Pitch deposit awareness and control

G. D. "Skip" Laubach and Carol S. Greer

Pitch deposits and the associated problems in paper machine systems will likely increase in the future. Faster paper machines mean higher shear rates, which aggravate pitch deposition. Higher production rates often mean overloaded pulp washers and dirtier, more pitch-filled pulps. Increased use of high-yield pulps and secondary fibers translates into more contaminants and pitch in the pulp. The trend towards increased mill closure and greater water recirculation and reuse means more pitch in the system. And more pitch in the system translates to a greater chance of deposits and runnability problems.

The obvious costs resulting from pitch deposits in a machine system include lost or downgraded production resulting from specks, spots, and holes in the sheet, reduced wire and felt life, and downtime due to clothing changes and clean-up of the machine. More subtle costs to the mill arise from the corrosion which can result from the microbial growth that can occur in conjunction with pitch deposits. And, of course, paper machine downtime means less profits for the mill.

To understand pitch, the whole papermaking system must be considered. A pitch problem on the paper machine may be originating back in the pulp mill.

What effect does wood storage have on pitch components?

Enzymatic hydrolysis and air oxidation reactions can occur which cause pitch components to become more water-soluble and therefore more easily removed in the pulp washing stages. Some organic materials (such as terpenes) are lost through volatilization. These beneficial reactions are more likely to occur in the warmer months of the year. Wood stored in chip form rather than log form will undergo hydrolysis and oxidation reactions to a greater extent, but storage of wood under water will retard the oxidation reactions. One drawback to seasoning wood is loss of pulp brightness. Therefore, a balance in wood chip handling must be achieved.

Pitch is released during the pulping process in the form of hydrophobic, microscopic particles (**Fig. 1**). Colloidal pitch droplets carry a negative surface charge and are in an unstable, dispersed state. Several different factors can cause this colloidal pitch emulsion to "break" and form large agglomerates and sticky deposits in a paper machine system (**Fig. 2**).

Pitch content in wood can vary anywhere from 1% to 10% by weight. The amount of pitch released during pulping depends on the type of wood being pulped. Softwoods generally contain a larger amount of pitch (due to the presence of resin canals in the wood), but hardwood pitch is often more difficult to treat due to its generally higher levels of insoluble neutral organic pitch components (e.g., waxes, fatty alcohols, and sterols).

Laubach is a product specialist and Greer is a senior research chemist at Nalco Chemical Co., One Nalco Center, Naperville, Ill. 60563-1198.

How do the various pulping processes affect pitch components?

In the kraft process, the alkaline conditions serve to saponify the fats (glycerol esters of fatty acids) and fatty and resin acids to their soluble sodium salts, which act as natural surfactants for the neutral organic pitch components. Thus, removal of pitch through an efficient brownstock washing stage is usually very good. In the kraft process, much of the lignin is solubilized, and many of the parenchyma ray cells (containing encapsulated colloidal pitch) are ruptured, releasing pitch so it can be removed from the system along with the lignin in the pulp washing stages.

In the neutral or acid sulfite pulping process, fats are hydrolyzed to the free fatty acids and glycerol. Resin acids remain unchanged, as do the neutral organics. All of these pitch components are insoluble under acid pH conditions. Since the fatty and resin acids are not in their soluble sodium salt form, they cannot act as emulsifiers for the neutral organics in this system. Although the sulfonated lignins can serve as natural dispersants for the pitch particles, removal of the insoluble pitch components by pulp washing is poor. Many ray cells remain intact during this milder pulping process, so a significant percentage of the sulfite fibers contain encapsulated pitch. This form of pitch can cause problems further on in the system, since it can be released when the fiber cell walls are broken at shear points (such as press nips).

In the mechanical pulping process, the heat and mechanical action of the grinders releases large amounts of colloidal pitch as an unstable dispersion. The pitch components themselves are largely unchanged, lignin remains insoluble, and many of the ray cells are ruptured. Since little or no pulp washing occurs, all of the pitch released into the system is carried along with the pulp. Severe pitch-related problems can occur under these conditions.

More often than not, pitch deposits in a paper machine system are a combination of organic and inorganic materials. Materials that contribute to organic deposits in a paper machine system not only include the chemical components of pitch but also secondary fiber contaminants and even petroleum products (such as the oils found in brownstock defoamers). Materials that contribute to inorganic deposits include fillers such as clay, titanium dioxide, calcium carbonate, and talc, and insoluble salts such as barium sulfate. Often these materials will co-deposit along with pitch due to the hydrophobic, tacky nature of a pitch deposit.

What are some of the pitch deposit triggering mechanisms often encountered in a paper machine system?

Hydrodynamic or mechanical shear can destabilize the colloidal pitch emulsion, causing pitch to agglomerate and deposits to form. Similarly, sudden temperature drops, pH shocks, or the introduction of water hardness ions (e.g., from fresh water inlets or showers) can also cause pitch deposits by destabilizing the colloidal pitch emulsion. Inorganic salts such as calcium carbonate can catalyze pitch deposition by acting as the "bricks" for the "mortar-like" pitch. Calcium ions in the white water can react with fatty and resin acids, forming insoluble, tacky calcium soaps.

What methods can be used to control pitch in papermaking systems?

Control of pitch outbreaks in the wet end is a continual process. The desired method of control dictates the chemical treatment. The traditional agents for pitch control include talc, surfactants, dispersants, surfactant-dispersant blends, crystal modifiers, chelating agents, alum, and sodium aluminate.

The hydrophobic surface of talc crystals adsorbs the hydrophobic, colloidal pitch particles, thereby preventing agglomeration of these particles. If talc is added to the system after pitch deposits have already formed, it adsorbs onto the surface of these deposits and "detackifies" them. The advantages of using talc for pitch control are that it's economical, works fairly well, and, in systems with a good retention program, most of the talc and pitch particles are trapped in the forming sheet. Some disadvantages include the high usage rates often required to control pitch deposition, talc abrasiveness to machine components, and difficulty in handling and makeup.

Surfactants act to make pitch more water-soluble by placing a hydrophilic coating around the hydrophobic pitch particles. Surfactants are like soaps in that they have a polar, hydrophilic end and a nonpolar, hydrophobic "tail." In water, the "oil-loving" tails of the surfactant molecules are oriented toward each other with the "water-loving" ends facing outward. If enough surfactant is present in the system, the hydrophobic pitch particles are surrounded and "solubilized" in this manner.

Usually only low dosages of surfactants are required for pitch control. Another advantage is that old pitch deposits can be cleaned out of the system. Disadvantages include a potentially adverse effect on sizing at higher usage rates, foam formation, and holes or breaks in the sheet which can occur if old deposits break loose in large pieces.

Dispersants act to prevent pitch agglomeration by effectively increasing the net anionic surface charge of the particles. The greater the surface charge, the greater the interparticle repulsive forces. As with surfactants, the advantages to using dispersants are that low dosages are effective and accumulated deposits in the system can be removed. A disadvantage to using dispersants for pitch control is that they can build up in the white water (especially in a closed system) and adversely affect retention programs. Also, some dispersants foam, and chunks of old deposits can be dislodged and cause holes and sheet defects. Some very effective pitch "dispersants" are actually blends of dispersants and surfactants.

As mentioned earlier, calcium carbonate scale and hardness ions can cause pitch to deposit. Chelants and crystal modifiers can prevent this from happening. These chemicals act to sequester polyvalent ions such as Ca^{+2}, thereby preventing the formation of $CaCO_3$ microcrystals and insoluble calcium and magnesium soaps of fatty and resin acids. Chelating agents work very well in kraft pulp mills and bleach plants but have very poor cost performance since stoichiometric amounts are required to be effective.

Alum and sodium aluminate have been used very effectively to control pitch deposits. These chemicals act as coagulation aids to attach pitch particles to fibers and fines, in much the same way that rosin size is set onto fibers by alum. The advantages to using alum are that it's economical, and it's very effective in some grades, especially newsprint. Disadvantages include the high sulfate levels associated with high alum usage, which increases the corrosivity of process waters, and alum's less than optimum effectiveness at pHs outside the range of 4.6 to 5.5.

A new method to control pitch involves the use of a specially formulated polymeric pitch "retainer," which acts to retain colloidal pitch onto the surface of the fibers and fines. Pitch is attached to the fibers in a finely dispersed manner and is ultimately removed from the system with the finished sheet. Such a product is much more efficient than alum in attaching pitch to the fibers (due to its higher cationic charge density), has better wet-end compatibility, and will complement an existing retention program. This method will reduce free pitch in a papermaking system and eliminate pitch-related sheet defects and machine deposits.

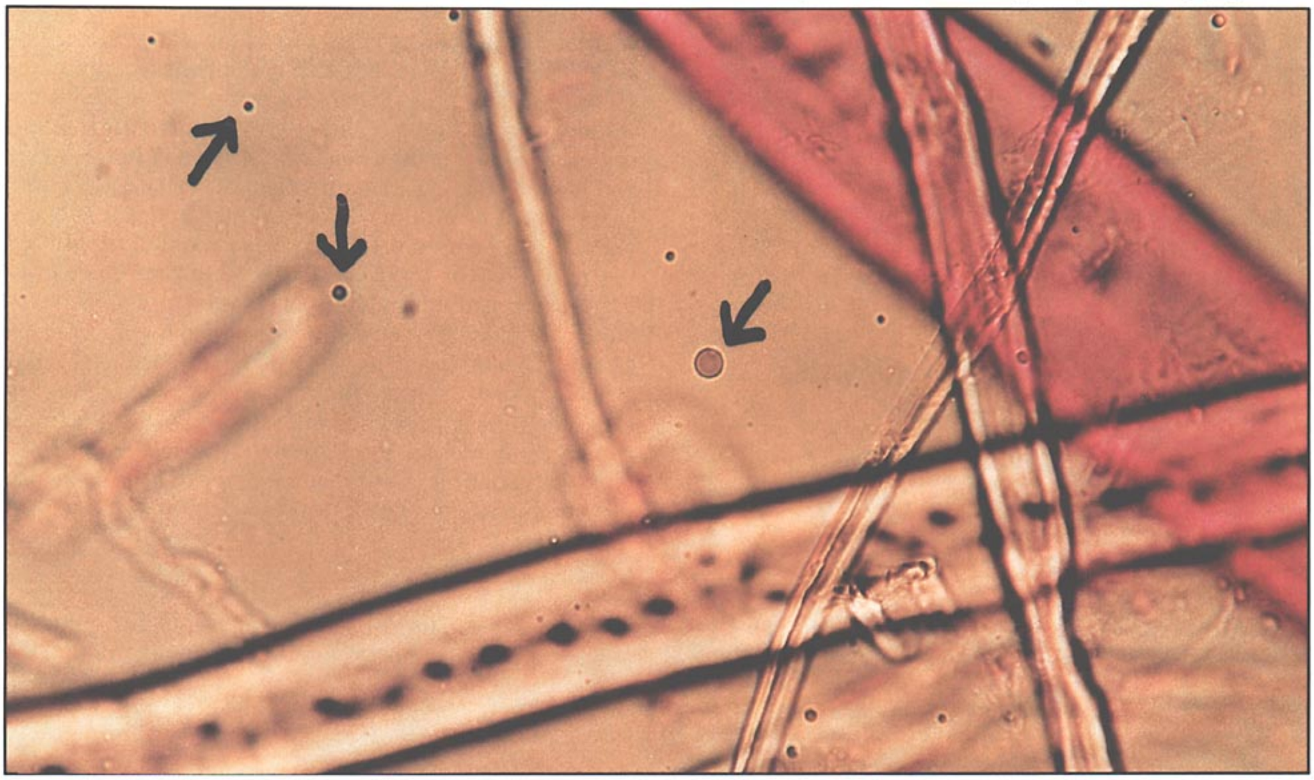
What are some of the analytical techniques available to identify pitch deposits?

Qualitative tests can be used on-site to identify the presence of resin and fatty acids in a deposit or a sheet defect. Thin-layer chromatography and infrared (IR) methods can be used to identify the organic components; X-ray fluorescence is used to identify the inorganic components. Microscopy is often a very useful tool for further characterization of deposits. Gas chromatography (GC), GC-mass spectroscopy, Fourier transform-IR, and scanning electron microscopy X-ray diffraction are other analysis techniques that are helpful in identifying the components of deposits.

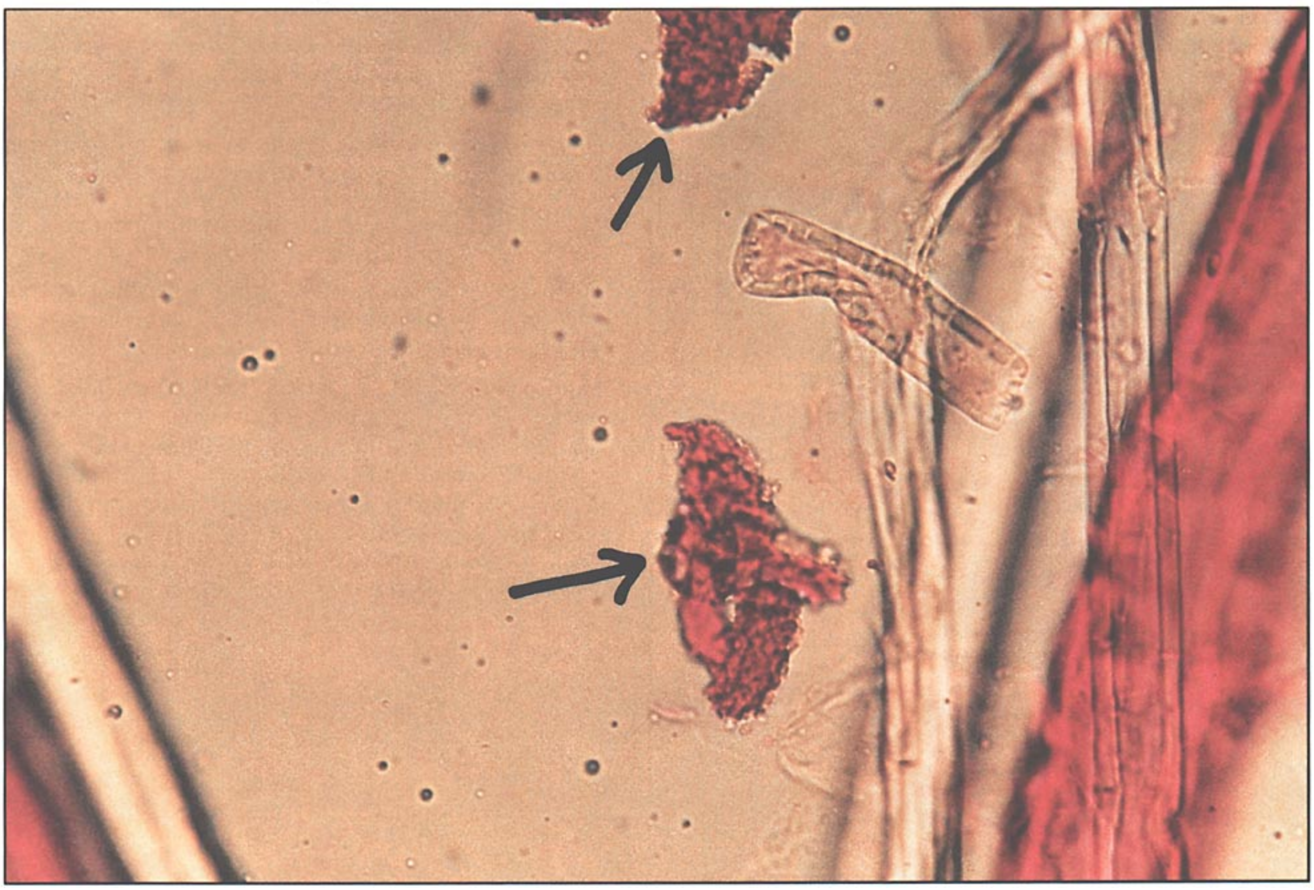
What are some methods that can be used to monitor pitch in a pulp and paper mill?

Machine deposits can be an obvious indication of a pitch problem, as well as sheet defects and lost or downgraded production. Pitch deposition plates can be placed in pulp

1. *Arrows point to examples of colloidal pitch particles dispersed in white water among hardwood kraft fibers (360X photomicrograph).*



2. Arrows indicate examples of pitch agglomerates in a machine chest stock sample. Many colloidal pitch particles can also be seen in the background (630X photomicrograph).



transfer lines or process streams to monitor both the "pitch-troublesome" potential of pulps and the effectiveness of current pitch deposit control programs. A test employing a high-shear mixer to induce pitch deposition from pitch and pulp mixtures has given excellent results in laboratory evaluations of pitch control programs. Microscopic techniques have proven very useful for monitoring pitch and demonstrating the effectiveness of pitch control chemicals. A quantitative method employing a hemacytometer can be used to determine colloidal pitch particle concentrations in wood pulps. An oil-soluble dye can be used to help distinguish pitch particles from other colloidal materials. Pitch dye, in conjunction with the microscope, can also be used to assess the physical form (e.g., colloidal, agglomerated) of the pitch in pulps throughout the machine system. A microscope equipped with a camera is a valuable tool for establishing a pictorial record of a pitch "situation" in a mill before, and after, implementation of a pitch control program.

Summary

Many factors can influence pitch deposition in a pulp and papermaking system:

- Pulping releases pitch as an unstable colloidal dispersion.
- Water hardness can cause colloidal pitch to form calcium soaps and deposits.
- Sudden temperature drops can decrease the solubility of pitch and cause it to precipitate and deposit.
- pH changes can also cause pitch to become less soluble and cause it to deposit in the machine system.
- Inefficient pulp washing results in more pitch being carried through the machine system with the pulp and increases deposit potential.

There are three basic concepts to keep in mind when formulating a pitch deposit control program:

1. Reduce inorganic scale potential by applying calcium scale control programs where necessary.
2. Improve the performance of pulp washing and extraction stages by applying pitch dispersant and emulsifier programs to increase the water solubility of pitch.
3. Use a polymeric pitch "retainer" to attach colloidal pitch particles to the fibers and send them out of the machine system with the finished sheet. This pitch control method has the added advantage of eliminating the build-up of pitch in the system through recirculation in a closed white-water loop.

Pitch control has been attained by understanding the process. By understanding how colloidal pitch forms deposits in a papermaking system, methods can be developed to control pitch before it affects runnability.□