A laboratory white pitch deposition test for screening additives

Larry H. Allen and Denise Filion

ABSTRACT: *A laboratory test has been developed for screening additives to control the deposition of white pitch (caused primarily by coating binders) in coated paper mills. The effects on white pitch deposition of a number of operating parameters in the test have been explored so that the user can knowledgeably choose appropriate conditions for an application. An initial trial of the laboratory test suggests that it gives results that correlate well with mill experience in screening additives for white pitch control.*

KEYWORDS: *Additives, broke, coated papers, deposits, fibers, paper grades, pitch control, reclaimed fibers, stickies, test methods, white pitch.*

White pitch is the term used in coated paper mills to refer to deposits caused primarily by coating latex from recycled coated paper. Deposition of white pitch is usually most severe on the Uhle boxes, press felts, first dryer fabric, and certain rolls (particularly the stretch roll) in the early part of the dryer section. The primary sticky material causing these deposits is usually either styrene butadiene rubber latex or polyvinylacetate latex. Because of an affinity between the latexes and certain papermaker's dyes, the deposits often, but not always, have a pale blue coloration.

The costs of problems associated with white pitch deposition can be considerable. Components include sale of off-grade product (either contaminated with pitch dirt or marred with coater streaks), premature retirement of machine clothing, solvents used to remove deposits, downtime, and additives to control the deposits. In the absence of effective white pitch control strategies, a single paper machine can lose millions of dollars per year to white pitch problems.

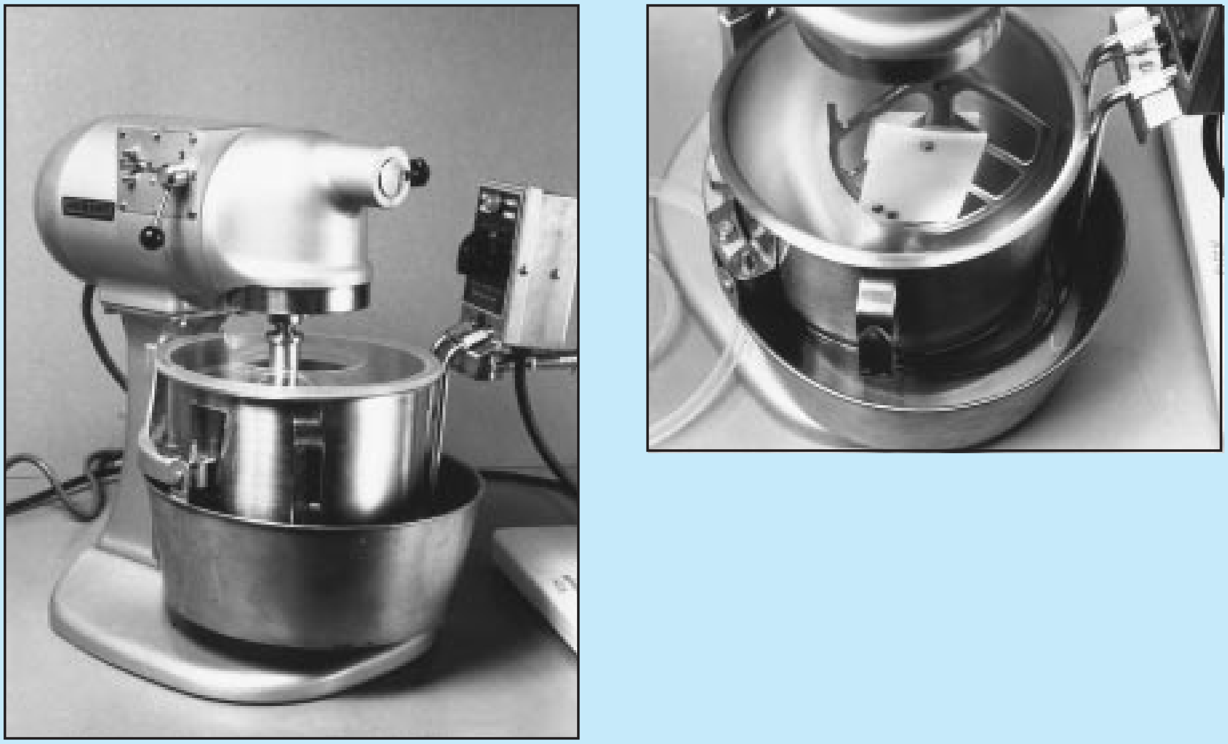
One of the best strategies for avoiding white pitch problems consists of "evening out" the use of recycled coated paper; that is, the fraction of the furnish supplied to a paper machine consisting of recycled coated paper is kept to a low and relatively constant value, as opposed to sometimes having large amounts of recycled coated paper and at other times having none. To control white pitch deposition, it is also important to avoid dumping excess coating color into the broke repulper or paper machine stock. There is also indication that the use of high-surface-energy ceramic foil blades and fabrics that are designed to impart lower shear reduce the tendency of white pitch deposition *(1)*. Because white pitch tends to codeposit with other sticky materials in the pulp, such as wood resin, defoamer, calcium soaps, and microbiological materials, a good program for controlling pitch and microbiological deposits can also reduce the deposition of white pitch.

Additives that have been advocated for controlling white pitch include dispersants; talc; alum; low-molecular-weight, high-charge-density cationic polymers; and high-molecular-weight polyacrylamides *(2–6)*. These are usually added, either singly or in certain combinations, at the broke repulper.

A difficult question, which often arises in conjunction with these additives, is which is the most effective in a particular mill application. Because of the many changeable parameters involved in paper machine operation, mill trials are often inconclusive. It is, therefore, highly

Allen is director of research, science, and Filion is assistant technical specialist at the Pulp and Paper Research Institute of Canada, 570 St. John's Blvd., Pointe Claire, PQ H9R 3J9, Canada.

1. Hobart mixer with thermostatic bath



desirable to be able to screen the additives in the laboratory using reslushed paper from the mill. Unfortunately, the standard laboratory pitch deposition tests, such as those developed by Gustafsson *(7)* and that involving the Vibromixer *(8)*, usually fail to give a measurable deposit. Latimer *(9)* has developed a laboratory procedure for measuring white pitch dirt spots in paper, but it is not a deposition test. His procedure would be very useful as a diagnostic tool for evaluating changes in process variables during mill trials.

The objective of the work described in this report was to develop a new procedure for the laboratory screening of additives for use in recycled broke to control white pitch deposition. This paper describes the method, its optimization, and its use on broke from two lightweight coated paper mills.

Experimental

Apparatus

The white pitch deposition tester consisted of a Hobart Model M-50 mixer (Hobart Manufacturing Co., Don Mills, ON, Canada) with a spade-shaped agitator and with a water bath surrounding the 5.6-L bowl, so that it can be controlled to a preset temperature (**Fig. 1**). High-density polyethylene plates, approximately 9.5 cm x 7 cm x 0.3 cm, were bolted to the agitator, as shown in **Fig. 2,** so that amounts of deposition on these plates could be measured gravimetrically.

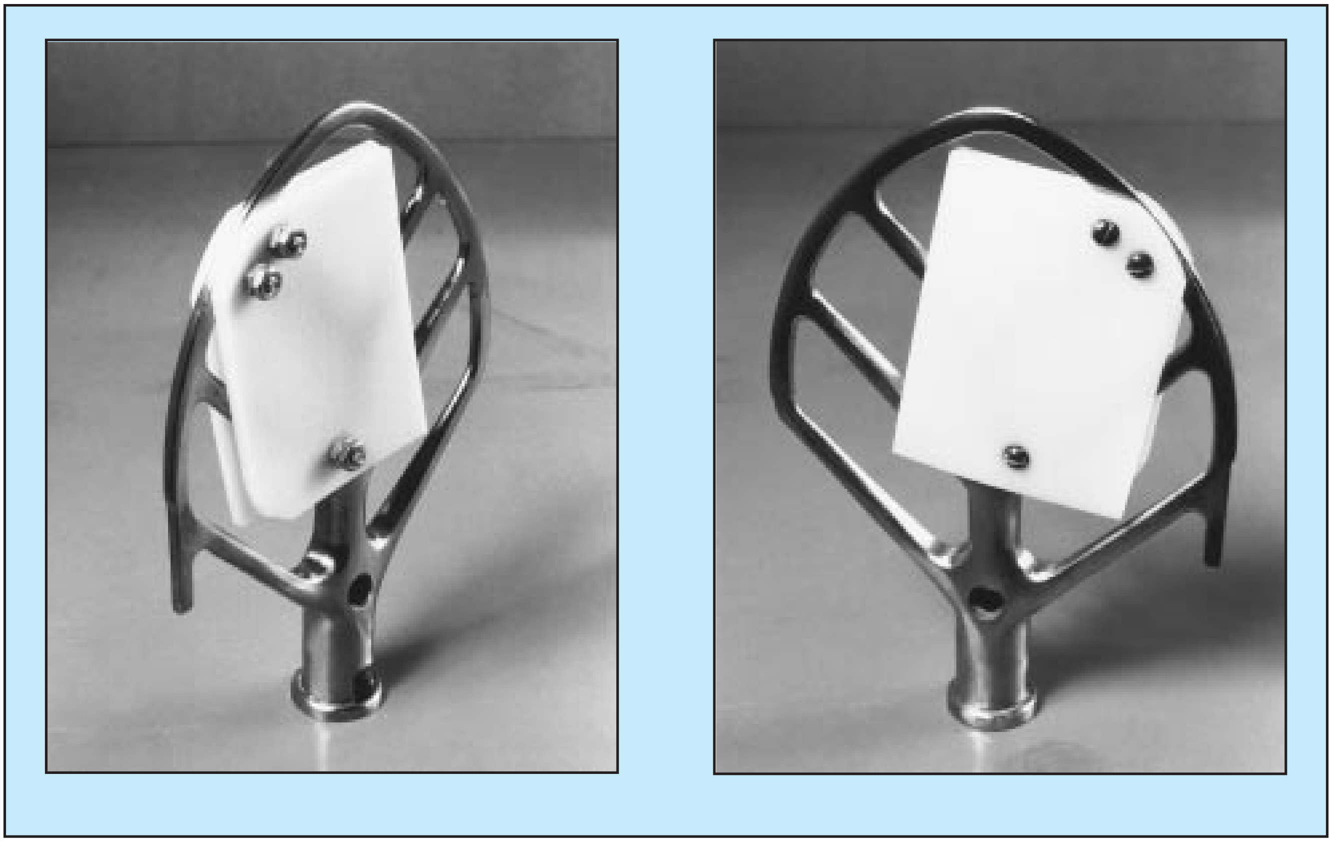
Procedure

Repulping/disintegration of paper. Shred 100 g (o.d. basis) of paper into approximately 3-cm pieces and soak in 0.8 L deionized water overnight at room temperature. Transfer the wet mixture into a stainless steel container, and add 7.2 L of deionized water at pH 5. Add additives, as required, and adjust the pH to a final value with diluted H_2SO_4 or NaOH. Disintegrate the paper using a standard pulp disintegrator *(10).* Except for the work reported in Fig. 8, all disintegrations were done at room temperature.

Pulp thickening. Centrifuge the resulting pulp at 6.5 x 10^3 G (5000 rpm in a Sorvall RC-3B centrifuge) for 20 min. Keep 1 L of the supernatant to dilute pulp mat to 10% consistency for the deposition test (and discard the rest). Determine the consistency of the pulp mat.

Deposition test. Heat the pulp mat and supernatant to 50°C in a microwave oven. Then transfer the pulp mat to the 5.6-L stainless steel bowl of the Hobart mixer, and add enough supernatant to give a 10% pulp suspension. Adjust the pH to 5.0 with diluted H_2SO_4 or NaOH. Weigh the plastic plates on an ana-

2. Placement of high-density polyethylene coupon on spade-shaped agitator blade



lytical balance and bolt to the agitator. Attach the agitator to the mixer, and run for 2 hours at 50°C and at the lowest speed setting (139 rpm). Rinse the plates and dry for 15 min in an oven at 105°C. Weigh the plates and calculate the weight of deposit.

Additives

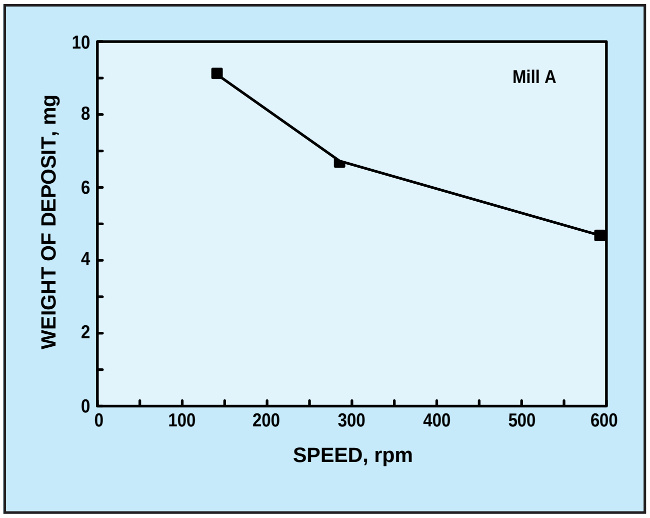
The screened additives fell into three major classes: minerals, dispersants, and flocculants/coagulants. In addition, one chelating agent was included in the screenings.

The minerals were tested at a concentration of 1% (based on the weight of o.d. fibers). A stock suspension of each mineral was prepared by weighing the required amount of powder, which was wetted to a thick paste by drop-wise addition of deionized water. The resultant paste was transferred to a blender and mixed at high speed for 3 min. The slurry was then transferred to a volumetric flask for final volume adjustment. Because calcium carbonate suspensions have a tendency to change with storage, calcium carbonate was added to the pulp, not as a slurry but as a powder. The origins of the minerals used were as follows: talc, Mistron Vapor (16 m^2/g), Luzenac America; $CaCO_3$, Hydrocarb 65, OMYA; TiO_2, Tioxide Canada; Kaolin, BN Filler, ECC; and colloidal silica, San-Sil PK 93, PPG.

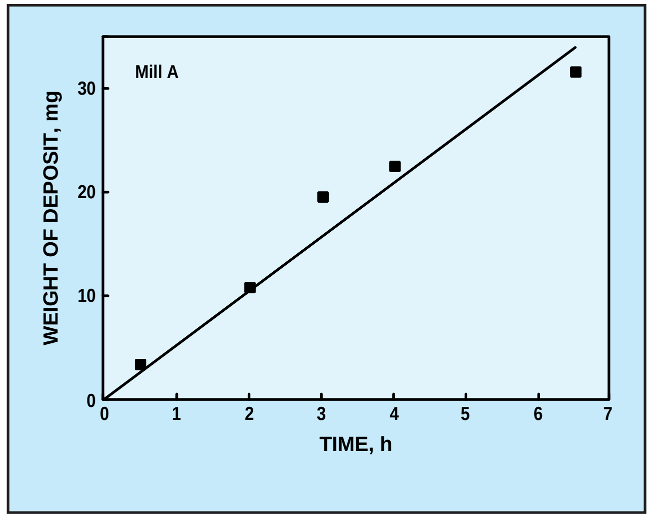
The dispersants, used in the tester at a concentration of 0.05% (on o.d. fibers), were diluted from stock solutions at 1% concentration. They included DFP 5000, naphthalene sulfonate, Handy Chemicals; Busperse 250, anionic surfactant, Buckman; Igepal CO 610, nonionic surfactant, nonylphenol ethoxylate, Domtar Chemicals; and Pluronic F-108 (molecular weight≈ 14,600), nonionic surfactant, BASF.

The flocculants and coagulants were added at various concentrations, as designated. The concentrations used were those estimated to give best results based on the authors' experience, and in some cases, advice from suppliers. For Polymin SK (BASF) and poly(DADMAC) (a low-molecular-weight, high-charge-density cationic polymer from Nalco), stock solutions (2.4% and 3.5%, respectively) were prepared, and the appropriate volume was pipetted to the pulp before disintegration. CATPAM (high-molecular-weight cationic polyacrylamide, Percol 280 L, Allied Colloids) and ANPAM (high-molecular-weight anionic polyacrylamide, Percol 120 L, Allied Colloids) were added without further dilution. For all four of the preceding polymers, the concentration was calculated from the percent active ingredients of these solutions as received. For the PEO [high-molecu-

3. Weight of deposit vs. Hobart mixer speed. The largest deposits were observed at the lowest speed setting. Conditions: 50°C, pH 5.0, 10% pulp consistency, 2 hours.



4. The weight of deposit on the plastic plates increased linearly with the length of time of the deposition tests. Conditions: 50°C, pH 5.0, 10% pulp consistency, 139 rpm.



lar-weight (5 x 10^6) polyethyleneoxide, Polyox WSR-coagulant, Union Carbide], fresh solutions were prepared before each run by dissolving 1 g of polymer in 10 mL of 99% ethanol before dissolution in 200 mL deionized water. The cationic starch (cationic corn starch, CATO 2, National Starch and Chemical) was added from a 0.8% stock solution by adding the powder to water with mixing, heating to 90°C, and cooking for 30 min. The resultant solution was cooled with stirring and transferred to a volumetric flask for final concentration adjustment. Fresh batches were prepared prior to each run. A stock solution of alum (Baker Analyzed Reagent) was prepared at a concentration of 1.3%, and the Al concentration was determined by atomic absorption spectroscopy.

The chelating agent, (Na EDTA) disodium ethylenediaminetetraacetate, Fisher ACS grade, was prepared as a 4.5% stock solution.

Paper samples

Samples of coated paper were obtained from two eastern Canadian mills. The base sheet for the paper from Mill A consisted of a mixture of semibleached kraft and stone groundwood pulps, and styrene butadiene rubber (SBR) latex was used as a coating binder. The paper from Mill B was made from a mixture of sulfite and stone groundwood pulps with polyvinyl acetate (PVA) as the binder.

Results

Choice of operating conditions

Figures 3 through 8 show the results obtained with the deposition apparatus to arrive at what we considered to be the best set of operating conditions. All of these experiments were conducted using coated paper from Mill A in the absence of additives. Figure 3 shows the weight of deposit obtained at the three different speed settings available on the Hobart mixer. The lowest speed setting (139 rpm) gave the highest weight of deposit, which is fortunate, because at the highest speed setting, the apparatus occasionally threw some pulp from the bowl. The deposit weight on the plastic plates increased with increasing time of the deposition test, as shown in Fig. 4. Figure 5 shows the effect of pulp consistency during the deposition test on weight of deposit. The deposit weight increased with increasing pH, as shown in Fig. 6. Shown in Fig. 7 is the effect of temperature of the stock in the deposition tester on deposition. Note that, as the temperature of this recycled furnish rises above 40°C, the amount of deposition increases. The occurrence of white pitch deposition in the first part of the dryer systems of paper machines, which is hotter than the press section, suggests that the deposition test is giving the same trend as is observed on the paper machine. With pitch deposits originating from wood resin, the amount of deposition is often observed to decrease with increasing temperature *(11).*

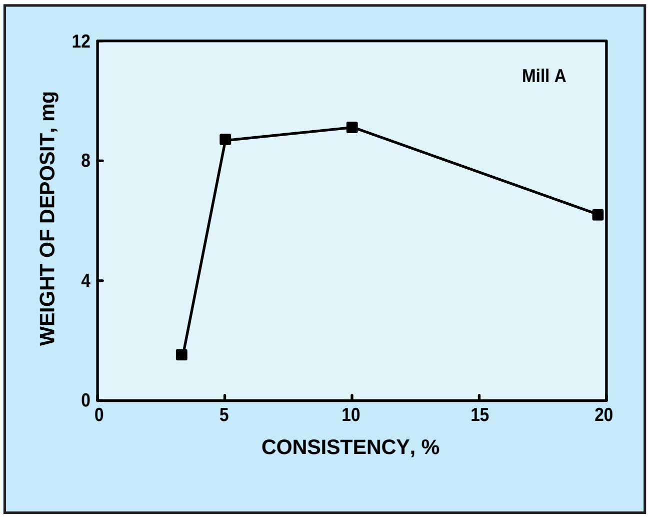
In Figs. 3–7, the effects of various parameters on the deposition test were determined. For the disintegration process, the deposit weight is given as a function of temperature in Fig. 8.

Our choice of operating conditions for the additive screening test reflects a compromise between those that gave the largest deposit weight, and hence the highest precision in the results, and those that best reflected repulper and paper machine conditions.

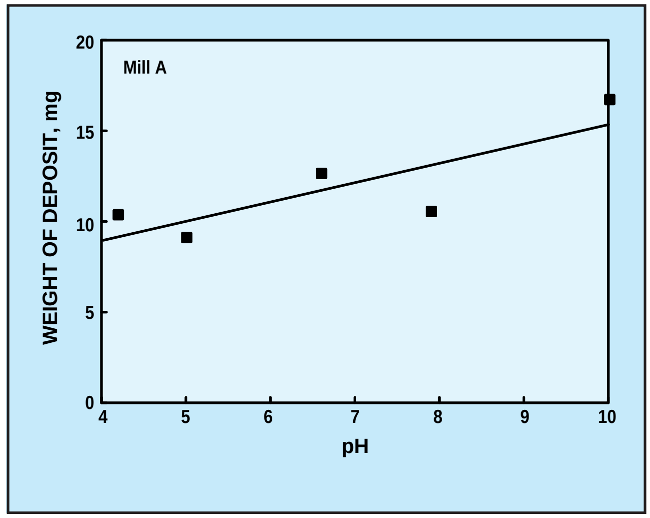
Screening of additives

The white pitch deposition test was used to screen additives on two different reslushed lightweight coated

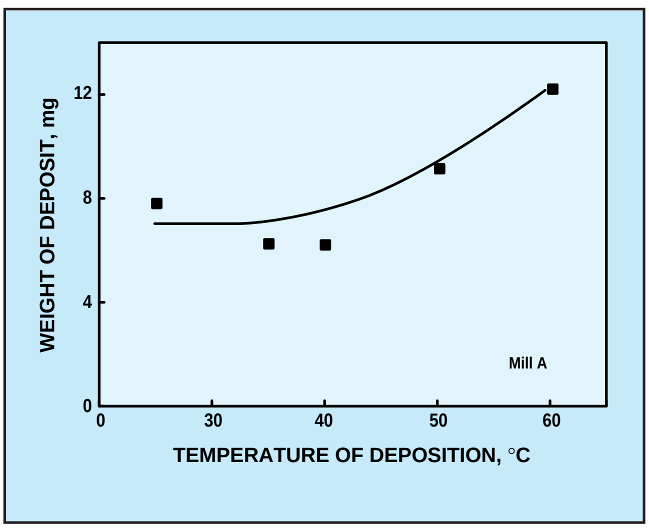
5. When weight of deposit was determined as a function of pulp consistency, a maximum of about 10% was observed. Conditions: 50°C, pH 5.0, 2 hours, 139 rpm.



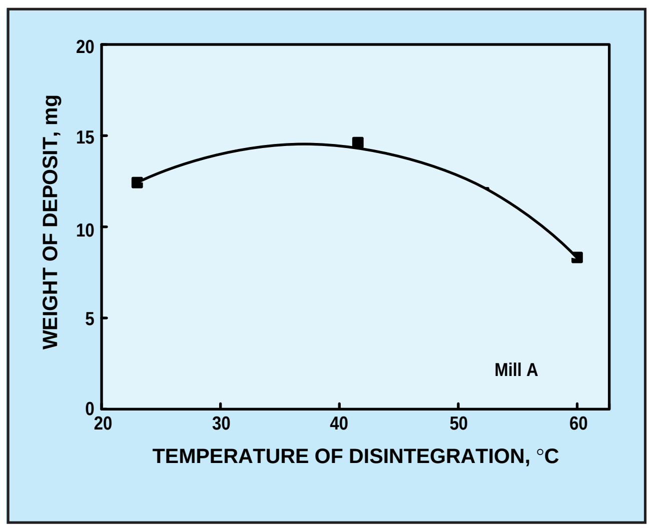
6. The weight of deposit increased with pH. Conditions: 50°C, 10% pulp consistency, 2 hours, 139 rpm.



7. The weight of deposit on plastic plates increased with temperature, above 40°C. Conditions: pH 5.0, 10% pulp consistency, 2 hours, 139 rpm.



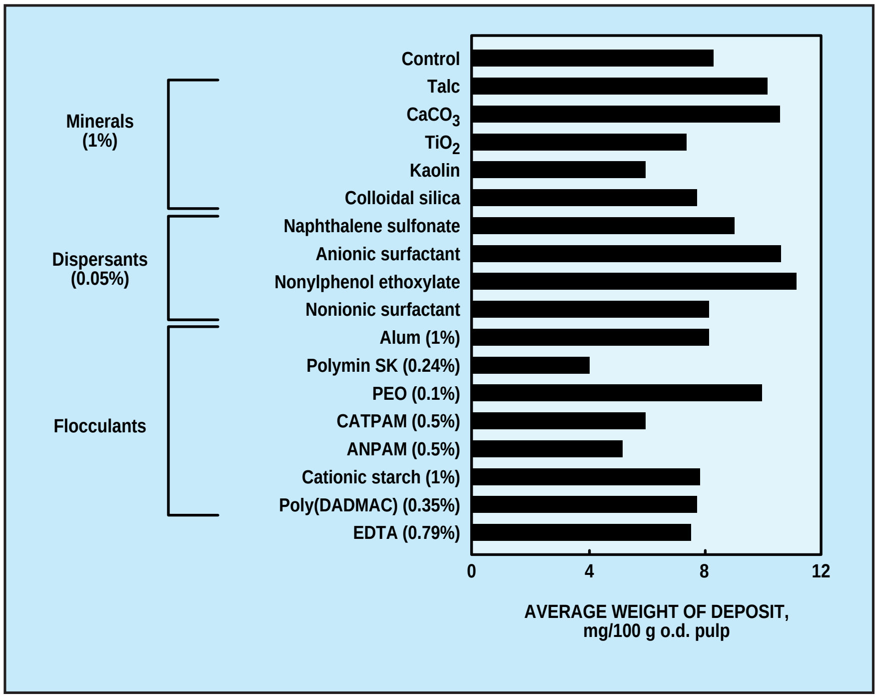
8. The temperature of disintegration had some effect on the weight of deposit. Conditions for deposition test: 50°C, pH 5.0, 10% pulp consistency, 2 hours, 139 rpm.



papers from two mills. The results of the deposition test are given in **Figs. 9 and 10.** Each bar in these figures shows the average deposit weight from at least two, and often three, deposition tests. The control experiments, without additives (top bar in each figure), are averages of ten tests for Mill A and four tests for Mill B. The pooled standard deviations of the results from Mills A and B were 2.4 and 1.3 mg/100g o.d. pulp, respectively.

Of the minerals used, only talc is commonly employed for white pitch control. The other minerals were of interest, however, because they are often present in the reslushed furnish, and their effects on deposition might be substantial. The increases in deposit weight observed for talc and $CaCO_3$ in Fig. 9, and for $CaCO_3$ in Fig. 10, are probably attributable to these materials becoming part of the deposit. It has recently been deduced *(12)* that talc functions primarily by a detackification mechanism and hence must be part of the deposit to control further deposition. The test may therefore discriminate against additives that function this way. The results suggest that $CaCO_3$ filler may aggravate white pitch deposition; however, it should be noted that the deposition was done at pH 5.0 and not the alkaline conditions under which $CaCO_3$ is typically used in mills.

9. A screening of additives for the recycled coated paper from Mill A. Polymin SK proved to be the most effective additive for suppressing deposition in this furnish. Amounts of additives used are expressed as percent of weight of oven-dried fibers. Conditions as in Fig. 8.



We are at a loss to explain the increases in deposit weight associated with the use of several dispersants (Figs. 9 and 10). Pitch dispersants are used in some mills at the broke repulper with the rationale that they facilitate the redispersion of the paper coating and stabilize the resulting suspension for white pitch control. The test results suggest that this would not be the best strategy in Mills A and B.

It is evident from Fig. 9 that for Mill A, Polymin SK gave the lowest amount of deposition with the laboratory test. The next most effective additive, at the concentrations used, was ANPAM. A subsequent series of runs as a function of Polymin SK concentration, shown in **Fig. 11,** suggested that concentrations of Polymin SK less than 0.24% were less effective at reducing the amount of deposition.

In contrast to the paper from Mill A, that from Mill B was relatively unaffected by the addition of Polymin SK and ANPAM. For this recycled furnish, alum was by far the most effective additive for depressing deposition.

The results suggest that there is no single best additive for white pitch. Rather, some additives are better than others in a given recycled coated furnish, and different additives excel in different furnishes. This has also been observed by others *(2).*

Verification and discussion

The mechanism of white pitch deposition in mills is not well understood. Because coating binders are always present in the deposits, it is evident that these hydrophobic materials have a tendency to deposit from pulps, at the consistencies found in the press and dryer sections, onto the surfaces of the process equipment, such as Uhle box strips, press felts, dryer fabrics, and certain dryer rolls. The deposit weight at a given time may be determined by the deposition rate of white pitch (binder and the materials that codeposit with it) and the rate at which the deposit is sheared from the surface by the action of the fibers at medium consistency. (If sufficiently thick deposits are present, large pieces may also detach, but the results in Fig. 4 suggest that this is not happening under the conditions used in our test.)

The downward trend in deposit weight with increasing stirring speed in Fig. 3 is probably attributable to a more rapid shearing of the deposit by the fibers at medium consistency. Figure 5 and mill experience suggest that pulp consistency is a key parameter controlling the weight of deposits. At low consistency ($<3\%$), little or no deposition occurs, perhaps because the pulp fiber/clay/latex system is not sufficiently sheared to expose fresh binder surface. At higher pulp consistencies (e.g., above 5%), the conditions of shear are right for deposition. The slight decrease in Fig. 5 above 10% consistency is possibly due to a greater shearing of the deposit from the surface by the pulp fibers. Due to the complexity of the system, we are unable to explain the dependence of deposit weight on pH, shown in Fig. 6. Preliminary experiments with reslushed newsprint from virgin pulps (in the absence of binder) showed no deposits, which again confirms the central role of the binder in this deposition test.

The new test for screening additives for their ability to control white pitch deposition has a number of attractive features:

- Unlike most other deposition tests that operate at low pulp consistency, it uses pulp at medium consistency, which probably best reflects paper machine conditions in the press section, where white pitch usually deposits.
- The reasonably linear increase in deposition with time (Fig. 4) suggests that, after 2 hours, the deposits are still growing rapidly and have not reached a point where they have sufficient thickness to start breaking away. This

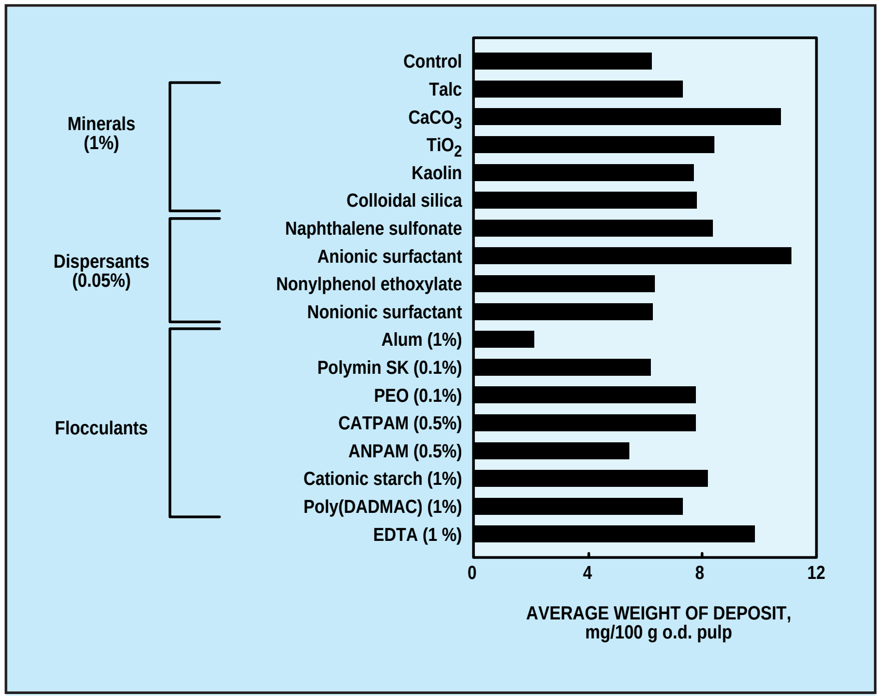
will probably lead to greater precision in the test, as the breakaway process is often random with respect to time.

- The dependence of the deposit weight on mixer speed reflects mill experience. At higher machine speeds and/or rates of shear, many machines can achieve better control of white pitch deposition *(1).*
- The effect of stock temperature on deposit weight (Fig. 7) reflects paper machine experience.

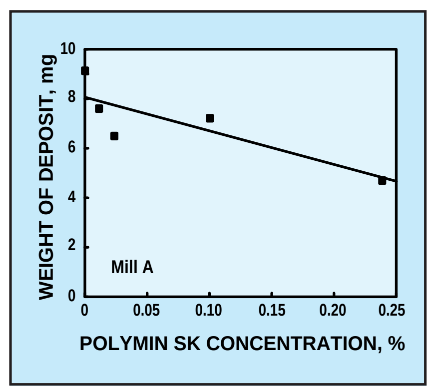
There is also some indication, from mill experience, that the test gives reliable information. In Mill B, where the test indicated that alum was the best white pitch control additive, mill personnel stated that they have observed that a reduction in the feed rate of alum usually leads to an increase in white pitch problems. Mill staff had, over the years, tried a variety of other additives with little or no success.

We hope that the future will provide more opportunities to determine the reliability of this test. TJ

10. A screening of additives for the recycled coated paper from Mill B. Of all the additives, alum was the most effective at suppressing deposition. Amounts of additives used are expressed as percent of weight of oven-dried fibers. Conditions as in Fig. 8.



11. Weight of deposit as a function of Polymin SK concentration for coated paper from Mill A. Results demonstrated that concentrations of Polymin SK less than 0.24% were less effective at suppressing deposition. Conditions as in Fig. 8.



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