New Technology for Deagglomeration of Pigments

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Abstract: MICAP Technology Corporation has developed a new technology for chemical deagglomeration of pigments. This technology is now being applied to ink manufacturing, but has numerous other potential uses in paints, coatings, and other processes utilizing pigments. Traditionally, pigment preparation depends on mechanical methods to achieve deagglomeration. The new technology is a method for associating a polymer to the pigment surface. This protective polymer assists with deagglomeration and prevents reagglomeration of pigments. This polymer has hydrophobic tails that create an attraction of the polymer to the hydrophobic vehicle system. The result is a homogeneous linking of the pigment to the carrying vehicle with the formulation of an efficient product film. Benefits achieved in lithographic inks include better color, reduced fountain concentrate use, better ink dry time, less dot gain, greater versatility, and easier product use.

Good Afternoon. I'm pleased to have this opportunity to address the Technical Association of the Graphic Arts. I've come here today to tell you about a new technology that we believe will have a major impact on the printing industry.

A couple of years ago, A. B. Dick Company was faced with a challenge. The challenge was to find a way to protect iron oxide from water as it went through the lithographic printing process.

Since iron oxide has an extremely high affinity for water, this was a significant problem. As they searched for a way to protect the iron oxide from water, a rather remarkable discovery was made.

This discovery is the basis for a technology that we believe will change the way that inks will be manufactured in the future...

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So what did they have? What was this discovery? Basically, the microencapsulation technology involves coating pigment particles in a polymer shell that make the pigments more compatible to the ink vehicle system.

A. B. Dick concluded that the new encapsulation technology had potential well beyond that of iron oxide in lithographic inks.

General Electric Company of England... the parent company of A. B. Dick... looked at the technology and felt that a significant technology had been discovered.

So, to fulfill the potential of this process, they formed a new company... MICAP Technology Corporation, with the specific purpose of developing and commercializing this newly-discovered microencapsulation technology.

To expand our research and optimize our results, MICAP went on a worldwide search recruiting the best polymer chemists available...

By now, we knew we were on to something important and the polymer chemists would bring the additional experience and broader focus to help us develop this technology.

Although we are planning to look at other areas outside graphic arts to utilize the new technology, our first area of attention is lithographic inks. My discussion today will be focused on that area.

Over the years ink chemists and manufacturers have known that a key step in quality ink manufacturing is to insure that the ink is properly milled. This ink milling process is costly and time consuming. Numerous equipment designs have evolved in an attempt to improve the milling process.

What are ink makers trying to accomplish with this milling process? The purpose of milling is to deagglomerate the pigments and to wet them out. How well this task is accomplished will determine ink performance features such as color strength, ink mileage, ink gloss, dot gain, dry time and coverage. An improvement in the milling process will improve the performance of all the previously mentioned features.

To understand this process and its current limitations, we first have to look at the surface of a pigment particle. Typically, the surface of the pigment will be covered with active chemical function groups.

Even carbon black pigment is not made up of just carbon molecules. The surface of the carbon black pigment will contain by-products of combustion. Typical examples of function groups you might expect to find are **carboxyl groups, lactone groups and phenol groups**.

The one characteristic these groups share is they're **all extremely hydrophilic**. They love water. So much so that they'll pull water out of the atmosphere like a desiccant. Once they've attracted water molecules, the active sites lock them to the pigment particle.

Particles are typically attracted to each other by van derWaals forces... Once these particles come in contact with each other, the hydrophilic attraction of the water on the surfaces help bind the particles together.

Certainly, there are other actions that also bind particles together to counteract the efforts of milling, but I need not talk about those today.

So let's go back to our ink maker. The challenge at hand is to disperse agglomerated pigment particles that have hydrophilic surface function groups (and often actually have attached water molecules) into a hydrophobic (lipophilic) media (oils and varnishes). We all know that oil and water don't mix. We want to deagglomerate the pigment particles and thoroughly wet them out. We then want to take the resultant ink and run this on a press while mixing the ink with water (the fountain solution).

What's wrong with this picture? The obvious answer is lots.

This is where our technology comes into play. We've developed an efficient method of associating polymers to the surface of the pigment to mask or negate the pigments. A feature of this microencapsulation process is that the polymer attached to the pigment has a long hydrophobic or lipophilic tail. So it loves the oil, resin, and varnish that make up the typical ink.

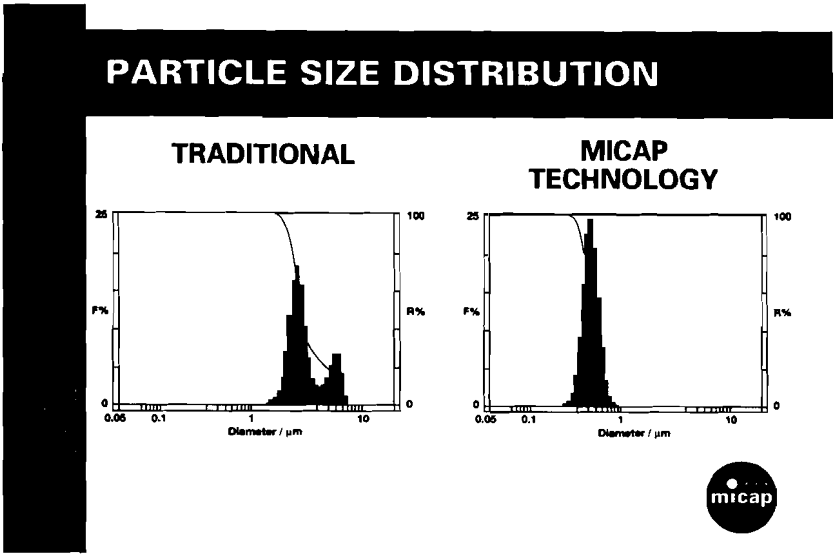
This effectively results in an efficient homogenous ink film where the pigment is linked into the ink vehicle system by the polymer. This is in direct contrast with current ink manufacturing processes which, by necessity, attempt to mix pigments that have hydrophilic surface chemistry with a hydrophobic carrier.

The detrimental effects of the hydrophilic function groups has long been common knowledge. Over the years numerous methods including resination or surfactants have been employed to bond to these function groups. However, these methods have fallen short due to high costs or other detrimental side effects such as unacceptable water pickup stability.

This is one of the issues our technology addresses.

Another is enhanced deagglomeration of pigments.

Our polymer encapsulation significantly enhances milling efficiency and produces a superior particle size distribution. We call this process deagglomeration.



Here's what we're getting as a typical particle distribution. We're using a particle size light diffraction analyzer for measuring the size of the clumping of the pigment groups...

In our tests, we compared our microencapsulated pigments against the current industry leader inks and this profile is typical of the results.

As you can see, traditional inks have an average particle size that range from **over one micron to nearly ten microns.**

With our process, we've **reduced the particle size average** to **less than one micron**... and we control the size variations to **within a much more narrow range**...

In other words, we have a better range of distribution and the particles are all within the sub micron range...

I'd like to take a minute to explain how we get this improved particle size distribution.

Traditionally, pigment milling depends on mechanical action to separate the individual pigment particles from each other.

Unfortunately, this mechanical process does not eliminate the active function groups on the pigment surface... Nor does it eliminate the water.

Consequently, as you break the pigment particles apart, a large percentage of the separated pigments will immediately re-agglomerate as soon as they come in contact with each other or with water. No matter how much milling you do the natural chemical properties of the pigments will make much of your work counter-productive. Conventional milling is very inefficient, since the particles are simply broken up, recombined and broken up to recombine, over and over...

Until you finally get enough separation for an acceptable size...**Not an optimal size**... The major result of this inefficient milling process is heat.

With our technology, the function groups exposed due to milling become neutralized...

We don't accomplish the deagglomeration with **traditional mechanical milling**. The process actually takes place during the mixing of our product. Milling, as we know it today, is not required for encapsulated pigment.

We're accomplishing the same milling function... but with far superior results... through a vigorous mixing of the pigment and the polymer...

We've discovered we can get enough action through high turbulence mixing to break up the larger particles... In the same operation, as soon as a function group is exposed, it immediately takes on the polymer to neutralize it... The polymer creates an extremely effective shield to prevent re-agglomeration.

When conventional ink is subjected to fountain solution on the press, if there wasn't water in the pigment to begin with, you'll certainly end up with water attached to the pigments now.

Contrast that to our microencapsulation process, which provides a very fine, interlocked homogeneous system of pigment and vehicle with a high affinity for the imaging areas of the press.

The end result of our finer particles (better deagglomeration) and the homogeneous ink system where the pigment is tied effectively to the ink's vehicle system shows up at the press through **superior ink mileage... stronger color... faster, more uniform drying... superior open time on the press... superior dot gain... and easier operation for the press operator** because of the excellent ink transfer.

We know that ink dries due to a combination of three factors...

Evaporation...

Absorption into the paper...

And oxidation.

If you're laying down ink with oil and varnishes trapped in the large clumps of pigments you're not going to get good drying.

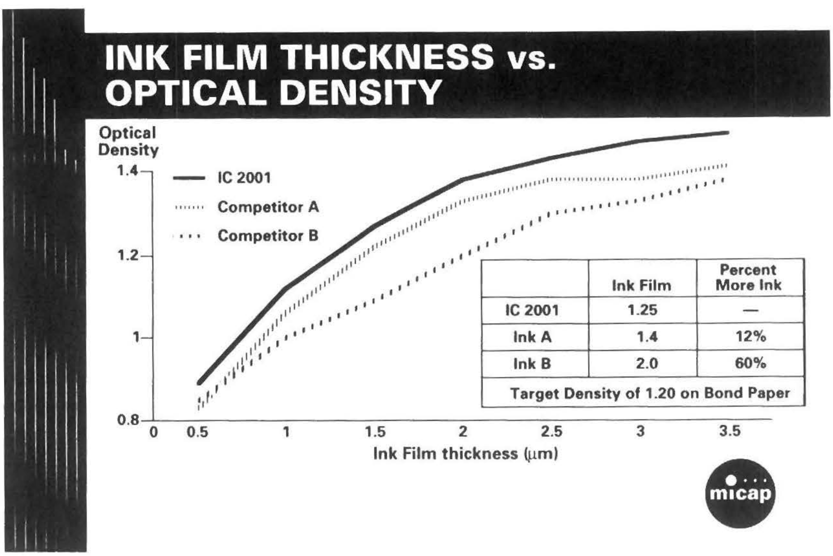
First, the clumps won't allow the oils to wick into the paper to promote drying...

Second, evaporation is hampered by entrapping the fluids in the agglomerated pigment.

And finally the clumping inhibits oxidation since the oxygen can't easily penetrate to the center of the clumps to get at the oils and varnishes.

However, if the same particles are laid down in thin, uniform manner... **As they are with our encapsulated technology...**

The drying is much more efficient. Without large clumps of pigments to trap and hold the varnishes and oils, the effects of evaporation, absorption, and oxidation are more rapid.



A combination of pigment deagglomeration with its resultant particle size distribution and the linking of the pigment to the ink vehicle system yields a very efficient ink film that allows printers to achieve more color strength from the same amount of ink when compared to a conventional ink.

The benefits of this are immediately apparent to the printers.

They don't have to put down **as much ink to get the same amount of color strength**...

Thus they'll see a **decrease in the dot gain...**

By using less ink, they'll experience **faster drying without having to use large amounts of driers.**

And finally, encapsulated ink is a lot **easier to work with** on the press since it provides better roller to roller transfer and makes the ink easier for the operator to run.

Another area that we have been able to demonstrate a major on-the-press improvement is with the ink behavior on the printing plate.

As I had pointed out earlier, pigment surfaces are covered with hydrophilic function groups. These function groups have a natural attraction for water from the fountain solution when the ink is on the press.

Keep this in mind as we consider how a lithographic printing plate works.

The plate's designed with two chemically different surface areas...

One is designed for the image area... and the other is designed for the non-image area.

The image area is designed to be lipophilic, that is, to have an affinity for oil while repelling water.

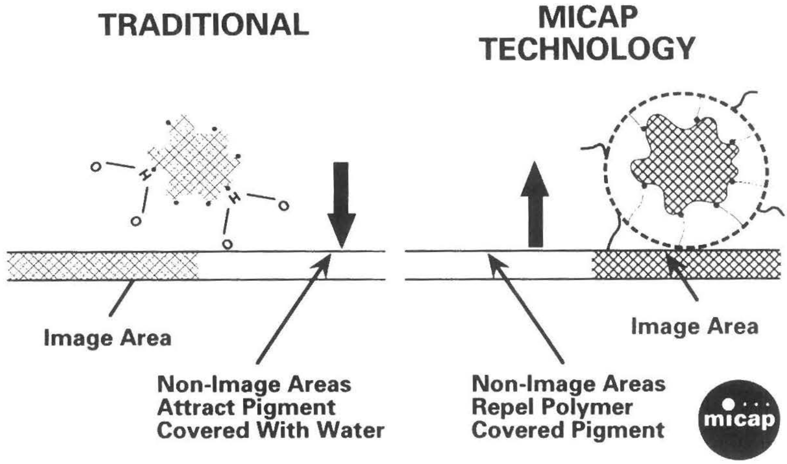
And the non-image areas are chemically designed to be hydrophilic.

Of course, the idea is that the oil based ink won't go where water is and vise-versa. As we all know, that's the basic theory behind lithography...

So what's wrong with this picture?

Well, we also know that conventional pigment particles frequently have water attached to their surface because of their hydrophilic surface function groups.

When these pigments are exposed to the water in the fountain solution they continue to attract and take on water. This causes the pigments to separate from the ink and deposit on the non-image area of the plate. We call this phenomenon toning. The particles stick to the hydrophilic non-image area because of the water attached to the pigment.



To counteract the migration of pigments to the non-image area of the plate, fountain solutions are designed to wash off the constant build up of errant pigment that breaks out of the ink carrier.

Our encapsulation **neutralizes the hydrophilic tendencies** of pigments... and it's lipophilic **polymer coating makes it chemically compatible with the carrier** oils, resins, and varnishes.

Consequently, the **non-image area of the printing plate tends to repel the water-free pigment...** This results in a printing operation that requires much less fountain solution, is far less sensitive to toning, and the fountain solution stays much cleaner.

Our new technology also offers **environmental benefits** to meet the increasing demands of regulators. MICAP's encapsulated pigment uses a high "non-free" percentage of soy bean oil. Because of environmental issues, legislation in many states requires the use of soy oil in inks.

However, as you're well aware, soy oil is not as strong a drying oil as traditional linseed oil.

Yet, with our encapsulated process, the polymer's hydrophobic tail effectively entraps and holds soy oil. Since the soy oil is trapped with the pigment, an ink can now be formulated with an acceptable soy percentage and still have all the running features of linseed oil inks.

A. B. Dick is currently manufacturing sheet-fed lithographic inks with over 40% soybean oil concentration by weight.

Besides dealing with the soy oil issue, encapsulated inks can be manufactured in this environmentally sensitive world without solvents that currently produce V.O.C.'s in conventional inks.

So in conclusion - we have developed a technology that involves coating pigment particles in a polymer shell. This technology allows us to more efficiently deagglomerate pigments and link these pigments to the ink vehicle system. Inks using this technology yield numerous performance improvements over conventional inks.

Thank you.