my thesis, I will try to show how the use of talc and bentonite can reduce the number of visible spots, made from hot-melt adhesive, in the final sheet of paper.

THESIS OBJECTIVE

The objective of this thesis was to show what affect, if any, different fillers have on reducing the number of visible spots in the final sheet formed.

Two different fillers, talc and bentonite, was evaluated at 5 addition levels. Both fillers were evaluated against the same sticky contaminant, a polyethylene hot-melt adhesive.

An overall evaluation was completed to determine if one type of fi filler was more effective at reducing the number of spots in the final sheet.

EXPERIMENTAL PROCEDURE

The experimental portion of this thesis consisted of contaminating a known fiber stock, 50/50 softwood to hardwood ratio, with a known quantity of sticky contaminants, a polyethylene based hot-melt adhesive.

Observations were made on the effect of addition of talc and bentonite had on the hot-melt during pulping.

1. Weigh base stock to the nearest 0.01g.
2. Melt down hot-melt adhesive and apply it to the base stock. The hot-melt is applied to the base stock with drawdown techniques.
3. Allow hot-melt to cool. Then weigh base stock with hot-melt to the nearest 0.01g.
4. Fill 1 gallon Warning blender with 3 liters of water. Tear up base stock with hot-melt adhesive applied on it and let soak for 5 minutes.
5. Blend blender contents for 1 minute at low speed.
6. Remove pulp slurry to metal container and heat on hot plate, at high temperature, to 150-160°F. Apply constant stirring to pulp slurry.
7. Weigh out* amount of filler, talc or bentonite, and add to metal container contents after pulp slurry has reached desired temperature of 150-160°F. After adding filler allow mixing to occur for 15 minutes at constant temperature.
8. Let pulp slurry cool.
9. Weigh filter paper.
10. Place filter paper in Buchner funnel and wet it down.
11. Measure 500 ml of pulp sluury out of metal container.

12. Pour 500 ml sample in Buchner funnel and turn on suction.

13. Take pad formed on filter and press.

14. Condition handsheets.

15. Run brightness and opacity on handsheets.

16. Weigh handsheets.

17. Count sticky spots on handsheets.

*Note: Amount of filler is based on a percentage(5,10,15,20,25%) of total fiber + hot melt weight.

Fiber + H. melt Wt. x Addition Level = Wt. of Filler

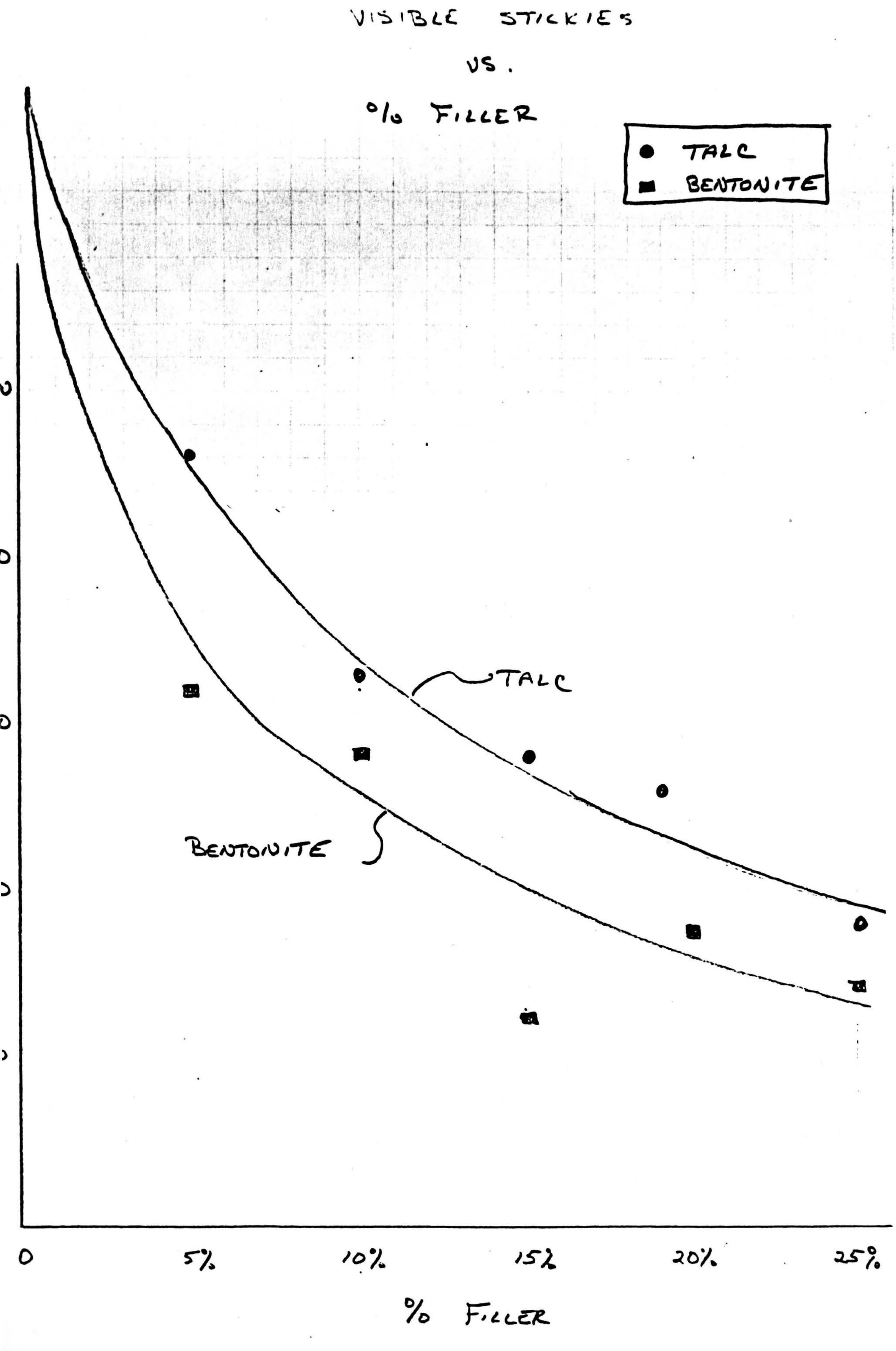
NUMBER OF VISIBLE STICKIES

PERCENT FILLER	TALC	BENTONITE
5%	46.1 ± 0.5	31.8 ± 0.6
10%	32.7 ± 0.7	28.3 ± 0.8
15%	28.2 ± 0.6	12.4 ± 0.4
20%	26.2 ± 0.9	17.4 ± 0.5
25%	18.0 ± 0.6	14.4 ± 0.5

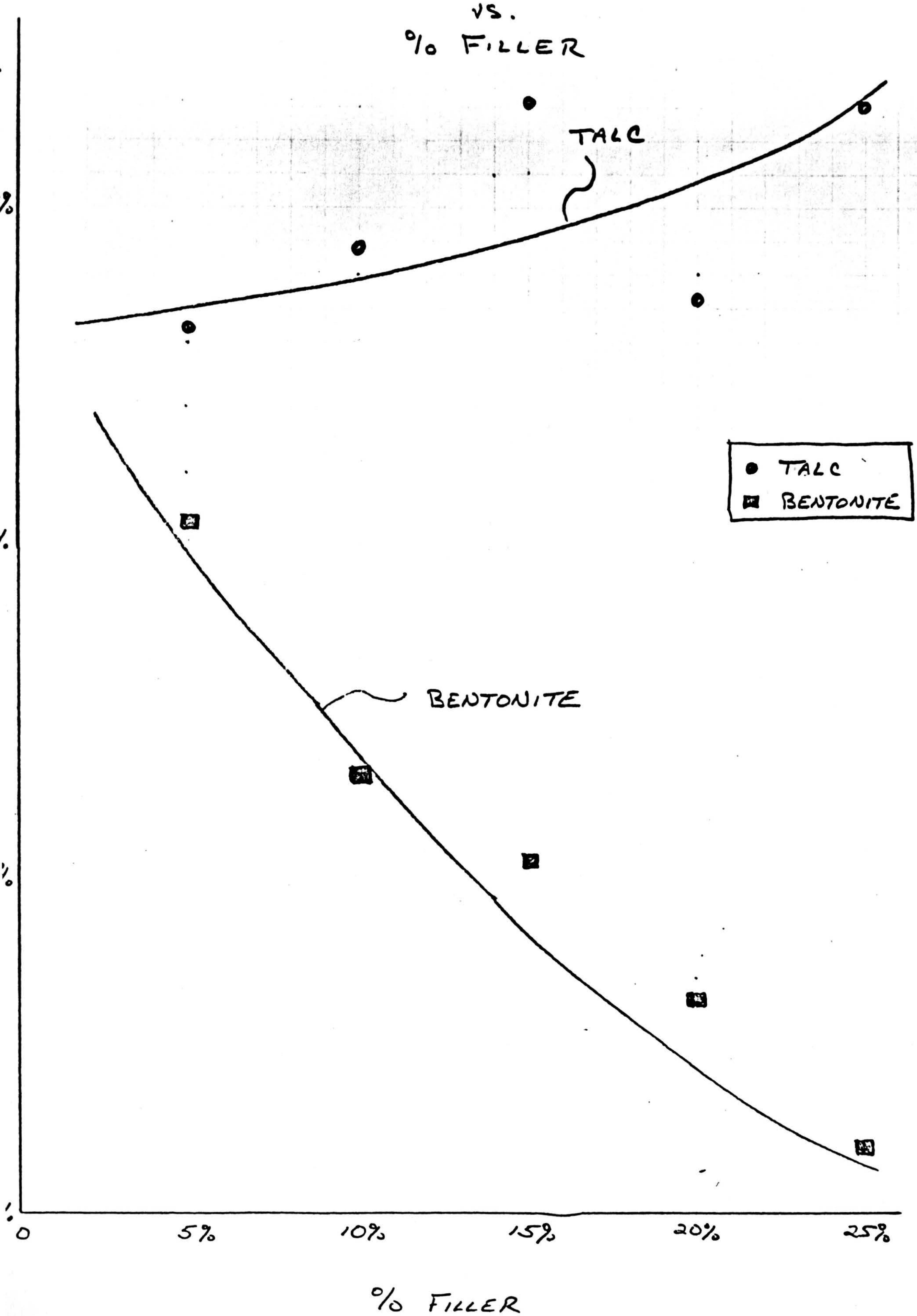
OPTICAL PROPERTIES

PERCENT FILLER	TALC		BENTONITE	
	BRIGHTNESS	OPACITY	BRIGHTNESS	OPACITY
5%	73.2±0.3	92.9±0.2	70.3±0.3	92.7±0.3
10%	74.4±0.4	93.9±0.5	66.5±0.3	96.0±0.3
15%	76.6±0.3	94.5±0.3	65.3±0.2	97.3±0.2
20%	73.6±0.2	95.0±0.2	63.2±0.2	97.6±0.2
25%	76.5±0.2	95.8±0.1	61.0±0.2	98.5±0.2

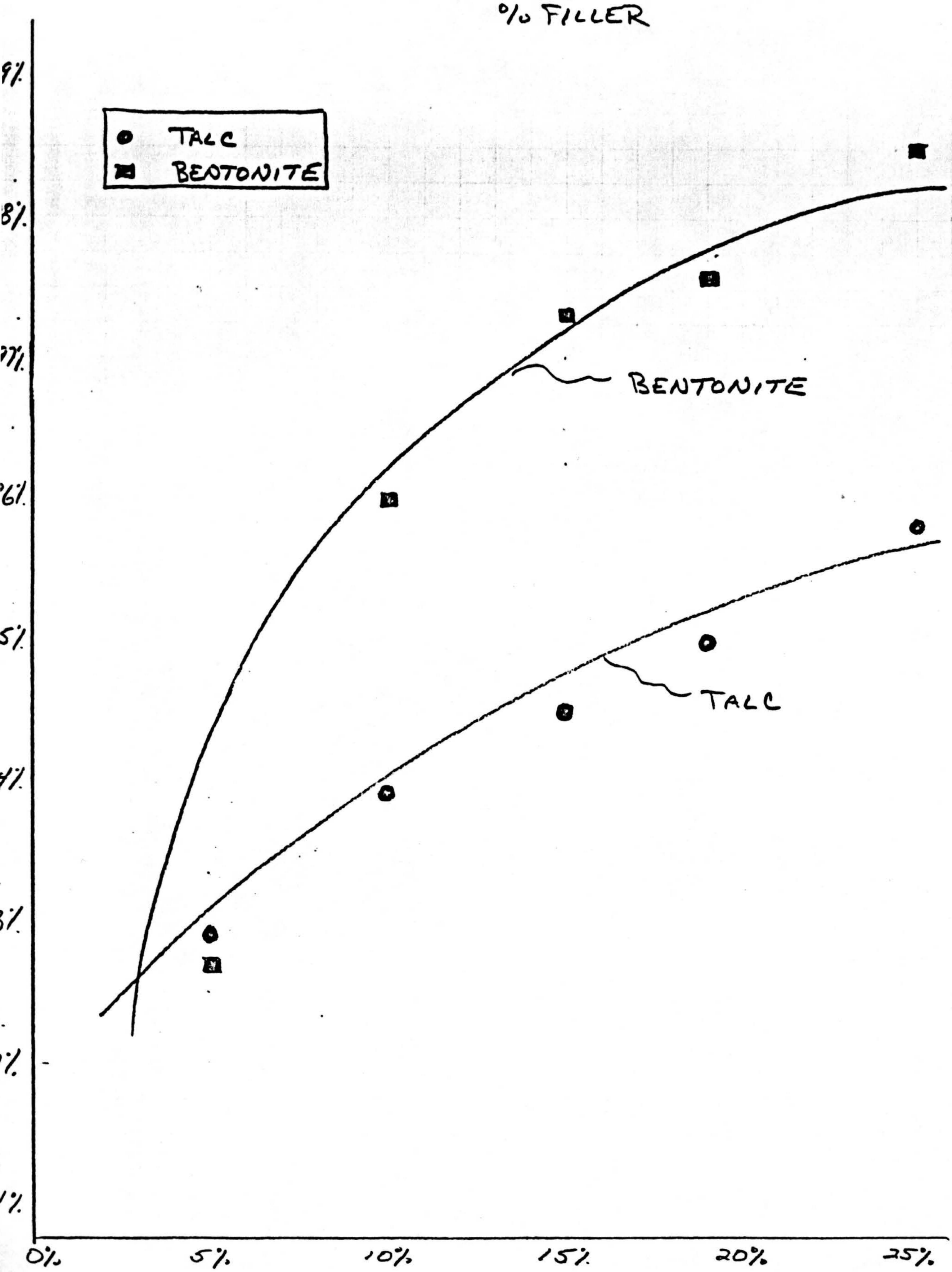
Sticky particle size range - 1/32 to 1/8 inch


VISIBLE STICKIES
VS.
% FILLER
TALC
BENTONITE
TALC
BENTONITE
0
5%
10%
15%
20%
25%
% FILLER

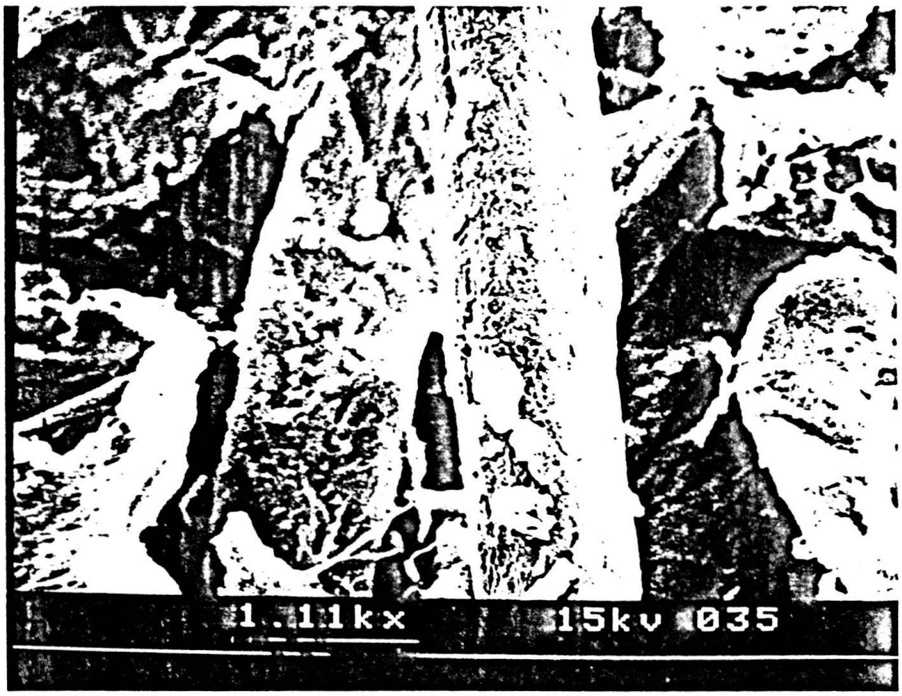
BRIGHTNESS vs. % FILLER



OPACITY
VS.
% FILLER



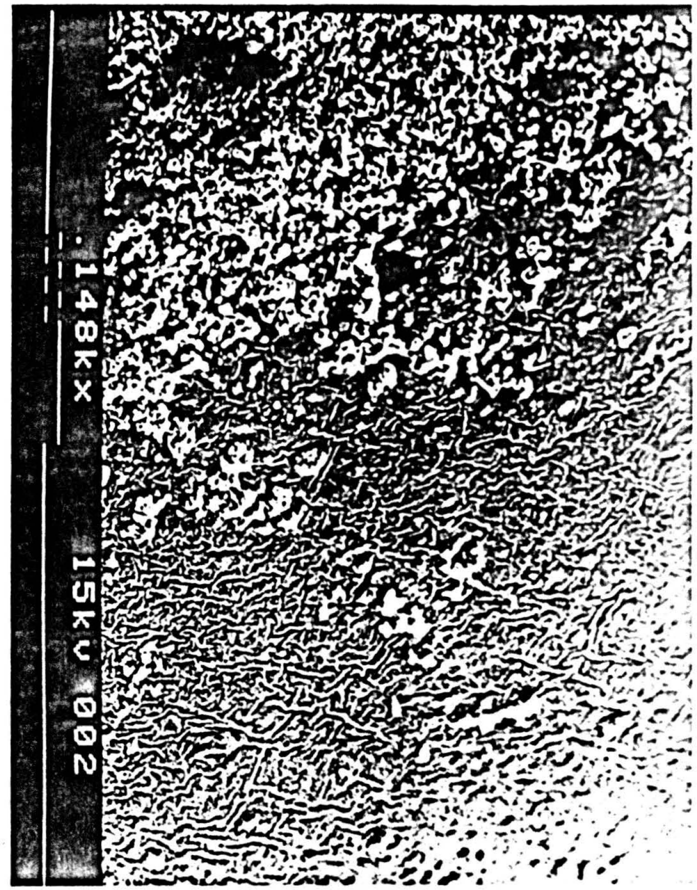
HOT MELT ADHESIVE APPLIED TO PAPER WEB



TALC PARTICLES

BENTONITE PLATELET ADHERED TO
HOT MELT SURFACE

BENTONITE PARTICLES ADHERED
TO HOT MELT SURFACE



RESULTS AND DISCUSSION OF RESULTS

As can be seen, with the addition of either talc or bentonite a reduction in the reagglomeration of sticky particles occurred. As the addition level of both talc and bentonite was increased, the number of visiable sticky spots in the handsheets decreased.

It was shown that the bentonite gave better results when compared with those results generated by the addition of the talc. The effectiveness of each filler is proportional to the amount of surface area available to absorb the hot-melt onto. Both talc abd bentonite have a surface area of approximately 15 to 17 sq. m/g. Therefore the relative surface area gave no clear advantage for either filler. Overall, the available surface area is the most important consideration when determining the type of chemical filler to use in the reduction of the reagglomeration of the sticky particles.

As the amount of bentonite was increased the brightness of the handsheets decreased, while talc showed as increase in the brightness as the amount of talc was added. Bentonite showed a decrease in the brightness due to the type of bentonite being used. The type of bentonite used was the Wyoming type which turns a light tanish color when added to water. Talc remains a white color when added to water and thus the reason for the higher overall brightness of the handsheets tested with the talc.

The sticky spots produced in the handsheets were a light yellow color. Being a light yellow color they were easier to hide in the darker handsheets produced with the bentonite than the lighter, more brighter sheets made with the talc. The main reason why bentonite appeared to give better results is due to the light color of the contaminant and the darker sheets produced.

Opacity increased with the addition of both talc and bentonite. The increase in opacity is a result of more light scattering from the sheet. As the filler content is increased the overall surface area is increased allowing increased light scattering from the surface of the handsheet, which will increase the opacity of the sheets.

Theoretically it is stated that the talc and bentonite should absorb the hot-melt adhesive onto the planar surfaces of each of the fillers. However, as can be seen by the pictures from the electron microscope, the opposite occurs. The fillers attach themselves to the hot-melt adhesives by their planar surfaces however, it appears that the hot-melt adhesives absorb the fillers, not the fillers absorbing the hot-melt as stated.

CONCULSIONS

Both talc and bentonite reduced the reagglomeration of sticky particles for a polyethylene based hot-melt adhesive. These fillers may or may not be effective on other types of contaminants.

Bentonite gave slightly better results in the reduction of visiable spots in the handsheets. I believe however, that talc does just as an effective job at reducing reagglomeration of the particles but not as an efficient job of hiding the spots in the handsheets.

Overall the most important factor on deciding what type of inert chemical additive to use is the available surface area of the chemical's organophilic surfaces.

This type of test would not be an effective method for controlling contamination problems of incoming secondary fiber if the type and quantity of contamination is uknown. For an in-mill situation with the type of contamint and the quanity being known this type of procedure can provide reduction in the reagglomeration of sticky particles.

It was shown that the hot-melt adhesive absorbed the filler onto its surface and not the other way as stated. It was also shown that the filler particles attach themselves to the hot-melt adhesive by their organophilic surfaces.

RECOMMENDATIONS FOR FUTURE WORK

Experimental work was designed to simulate conditions which occur in a secondary pulp mill which uses secondary fiber, with a contaminant,' as a fiber source.

A number of variables were incorporated into the procedure.

Temperature was the hardest variable to control. Temperature may be reached using steam instead of heating on a hot plate. Heat concentration at the bottom of the container during the heating of the pulp slurry was a problem. A heating jacket may reduce the concentration of heat at the bootom of the container.

The slusher in the pilot plant may be used to help give a more consistent consistency of the sluury during repulping. This should give more consisitent result from trial to trial.

Formation of the handsheets may be improved by using the British handsheet mold or the Noble and Wood handsheet machine. If either of these 2 methods is used they will simulate formation on a wire better, however some type of method will have to be determined to test the white water for fiber and hot-melt.

Various types of hot-melts, latexes, waxes, etc. can be used as a source of sticky contamination. Also different types of fillers may be tested.

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