Prevention of pitch and stickies deposition on paper-forming wires via adsorption of a cationic polymer associated with anionic species

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ABSTRACT

Deposition of colloidally dispersed pitch and stickies on hydrophobic polyester paper-forming wires is a common problem in paper manufacturing. The problem is mainly due to the hydrophobic–hydrophobic interaction between pitch particles and/or stickies particles and the paper-forming wires. Machine deposition may be significantly alleviated if the hydrophobicity of the forming wires and/or the hydrophobicity and tackiness of the pitch and stickies particles are reduced. This paper focuses on a mechanism that reduces the hydrophobicity of paper-forming wires via adsorption of complexes of a cationic polymer associated with anionic species on such surfaces. A fundamental test method will be discussed. This method allows us to better understand how to modify the surface of paper-forming wires and to interpret why a cationic polymer works for pitch and stickies control.

Surface tension, streaming potential, and contact angle measurements were used to study the mechanism of preventing pitch and stickies deposition on a simulated paper machine wire (i.e., polyester coupon) in the presence of cationic polymers and naturally occurring water-soluble anionic species. These measurements indicated that cationic polymers associated with anionic species and these complexes subsequently adsorbed on the polyester coupon, rendering it hydrophilic and hence preventing pitch and stickies deposition. The results correlated well with laboratory pitch/stickies detackification tests. The laboratory findings were also strongly supported by successful field applications.

Application:

The information from this work can help the reader (a) gain a better understanding of how the surface of paper-forming wires can be modified to prevent contaminant deposition and (b) interpret why a cationic polymer works for pitch and stickies control.

THE DEPOSITION OF ORGANIC contaminants in the pulp and paper industry can cause both product quality and manufacturing efficiency problems. The term *pitch* often refers to deposits originating from natural resins and their salts (e.g., fatty acid esters of glycerol, free fatty acid, rosin acid, and sterols). *Stickies is a term that refers to hydrophobic components used in the manufacture of a paper product where these components are used as contact adhesives or hot melts.* The most common components used as contact adhesives are styrene butadiene rubber (SBR), vinyl acrylates, polyisoprene, and polybutadiene. Hot melts are always mixtures of various components (e.g., wax and tackifying resins). The term *stickies* has increasingly been used to describe deposits that occur in systems using recycled fiber.

Pitch and stickies have many common characteristics, including hydrophobicity, deformability, tackiness, low surface energy, and the potential to cause problems with deposition, quality, and efficiency in the process. However, the two items are different from a physical standpoint. Pitch deposits have usually formed from microscopic particles of adhesive material (natural or man-made) in comparison to stickies, which usually have been visible or nearly visible particles in the stock that originates from the recycled fiber.

Pitch and stickies deposits can readily be found on stock chest walls, paper machine foils, uhle boxes, paper machine wires, wet press felts, dryer felts, and dryer cans. These contaminants will reduce machine runnability due to breaks and cleanups, as well as holes, dirt, and other sheet defects that reduce the quality and usefulness of the paper for operations that follow (e.g., coating, converting, or printing).

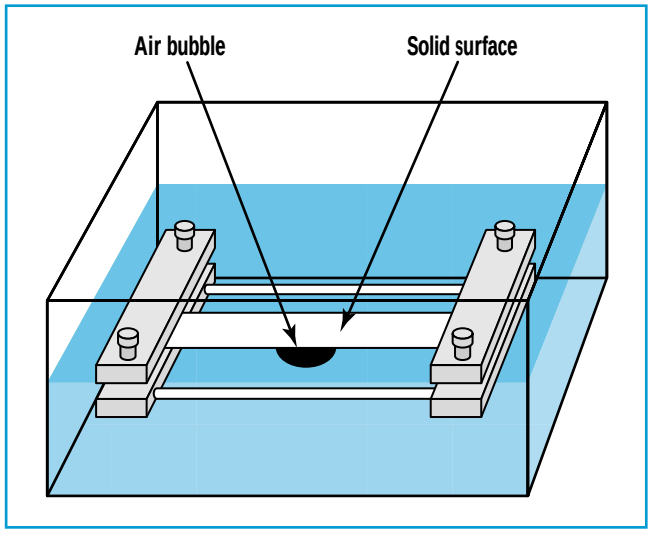
CONTROL OF PITCH AND STICKIES

The following parameters affect the extent of deposition of organic materials *(1)*. Minimizing the contribution of each of them can reduce the deposition. The parameters are as follows:

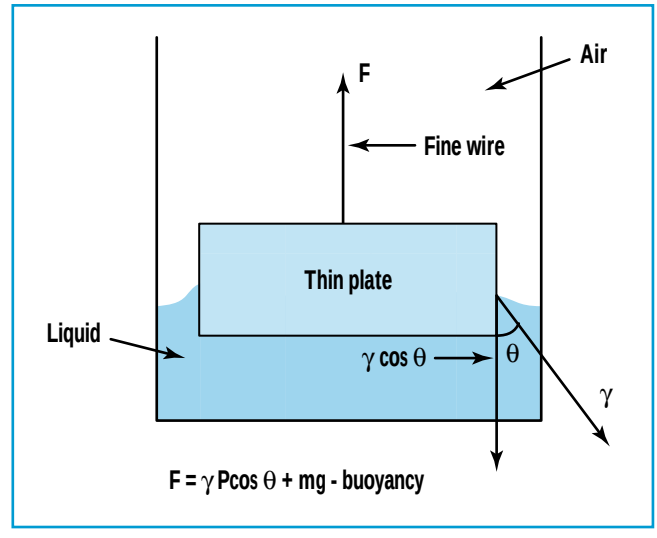
- Content of depositable organic material
- Depositability of depositable organic material
- Collodial stability of the depositable material
- Surface affinity.

Content of depositable organic material

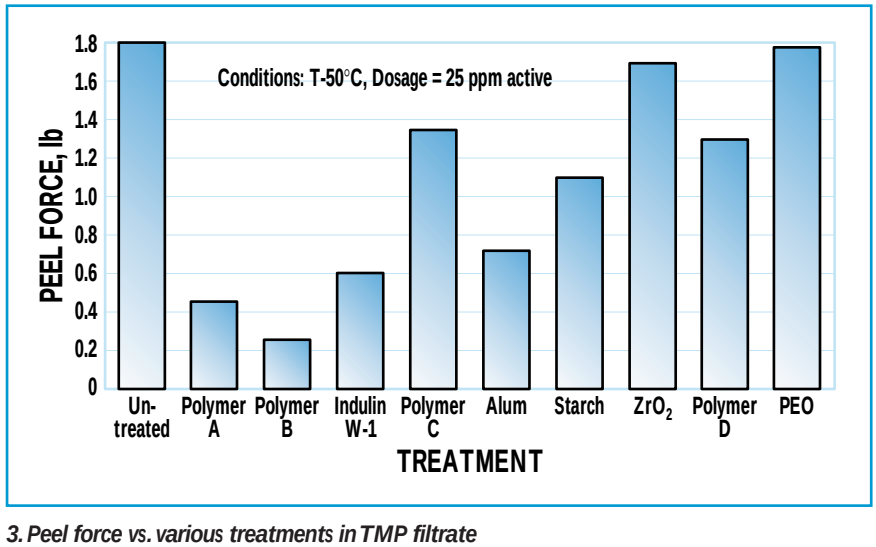
It is possible to considerably reduce the content of colloidal material in the system by "fixing" the colloidal pitch particles onto fibers, thereby reducing the deposition. Highly charged cationic polymers of a low molecular weight (less than 100,000) and alum are widely used to retain colloidal organic material with the sheet. Another way of reducing deposition is to use a solid



1. Test cell for contact angle measurement



2. Schematic drawing of the Wilhelmy plate method for measuring contact angles



3. Peel force vs. various treatments in TMP filtrate

adsorbent such as talc. Because of their smaller size, pitch particles will be adsorbed by talc. On the other hand, talc particles will coat the stickies due to the large size of the latter.

Depositability of depositable organic material

This parameter is a function of the viscosity of the organic material, which relates to its tackiness. For example, hot melts (having a melting point of 78°C) are solid at room temperature, so these materials will not readily form deposits at room temperature. However, as the temperature increases to 50°C, hot-melt viscosity decreases, and the material becomes semi-solid; extensive deposition can be expected as this material has a high degree of tackiness. Also, pH and water hardness can affect the viscosity of depositable material as the fatty acids may be converted into calcium soaps, which will increase the viscosity of the organic material. To the author's knowledge, no chemical additives are currently used to modify the viscosity of pitch particles to reduce deposition.

Colloidal stability of the depositable material

Deposition will be reduced considerably by maximizing the stability of the organic depositable material. Today there are two technologies that are commonly used: dispersion technology and detackification technology.

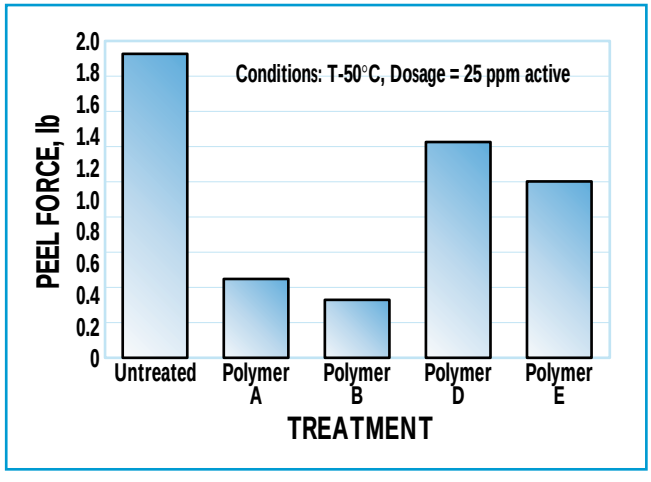
Dispersion technology. Dispersion programs use surfactants and dispersants to reduce the particle size of the contaminants. Reducing the size of the stickies contaminants improves sheet quality by reducing large, visible stickies in the sheet. Dispersion technology also acts to stabilize small contaminants to prevent agglomeration.

Detackification technology. Detackification involves eliminating the tackiness associated with pitch and stickies surfaces. Detackification technology also stabilizes pitch and stickies particles, thereby preventing agglomeration. However, unlike dispersion technology, detackification chemistry will not reduce the size of the contaminants.

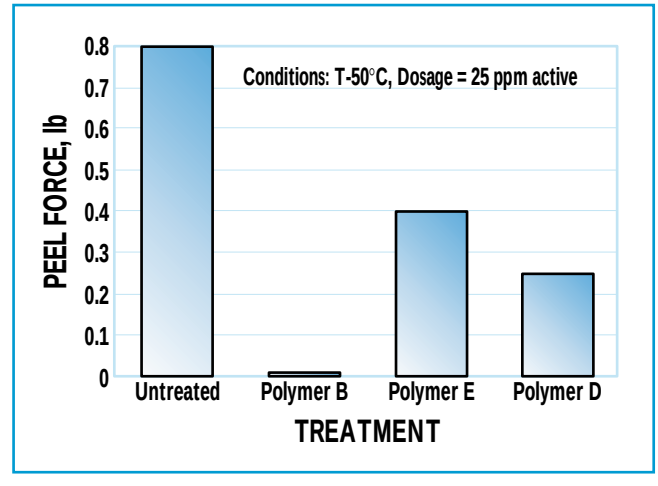
Surface affinity

Since pitch and stickies are hydrophobic, reducing the hydrophobicity of surfaces onto which the deposit is formed will minimize the affinity for the contaminants to adsorb on such surfaces. This is true only for surfaces that are submerged in or in contact with water. Certain surfaces (such as wires, felts, foil blades, and rolls) are prone to deposition and thus can be modified to minimize the deposition. Examples include the replacement of polyethylene with ceramic foil blades or the Teflon®[1] coating of drying cylinders.

[1]Registered trademark of DuPont Co.



4. Peel force vs. various treatments in linerboard filtrate



5. Peel force vs. various treatments in fine paper filtrate

The most common method of reducing the hydrophobicity of a paper-forming surface is commonly known as *wire passivation*. Wire passivation is achieved by spraying a water-soluble cationic polymer continuously onto the forming wires. The polymer often causes the wires to become darker, rendering them hydrophilic and thereby preventing/reducing pitch and stickies deposition *(2–4)*. The darkening is believed to be a result of the subsequent interaction between the cationic polymer and the anionic wood-derived polymer. It is difficult to say whether the wire "sees" the cationic polymer or the stock first. For the sake of argument, assume that the forming wire is exposed to the cationic polymer first, after which the wire "sees" the stock.

As indicated in "RESULTS AND DISCUSSION," the surface tension and contact angle data showed that the cationic polymer is not surface active and does not adsorb onto a clean polyester surface, which represents the wire. However, when the surface is treated with the white water, the contact angle was reduced from 52° (untreated) to 46°, indicating that small amounts of lignin and/or fatty acid molecules adsorbed onto the surface. Based on this experiment, it is believed that in the real world, small amounts of anionic surface-active species adsorb onto the wire first, followed by the adsorption of a cationic polymer, by forming complexes with oppositely charged molecules already present on the wire. This is the "initial" layer.

Once the cationic polymer is on the wire, the polymer can attract more anionic species as the wire is exposed to the white water. Subsequently, another cycle is repeated, in which the wire is treated with a cationic polymer and then exposed to the stock. This process is very dynamic and very difficult to simulate in the laboratory. In this work, a cationic polymer was added to the white water with no fibers present, and this solution was immediately used to treat the wire. We are fully aware that this procedure is not exactly the same as in the actual process, but we strongly believe that it is a reasonable and valid model of a phenomenon observed in the field.

The objective of this paper is to investigate a mechanism of reducing the hydrophobicity of paper-forming wires via adsorption of complexes of a cationic polymer associated with anionic water-soluble species (anionic trash) on such surfaces from an interfacial-phenomenon point of view.

Polymer	Description	Relative molecular wt.	Charge density
A	Polyamine	High	High
B	Polyamine	Low	High
C	Polyamine	Very low	High
D	Polyamine	High	Medium

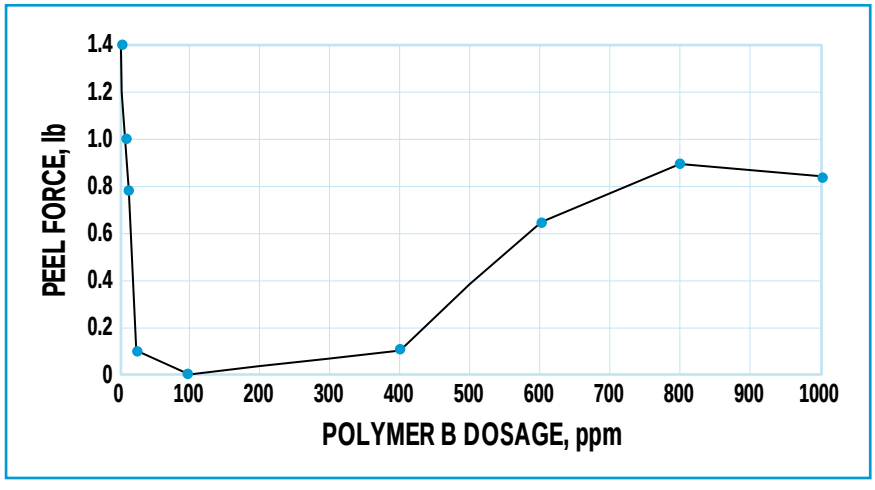
I. Characterization of the cationic polymers used in this work

EXPERIMENTAL

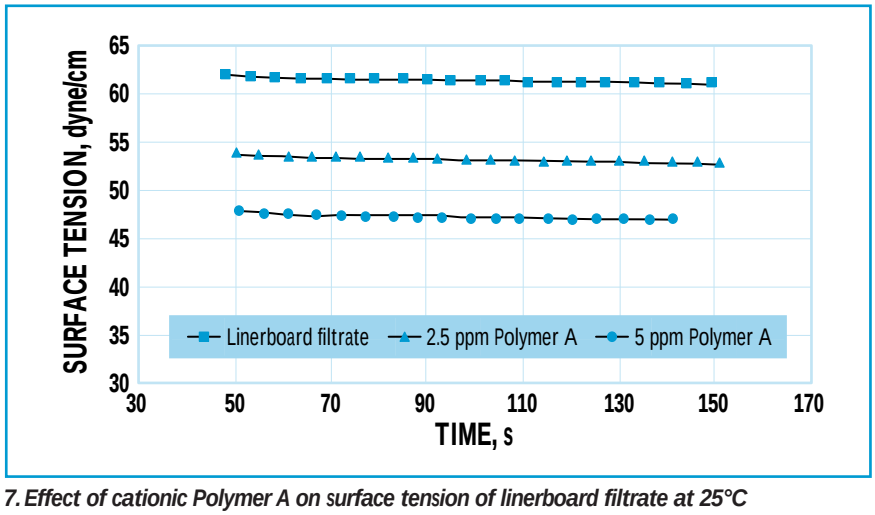
Materials

Various grades of white water, i.e., thermomechanical pulp (TMP), linerboard, and alkaline fine paper, were used in this investigation. Lignin and dichloroethane (DCE) extractives in these media were determined and found to vary from 77 to 900 ppm and from 20 to 150 ppm, respectively. The surface tension values for these media ranged from 50 to 63 dyne/cm. A synthetic medium comprised of kraft lignin (Indulin C), oleic acid, and abietic acid was also used in this study. The solution was prepared as follows:

1. A 1 wt.% solution of abietic acid and oleic acid (5.1:1) was dissolved in 0.5 wt.% NaOH by heating the mixture to 60°C.
2. A 1 wt.% solution of sodium salt of kraft lignin (Indulin C) was dissolved in water.
3. A stock solution of 0.1 wt.% was made by adding known amounts of 1% kraft lignin and 1% abietic/oleic acid solutions at the ratio of 1.2:1, respectively.
4. For the surface tension, contact angle, and surface potential measurements, known amounts of this stock solution were then added to 100 g of water.
5. Aqueous solutions were made with deionized water.



6. Peel force vs. Polymer B in TMP at 50°C



7. Effect of cationic Polymer A on surface tension of linerboard filtrate at 25°C

Apparatus

Surface tension measurements. The surface tension measurements were made using a Kruss K-12 tensiometer, which featured a Wilhelmy-type wetting force measurement technique. Before each experiment, the platinum plate was cleaned with water and then heated using a propane torch. All glassware used in this investigation was cleaned with a diluted soap solution and then immersed overnight in NoChromix®[2] solution. The beakers were then rinsed thoroughly with water and deionized water prior to measurements. All measurements were made at 25°C.

Contact angle measurements. The contact angle measurements were performed with a goniometer (Kruss G1) and with a tensiometer (Kruss K-12). A clean polyester film measuring 6 x 40 x 0.12 mm was clamped onto a film stage and placed inside a glass test cell measuring 58 x 29 x 21 mm (**Fig. 1**). The solution containing treatments (i.e., cationic polymers, nonionic polymer, and nonionic surfactant) was then added to the cell by carefully pouring 15 mL into the cell. The whole test cell was then placed inside the chamber of the goniometer.

The system was equilibrated for 1 min, after which a small drop of air was carefully placed on the underside of the film using a microsyringe with an inverted tip. Initial contact angles were then measured through the water phase. A smaller contact angle indicates that the surface is more hydrophilic. Contact angle measurements were made on both sides of a drop, and at least three drops were delivered to the surface. The accuracy of the contact angle measurements was ±2–3 degrees.

The Wilhelmy plate technique was used to obtain advancing and receding contact angles of various treatments on a clean polyester film (see **Fig. 2**). The Kruss K-12 tensiometer was used. Advancing and receding contact angles were computed from the wetting curves using Kruss software. Only receding contact angles were reported. Contact angle reproducibility was within 2–3 degrees. Measurements were made at room temperature (25°C).

Streaming potential measurements. The streaming potential (mV), which is related to the zeta potential, was measured using a Mutek PCD02 instrument. About 10 mL of solution was poured into a cell. The solution was then agitated, and after 5 min, measurements were reported.

Standard tape detackification test. This test method measures the effect of chemical additives on contact adhesion *(5)*. For this study, tapes made from styrene butadiene rubber and vinylic esters were used to mimic stickies, since these materials are known to cause deposition in secondary fiber utilization. A second coupon was fabricated from polyester film and used to mimic paper machine forming wires, which are frequently made of polyester and are susceptible to considerable deposition problems caused by stickies and/or pitch.

The polyester coupon was treated with the test solution for a predetermined time interval, after which it was pressed with the untreated tape coupon. The *peel force* was then measured. The reduction in peel force indicated the level of detackification of the adhesive surface. In general, it is

[2]Trademark of Godax Laboratories, Inc.

likely that the more the adhesive surface is detackified, the less the deposition potential for stickies to appear on the paper machine wires.

RESULTS AND DISCUSSION

Standard tape detackification test

Figures 3–5 show the effectiveness of various chemicals in TMP, linerboard, and fine paper filtrates, respectively, on stickies detackification. Polymers A, B, D, and E are cationic polyamine polymers of various degrees of molecular weight and charge density. **Table I** shows the chemistry of these cationic polymers. Polymer C is a high-molecular-weight nonionic polymer. It can be seen that nonionic polymers (i.e., high-molecular-weight polyethylene oxide and Polymer C), cationic starch, and zirconium (ZrO_2) were not effective for wire passivation as reflected by their high value of peel force. Alum and Indulin W-1 (a cationically modified kraft lignin) were moderately effective. These figures clearly reveal that only cationic Polymers A and B were the most effective chemicals for treating stickies and or pitch on the paper-forming wires.

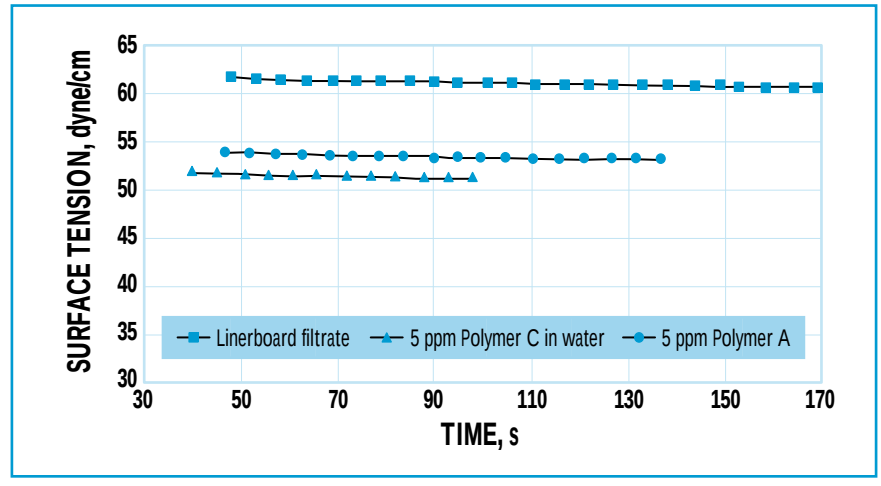
As will be shown later, these cationic polymers formed complexes with anionic trash and rendered the polyester hydrophilic, thereby minimizing or preventing pitch/stickies deposition. The dose response curve of cationic Polymer B in TMP filtrate is shown in **Fig. 6.** The efficacy increased with concentration and leveled off at 25 to 400 ppm, after which the performance started to decrease. As will be shown later, the reduction in performance is due to the precipitation of the complex, which can cause wire pluggage or a decrease in surface activity of the complex.

Surface tension and streaming potential measurements

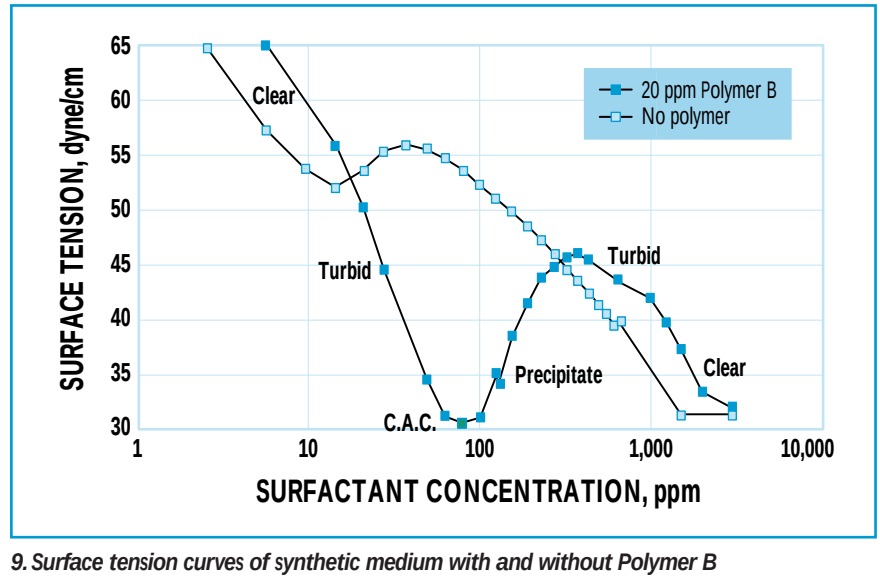
Paper machine white water. The Wilhelmy plate technique is commonly used to measure surface tension. Further details have been discussed elsewhere *(6)*. In this work, surface tension measurements were used to study the interaction between the cationic polymer and water-soluble anionic species naturally present in the white water. It is noteworthy that the surface tension of deionized water is essentially constant, at 72 dyne/cm, with the addition of cationic Polymer A, indicating that the polymer is not surface active.

Figure 7 shows the effect of cationic Polymer A on the surface tension of linerboard filtrate. The white water was analyzed for lignin content, and the result showed that about 100 ppm of lignin was present. The reduction in surface tension is probably due to the formation of complexes between the cationic polymer and water-soluble anionic species, such as lignin and/or fatty acids. Later studies with a synthetic white water will confirm this phenomenon. Additionally, we will show that the formation of the complex between the cationic polymer and anionic trash indeed accounts for the reduction in the surface tension.

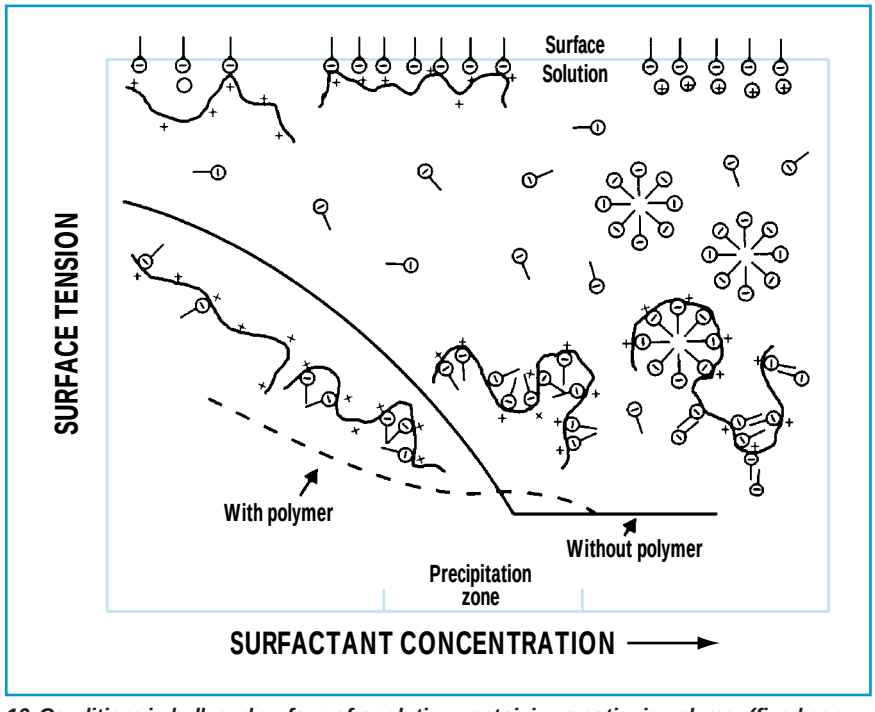
The effect of the nonionic polymer (Polymer C) on surface tension is illustrated in **Fig. 8.** By adding 5 ppm of the polymer to water, the water's surface tension decreased from 72 to 54 dyne/cm, indicating that this nonionic polymer is surface active. The addition of 5 ppm of the polymer to the linerboard white water reduced the surface tension to 51 dyne/cm compared to 54 dyne/cm when added to deionized water. This may be due to the weak in-



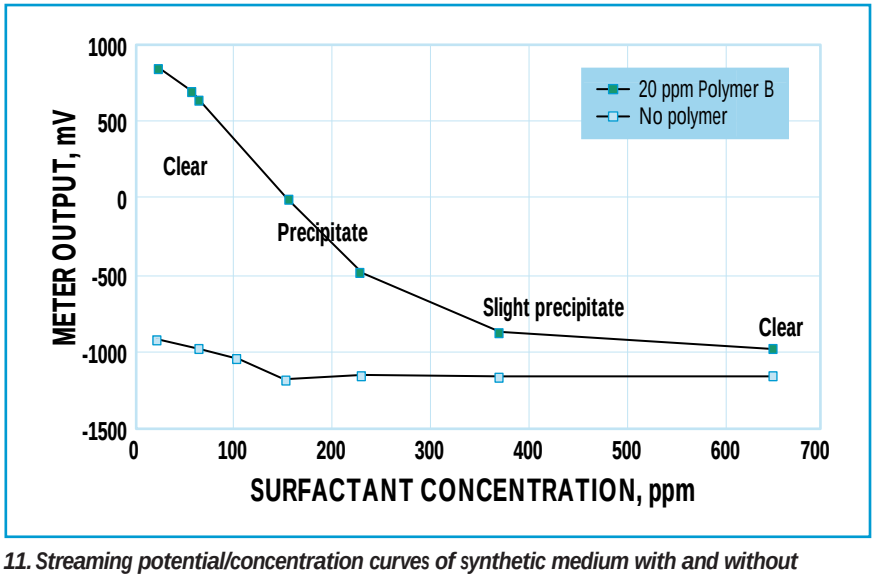
8. Effect of nonionic polymer (Polymer C) on surface tension of linerboard filtrate at 25°C



9. Surface tension curves of synthetic medium with and without Polymer B



10. Conditions in bulk and surface of a solution containing a cationic polymer (fixed concentration) and anionic surfactant **(12)**



11. Streaming potential/concentration curves of synthetic medium with and without Polymer B at 25°C

teraction between the nonionic polymer and anionic surfactant(s) molecules *(7–11)*. However, the change of the surface tension with the nonionic polymer is much less pronounced than that with the cationic Polymer A. This may be one reason why cationic Polymer A is superior to nonionic Polymer C for stickies/pitch detackification (see Fig. 3).

Synthetic white water. To confirm that the interaction between cationic and anionic water-soluble species occurred, a synthetic white water containing the following anionic species was prepared: abietic acid, oleic acid, and lignin. The formulation was discussed in "EXPERIMENTAL." The surface tension curves of the cationic Polymer B in synthetic white water are shown in **Fig. 9.** The cationic polymer concentration is held constant (at 20 ppm), and the surfactant level is varied.

Several points can be noted. First, a synergistic lowering of surface tension was observed at a surfactant concentration above 15 ppm. This may be attributed to a reduction of the electrical repulsion between head groups of the surfactants, thereby allowing more surfactants to adsorb at the air/water interface. Second, the break points occurring from about 60 ppm to about 105 ppm suggest critical concentrations at which the cooperative interaction between anionic surfactants and cationic polymer leads to a constant surface activity until the polymer is "saturated" with surfactant molecules (the critical association concentration, or c.a.c.). The c.a.c. value is indicated on the graph. Third, beyond 105 ppm, the surface tension increased to a maximum of 47 dyne/cm at about 370 ppm. This is due to the formation of insoluble surfactant–polymer complexes. Finally, when an excess of surfactant is added, the surface tension remains almost constant (at about 32 dyne/cm) and eventually coincides with the surface tension curve of the polymer-free surfactant system in the micellar region. Furthermore, at this concentration, the solution became clear due to the presence of micelles, which resolubilized the precipitate *(12)*.

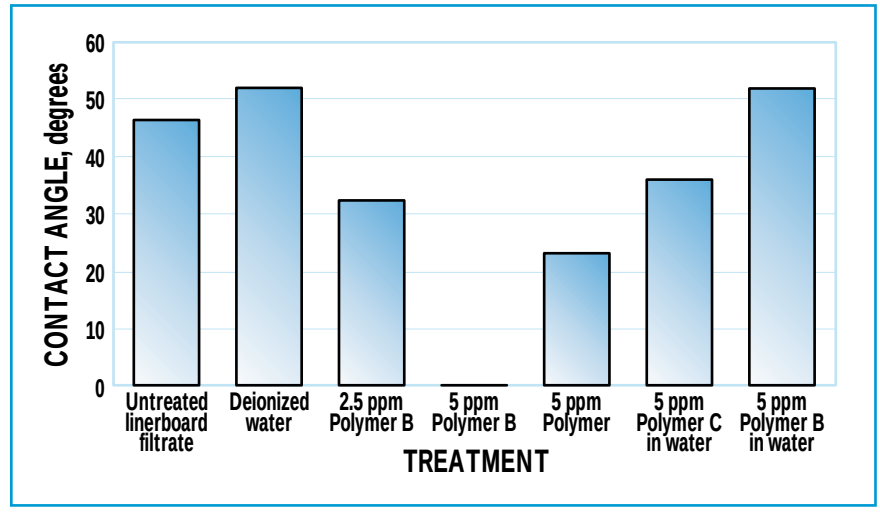
Recently, Barck and Stenius studied the interactions between carboxylmethyl cellulose and cationic surfactants via surface tension measurements, and they observed similar phenomena *(13)*. The phenomena observed can be explained in terms of the diagrams shown in **Fig. 10** *(12)*. This figure illustrates the progressive uptake of anionic surfactant by the cationic polymer. For a thorough discussion of interactions of surfactants with polymers, readers should refer to a book edited by Goddard *et al. (14)*. As indicated in Fig. 9, above 105 ppm,

the solution precipitated as indicated by an increase in surface tension. As pointed out by Lindman and Piculell *(15)*, the main driving force for phase separation is the interaction between the oppositely charged polymer and surfactants. However, phase separation can be completely suppressed by the addition of screening electrolyte *(13)*.

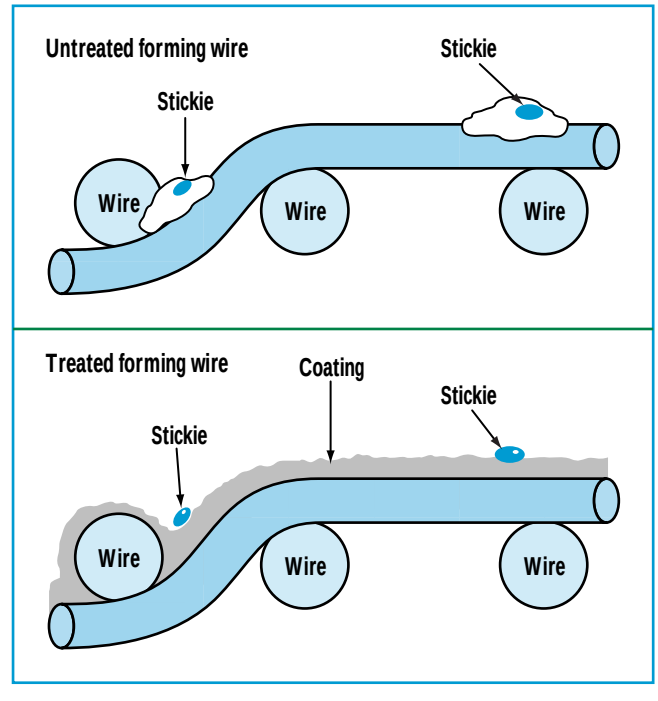
Shetty *et al.* also observed a reduction in the surface tension of a synthetic white water containing anionic species such as fatty acids with the addition of a cationic polymer *(16)*. They attributed this to the adsorption of "free" surfactant at the air/liquid interface. The polymer replaced the surfactants at the pitch/water interface, thereby increasing the amount of "free" surfactant available for adsorption at the air/water interface. This explanation is not acceptable, since the attractive interaction between polymer and surfactant molecules of opposite charge is well documented in the literature *(12, 17–24)*.

The *streaming potential*, one of the four electrokinetic phenomena, is induced by the liquid phase moving along a charged stationary solid phase and can be measured by using a Mutek PCT 10 instrument. The sign of the streaming induced potential (SIP) indicates the polarity of the surface-bound charge. A positive value indicates a cationic surface, and a negative value is indicative of an anionic surface. The surface is neutral or discharged when the SIP is zero.

Figure 11 shows streaming potential/concentration curves of synthetic white water with and without cationic Polymer B. The concentration of the polymer is fixed at 20 ppm. The streaming potential of synthetic white water alone was highly negative (anionic) and did not change considerably with concentration. On the other hand, the streaming potential of synthetic medium containing polymer decreased from a positive value (cationic) to a negative value (anionic) as the concentration of the anionic surfactant increased. This indicates that cationic polymers formed complexes with anionic surfactants present in the synthetic medium. At zero streaming potential, which corresponds to 150 ppm, the solution precipitated. This is in complete agreement with surface tension measurements. Similar findings were also reported by other authors *(25, 26)*.



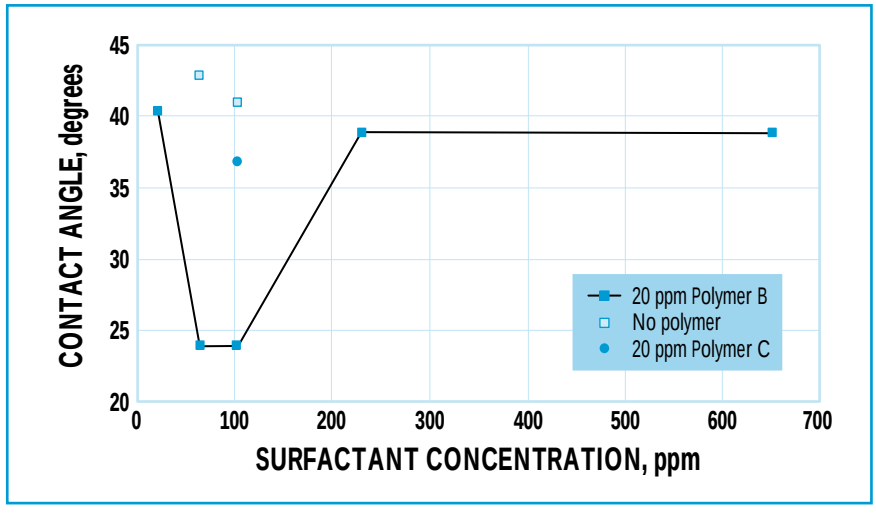
12. Effect of cationic and nonionic polymers on contact angle of polyester in linerboard filtrate at 25°C



13. Schematic of (a) untreated forming wire and (b) treated forming wire with a cationic polymer

Contact angle measurements. Adhesives are hydrophobic, as indicated by their low values of surface energy (20–40 dyne/cm) *(27)*. The surface energy of a polyester forming wire is about 43 dyne/cm *(28)*, which is less hydrophobic than adhesives. Hence, contaminants having a surface energy less than that of the polyester, 43 dyne/cm, will have a greater tendency to deposit on the polyester forming wire surface. However, if the surface energy of the polyester forming wire increases to a value close to the surface tension of water (72 dyne/cm) or white water (~62 dyne/cm), water will wet and form a thin film on the forming wires. In other words, the forming wires become hydrophilic. Adhesives are less likely to deposit on treated forming wires, because the surface energy of adhesives is much larger than the surface energy of polyester coated with a polymer film and water.

Recently, D. T. Nguyen estimated the total surface energy of the



14. Contact angle vs. fatty acid/lignin concentration at 25°C

polyvinyl alcohol (PVA)-coated polyester surfaces under water via contact angle measurements *(29)*. The results revealed that when the polyester surface was treated with a high-molecular-weight and partially hydrolyzed PVA, the interfacial energy of the solid and water was significantly reduced from 5.1 dyne/cm (i.e., untreated) to about 0.08 dyne/cm. Another method of preventing stickies deposition is to modify the stickies surface with chemicals such as surfactants or nonionic polymers, as shown by Ling *(5)*. The interaction of a liquid with a solid is commonly termed *wetting*. This involves the spreading of a liquid over a surface, the penetration of a liquid into a porous medium, or the displacement of one liquid by another. The contact angle is a measure of wettability. A low contact angle is indicative of high wettability and vice versa.

Figure 12 shows the effect of cationic Polymer B and nonionic Polymer C on the contact angle of polyester in water and in linerboard filtrate. The contact angle of a polyester film in water was about 52°, which is in agreement with the literature value *(30)*. In white water, the contact angle slightly decreased to 46°, perhaps due to the presence of surface-active agent(s). Note that the addition of the cationic Polymer B to deionized water did not change the contact angle because, as found in surface tension measurements, this polymer is not surface active. However, addition of the cationic Polymer B to the white water caused the contact angle to decrease considerably.

For example, at a concentration of 2.5 ppm, the contact angle decreased from 52° for an untreated state to 32°. At 5 ppm, its value decreased to 0°. A low contact angle indicates that the polyester film becomes hydrophilic. This can be attributed to the adsorption of the complex formed between cationic polymers and anionic species in the white water onto the polyester film, which in turn renders the surface hydrophilic, thereby preventing pitch/stickies deposition. Addition of 5 ppm nonionic Polymer C to the white water also lowered the contact angle from 46° to 23°. However, this value is much higher when compared to the cationic polymer.

The result indicates that the surface of the polyester film is more hydrophilic when treated with a cationic polymer than a nonionic polymer. In other words, the cationic polymer is more efficacious in preventing pitch/stickies deposition on the polyester forming wire than the nonionic polymer. This observation was also supported by a standard tape detackification test. A diagram of an untreated forming wire and a treated forming wire with a cationic polymer is shown in **Fig. 13.** Bear in mind that this figure only serves as a demonstration and is not drawn to scale. In the real world, the cationic layer thickness is several orders of magnitude less than the thickness of the forming wire.

A similar experiment was also conducted with the synthetic medium. The results are reflected in **Fig. 14.** The polymer concentration is kept constant at 20 ppm, and the surfactant level is varied. A synergistic decrease in contact angle at low surfactant concentration was observed, implying the formation of a highly surface-active complex. The first break occurred at about 60 ppm, which is in agreement with surface tension measurements. Above 100 ppm, the contact angle started to increase, perhaps due to the phase separation. At 600 ppm, the solution became clear. As shown in the linerboard filtrate, the cationic Polymer B was found to be much more effective in lowering the contact angle of polyester film than the nonionic Polymer C.

FIELD APPLICATION

Case history 1

An eastern U.S. mill making corrugating medium out of old corrugated containers (OCC) and old newsprint (ONP) wanted to improve the cost effectiveness of its stickies control program. Stickies were filling the forming fabric, leading to downtime for batch cleaning. The cationic Polymer B was applied to the surface of the forming fabric via a low-volume chemical shower. Wire cleanliness was improved dramatically. Note that prior to treatment, the wire filled with stickies

KEYWORDS
Anionic compounds, bibliographies, cationic compounds, contact angle, electrical properties, forming fabrics, pitch control, polymers, stickies, surface tension, water repellence, white water system.

after 2 hours. After treatment, stickies were not apparent for over 6 days. The program improvements were accomplished at a 40% savings over an alternate passivation program.

Case history 2

A northern U.S. tissue mill was using deinked recycled fiber to supply a twin-wire paper machine. Both forming fabrics were experiencing severe stickies deposition, leading to solvent batch washes every shift. By applying cationic Polymer B to the surface of both wires, batch wash frequency was reduced to once per week. The mill saw increased production from reduced downtime, improved sheet quality from fewer sheet holes, and improved system operation from fewer solvents in the white water.

Case history 3

A southern U.S. tissue mill was using virgin market pulp to produce consumer tissue. Pitch from the virgin fiber was depositing on the forming fabric, leading to sheet holes. The mill was solvent-washing the fabric six times per month to deal with the deposition. To help solve the problem, the cationic Polymer B was applied to the surface of the fabric via a low-volume shower. The program solved the sheet hole problem and completely eliminated downtime to clean pitch off the forming fabric.

CONCLUSIONS

Surface tension, contact angle, and streaming potential measurements showed that the cationic Polymers A and B formed complexes with naturally occurring water-soluble anionic species. Contact angle measurements indicate that the cationic Polymers A and B adsorb on the polyester substrate and render it hydrophilic, thereby preventing/minimizing pitch and stickies deposition on the paper-forming wires. The results correlated fairly well with laboratory stickies deposition tests. The laboratory results were also strongly supported by successful field trials.

The interaction between the cationic Polymer B and water-soluble anionic surfactants present in the white water leads to strong adsorption at the air/liquid as well as solid/liquid interfaces. The very strong enhancement of adsorption at the air/liquid and solid/liquid interfaces at very low surfactant/polymer concentrations is of interest in the use of these compounds as emulsifiers as well as wetting agents. At concentrations near neutral charge, the cationic Polymer B and anionic surfactants form a precipitate. The main driving force for this phase separation is electrostatic interaction between the cationic polymer and anionic surfactant aggregates. TJ

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