Alkaline papermaking experience at Simpson Plainwell Paper Co.

George W. Lawton

Experience since 1982 at Simpson Plainwell shows that alkaline papermaking is no more expensive than using conventional size.

Many years ago, there were not many technically trained people around the mills. Paper was made by practical men who learned how to do it from other practical men. They had a little so-called "technology"—some rules of thumb, a couple of finely calibrated fingers for rubbing the stock out, and a good set of teeth for chewing it. They also had the ever present use of alum as a cure-all.

A story from those days tells about a good ol' boy papermaker who was in a world of hurt. His machine was making nothing but "hay." He tried all the tricks he knew, even calling up some of the retired old-timers around town to see if they could help. No one had an answer to his problem. Finally, one of the bright young men in his organization suggested he needed help from a higher authority.

"What do you mean?" he said.

"Well, there's this new clairvoyant in town. She is supposed to be able to see in the future. People are saying she's real good."

Well, our good ol' boy was not too comfortable with this notion, but by nightfall things were no better at the mill and he was desperate. So he gathered his courage and walked over to the clairvoyant's house. He went to the door and knocked.

"Who's there?" came the call from inside.

"No help here," our papermaker muttered, and he turned around and left.

Papermaking problems generally are not solved by supernatural forces or by luck or even by applying experience or conventional wisdom. Usually, they are solved by setting objectives, determining ways to meet the objectives, and taking action to realize these objectives. The process through which Simpson Plainwell Paper came to use alkaline papermaking techniques followed that path.

The mill on the Kalamazoo River

Simpson Plainwell Paper Co. is the latest in a long list of names for the paper mill located on the banks of the Kalamazoo River about 15 miles north of Kalamazoo, Mich. Simpson Paper Co. purchased the mill in December 1987 from Chesapeake Corp. Chesapeake in turn had bought the mill plus Wisconsin Tissue Mills from Philip Morris Co. in 1985, and Philip Morris had bought it from Weyerhaeuser in 1974.

There has been a paper mill on this site for 103 years, and the oldest buildings still in use are approximately 90 years old. Historically, nearly every grade of paper—from rag-content bond to newsprint—has been made here.

The grades presently made are coated and uncoated printing papers and coated and uncoated technical specialties. Most of the uncoated specialty papers are used in the pressure-sensitive label business. Our largest single grade is basestock for subsequent silicone coating. We call it "release" paper.

Among the Simpson printing paper grades, we make a premium coated matte grade called "Kashmir," a No. 2 enamel called "Shasta Gloss," and two conventionally coated mattes called "Mojave Matte" and "Sequoia Matte." These are all made on No. 18 paper machine, a 124-in. wide, 2,000-ft/min fourdrinier with an on-machine two-side blade coater. This machine also makes some coated silicone coating basestocks and a few other grades.

The mill also makes an offset press grade called "Satin Kote," which is size press coated for enhanced ink holdout. This grade is made on No. 16 paper machine, a 100-in.-wide, 850-ft/min fourdrinier.

The other paper machine, No. 17, makes uncoated supercalendered silicone coating base, which we generally call "release." We will not discuss this grade here because its manufacture is not affected by the pH of the other machines.

The conversion to alkaline

The decision made in 1981 to start using alkaline papermaking techniques was precipitated by the situation the Plainwell Paper Co. faced at the time. In early 1981, the mill was starting up a complete rebuild of No. 4 paper machine (now No. 18 paper machine). This machine was really a new machine—faster, longer, and a tiny bit wider than the one shut down in September 1980.

Only a few parts were retained—some dryers, some rolls, some gear boxes, and most of the coater. The startup was going badly. The machine was difficult to get going and harder to keep going. We faced substantial problems at

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nearly every section of the paper machine. On top of that, we had a serious problem with staff personnel. People were quitting, and people were also being replaced—some voluntarily, some otherwise.

In my role as Technical Operations Manager, I was faced with problems other than the mechanical or personnel ones. One of the most important problems was that the wet-end chemistry of this machine was a mess. It took enormous amounts of alum to create an environment suitable for rosin sizing. Deposits appeared everywhere on the machine, with holes and breaks contributing to the machine's runnability problems. Something had to be done.

In addition to these problems, we had become aware that the major companies in the high-quality coated printing market were already using alkaline techniques or soon would be. As a small company in this market, Plainwell needed to contend with this situation if it was to compete in the marketplace.

So I made a proposition to my boss in the form of a question. Should we work hard to fix up the alum-rosin system, and once it was fixed, go alkaline, or should we just go alkaline? To tell the truth, I didn't have the slightest idea about how to fix the alum system, so I recommended that we go alkaline right away. My ideas about how to do this were somewhat in doubt, but at least I had a wide gamut of sales people who wanted to help by providing products and services.

Since I did not have much staff, much money, or much time, I took the easy approach—to change as few things as possible at once. We wanted to allow the process to guide us to more an optimal operation rather than force the operation to accept a new process. Therefore, as quickly as possible, the mill adopted alkaline techniques.

We did run some trials, we did involve the suppliers, and we did keep everyone informed. However, regardless of what else happened, we stuck to our decision to change over to alkaline papermaking and to remain an alkaline papermaking process.

I. Comparison of 1981 and 1988 furnish component usage as run, using 1988 costs

	Acid, lb/ton	*Alkaline, lb/ton*	*Savings in costs,* $*
Northern softwood pulp	510	300	
Southern softwood pulp	66	118	
Northern hardwood pulp	444	512	
Southern hardwood pulp	526	611	
Other pulps	99	54	
Difference in costs			837,434
Pitch control agent	0	20	(155,157)
Biological control			(12,930)
Retention polymer			
Cationic	5	2	
Anionic	0	1	
Difference in costs			129,660
Fillers			
Filler clay	200	0	
Calcium carbonate	0	340	
Calcined clay	0	4	
Difference in cost			(812,402)
Titanium dioxide	70	33	1,741,379
Defoamer	0.04	0.08	(1,968)
Sizing program			
Alum	70	0	
Rosin size	10	0	
Synthetic size	0	6	
Difference in costs			(145,568)
Pulp weight, lb/ton	1645	1595	
Total cost difference			1,580,447

*Costs in 1981 minus costs in 1988.

Trials

We ran three trials—one to prove you could make paper without rosin size and alum, a second to prove you could make better paper that way, and a third to prove that all the basis weights could be made without incurring additional problems. Our first trial illustrates the difference between studying a process to death—as many mills have done in preparing to change to alkaline—and doing what has to be done.

We ran the first trial on Kashmir, our matte grade of highest brightness. The plan was to shut down on a Monday morning, clean up, and boil out, bring in fresh furnish, and start adding ground limestone. The trial was to extend for 24 h, making only 146-lb coated paper (or 80-lb "cover"). All the suppliers I needed had people scheduled in the mill, and all the necessary materials were on hand the previous Friday.

When I came in early Monday, I found things messed up already. The paper machine had lost a wire on Saturday, so they boiled out after they started up. They were ahead of schedule, and they didn't look for another order to run before the 146-lb Kashmir. It was already running acid, of course.

I knew it would be a long time before I got a chance for a relatively long run of a desirable grade like this one, and I didn't have the guts to send all the suppliers' people home. I decided we would switch to alkaline anyway.

We just shut off the alum and rosin size. We dumped soda ash into the various chests. At an appropriate time, we started adding ground limestone as the filler. And we kept running. Remember, this basesheet weights 125 lb or so, and it is plenty strong.

I stood up on the headbox catwalk and watched the wire. The technician kept me informed about the pH. As the pH came up to about 6, the formation got worse and worse. At about 7, it looked like someone was throwing handfuls of stock on the wire. But the sheet did not break down. Suddenly, as the pH reached approximately 7.5, the formation started to improve and soon became saleable again. That process took about an hour and a half. We probably lost 15,000–18,000 lb for formation. But we kept on going, and we sold the product. Actually, we never told the sales department that we'd made the switch.

The only point I can see in this is that you can make

II. Comparison of 1981 and 1988 furnish component usage based on equalized components, using 1988 costs

	Acid, lb/ton	*Alka-line, lb/ton*	*Savings in costs,* $*
Northern softwood pulp	527	300	
Southern softwood pulp	68	118	
Northern hardwood pulp	459	512	
Southern hardwood pulp	544	611	
Other pulps	102	54	
Difference in costs			1,642,906
Pitch control agent	20	20	0
Biological control			(12,930)
Retention polymer			
Cationic	2.35	2	
Anionic	0	0.8	
Difference in costs			(2,834)
Fillers			
Filler clay	200	0	
Calcium carbonate	0	340	
Calcined clay	0	4	
Difference in costs			(812,402)
Titanium dioxide	32.5	32.5	0
Defoamer	0.04	0.08	(1,968)
Sizing program			
Alum	40	0	
Rosin size	6	0	
Synthetic size	0	5	
Difference in costs			(216,030)
Pulp weight, lb/ton	1700	1595	
Total cost difference			596,742

*Costs in 1981 minus costs in 1988.

going alkaline about as hard as you want to. You can do lots of studies and trials. You can get everyone involved and have everyone worried and offering objections. Or you can do what has to be done and just go with it.

I really believe that this conversion process is easier when ground limestone is used than it is when precipitated carbonate is the filler, but I have no experience to back up this belief. I also believe that using alkylketene dimer size is an advantage for conversion trials. There is time later for looking at alkenyl succinic anhydride (ASA), after the internal problems are out of the way. In addition, I believe you should not change the necessary things and sort out the details later.

Objectives

Having objectives is an important place to start. We made a list of objectives and kept track of the progress on these items over the years.

Primary objectives

There were two key objectives, beyond the implied one of successful running:

Objective 1: Use ground limestone to replace both filler clay and additional fiber.

Objective 2: Use ground limestone to replace coating clay in coating formulas.

Why ground limestone as the filler? The most important reason was that there was no precipitated carbonate available. A second but highly important aspect was that I felt that we could successfully use more ground limestone than precipitated carbonate in the basesheet without causing strength problems. The product that we started using was a filler grade of ground limestone having 30% of its particles finer than 1 μm.

The use of calcium carbonate as the filler is the economic basis of the project. If we could make paper with 17% carbonate filler that was just as strong as paper we could make with 10% clay filler, we would save an enormous amount of money. This turned out to be the case.

Why use calcium carbonate in coating? Coatings that contain calcium carbonate are generally acknowledged to print better than coatings that contain only clay. Our competitors were already using 25%, 35%, or 50% carbonate in their pigment mixes, whereas we were able to use only 10–15% in the acid mode. In that situation, their product was superior, and we wanted to compete.

Lesser objectives

Then there was a series of lesser objectives, each important in its own way and each contributing to the potential for a successful conversion.

Objective 3: Have a simpler wet-end chemistry. The alkaline system is easier to run, it causes less problems, and it does not require the control that was necessary before. For instance, it is not necessary to control the pH of the wet end, because the calcium carbonate maintains the pH under normal circumstances at approximately 7.8.

Objective 4: Run a cleaner paper machine. One truism about alkaline systems appears to be that, with proper care, they run cleaner than acid ones. Rarely are there hard deposits in pipes or on machinery. Boilouts are usually easier and more thorough. (It is not possible to say that there are fewer boilouts because our objectives on machine cleanliness have also changed with time.)

Objective 5: Run an unsized or waterleaf coating basestock. We have not been successful in this objective. We run relatively small amounts of alkylketene dimer size, up to 5 lb/ton. This quantity provides enough sizing to ensure good size press runnability. We do not concern ourselves much with internal size specifications on coated printing grades.

Objective 6: Improve our overall retention while improving optical properties. While our retention rates have improved in the alkaline mode, I suspect the cause is to be found in doing a better job of selecting and controlling the retention aids, rather than in the wet-end chemistry. We currently use what we call a "dual polymer system." This system consists of a highly charged, short-chain cationic polymer added in the machine chest and a long chain anionic polymer added as near the headbox as practical. The total first-pass retention values for coating basesheets are above 90% on all basis weights, while first-pass filler retention is around 70%.

Objective 7: Improve wire life. As to wire life, we had just about the worst experience possible. Our wire life dropped from a poor 32 days per fabric in 1981 (when we were an acid mill) to 16 days per fabric in 1982, excluding mechanically damaged wires in both cases. Almost anyone else would have abandoned the trial process when confronted with this prospect. However, we figured out that wire changes were costing us $900/day (in 1988 dollars), while the additional filler was saving us nearly $4000/day. So we kept going.

After a year of struggle, a papermaking solution was found. By adjusting the foil positions, by replacing high-vacuum boxes with low-vacuum boxes, by putting different kinds of covers on the high-vacuum boxes, and by removing several high-vacuum boxes with no replacements, the table was completely reconfigured. This redesign was done under the guidance of a supplier consultant. The first wire run after these changes lasted 92 days, and our overall wire life is now about 80 days. The point is that wire life is a papermaking problem, not an alkaline papermaking problem. This problem is solved by applying good papermaking techniques.

Objective 8: Maintain control of the biological situation. Actually, the biological control system has not changed much from the one we used in the alum-rosin size days. The basic slimicide is still the same, our philosophy about biological control is unchanged, and the costs are similar. We have never really lost control of the biological situation.

Objective 9: Improve the wastewater treatment plant operation. We were suffering from an odor problem at the wastewater treatment plant before the switch. It stood to reason that the sulfate ion in alum was contributing to sulfur-based odors. Removing alum as an ingredient should have reduced the problem. Well, as far as I can tell, it didn't. There are plenty of other sulfur sources in the mill.

I think that alkaline wastewaters are as easy to treat as acid ones, and they may be easier to treat. Settling rates do not appear to be affected much. Our biological secondary treatment system was installed after we went alkaline, so I cannot make a legitimate comparison. Primarily sludge appears as easy or as difficult to dewater (depending on how you look at it) as it ever was.

Quality aspects

We started with full-time alkaline papermaking on December 18, 1982, on No. 18 paper machine and about a month later on No. 16 paper machine. We enjoy good runnability, producing a high-quality sheet with excellent brightness. We use more TiO_2 than mills that have precipitated calcium carbonate available, but we have substantially reduced our usage, mostly by working on TiO_2 efficiency, not from being alkaline. We have also raised brightness and opacity targets at the same time. Our coatings print better now than they did, and they are brighter, stronger, and smoother.

On the other hand, our paper is thinner and less stiff than the equivalent grades we made before the change. We do not see any economical way to change this.

Coatings that contain carbonate tend to become transparent during supercalendering, so basesheet quality is important. Carbonate filler content tends to make a good-looking basesheet. Carbonate coatings tend to have fewer scratches or blade marks. The particle size and the particle size distribution of the carbonate is an important factor.

Cost savings

For many, the important question is not so much what it does to quality but what it does to cost. The cost savings can be looked at in several ways, but two important ways are:

1. What is the difference in cost between the way we made paper in 1981 and the way we did in 1988?
2. What would have been the difference in costs if we had stayed acid and improved all the other cost items?

The data in **Table I** show the answer to Question 1. We are saving $1.6 million per year at our current production rate on No. 18 paper machine. Comparing the differences between an improved acid system and the alkaline system is more difficult, and I have assumed that nearly everything we do now would be mirrowed in the acid process. There are a few things—biological control, filler amount and type, defoamer, and sizing costs—that are specific to alkaline papermaking, and these were not equalized.

The pulp figures are the actual percentages we used in 1981 and in 1988 in the entire mill. Our accounting system does not allow me to isolate the No. 18 paper machine easily. I do not know whether the change in percentages has anything to do with being alkaline or not. It would also be affected by the grade mix, and the grade mix changed between 1981 and 1988. **Table II** shows the results that occur when all of the items are equalized. There is an overall savings of $597,000/year. Most of these savings are in pulp savings, offset by increases in filler and sizing costs.

When we equalize the pulp consumption in 1988, the pulp cost savings are doubled. This increase is caused mainly by the difference in pulp percentage shown on the line called "Pulp weight, lb/ton" at the bottom and by the increase in standard costs. The difference between 1981 and 1988 is 50 lb/ton, while the calculated equalized estimate is 185 lb/ton.

We believe that we can use more hardwood and less softwood in the alkaline mode, but changes in the grade structure prevent me from proving that.

A pitch control agent is the next item on this list. We now use it regularly as an insurance against pitch problems, though we used to use it only when we had pitch problems in the past. It is probably not a factor in the alkaline vs. acid equation. Therefore, I simply equalized it out in Table II.

Switching back to Table I, let us review the cost of the biological control system. We believe that the biological control system costs somewhat more in the alkaline mode than it would have in the acid mode. But the system has gotten somewhat more complex, and it's really quite hard to say. I left in a small difference in the equalized chart, which seems to reflect the industry experience.

The retention aid program probably would have equalized as we worked on becoming more efficient in that area. I have shown it that way in Table II.

The filler situation is self-explanatory. We can use more ground limestone now than we could have used clay, even in an up-to-date acid system. The calcined clay product shown is a minor additive in one particular grade that we did not make in 1981.

Even though we have reduced substantially the amount of TiO_2 used on a per ton basis, I can see no reason why our alkaline system would be more efficient than a well-run acid system. I do not have precipitated calcium carbonate available to compare, and I simply equalized the titanium usage for Table II.

It probably takes a little more defoamer to run alkaline, although some people would not agree with that idea. I left in a small difference here.

The sizing situation is also self-evident. Synthetic sizes cost more than natural ones. But since you can't use rosin at pH 7.8 and you probably wouldn't use alkylketene dimer at pH 4.5, you can't equalize them.

Conclusions

From Simpson Plainwell's point of view, changing to alkaline papermaking was not particularly difficult, because we had clear objectives and a simple plan to follow. We changed as little as we could, and we adapted the changing conditions as they became necessary.

Where do we go from here? There are several loose ends that need to be looked after. One important question is, does precipitated calcium carbonate have a place at Plainwell? Another is, is our wet-end biological control system really up to snuff?

Another area we will be taking a look at is the area of what I call "wet-end systems," meaning those systems involving silica or other strange ingredients. Where do they fit into an alkaline program? Finally, because of the current situation in the TiO_2 market, we need to determine the best approach to minimize the usage of TiO_2 in our grades.

We are working on these projects, and we expect to find new solutions as we go.□

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