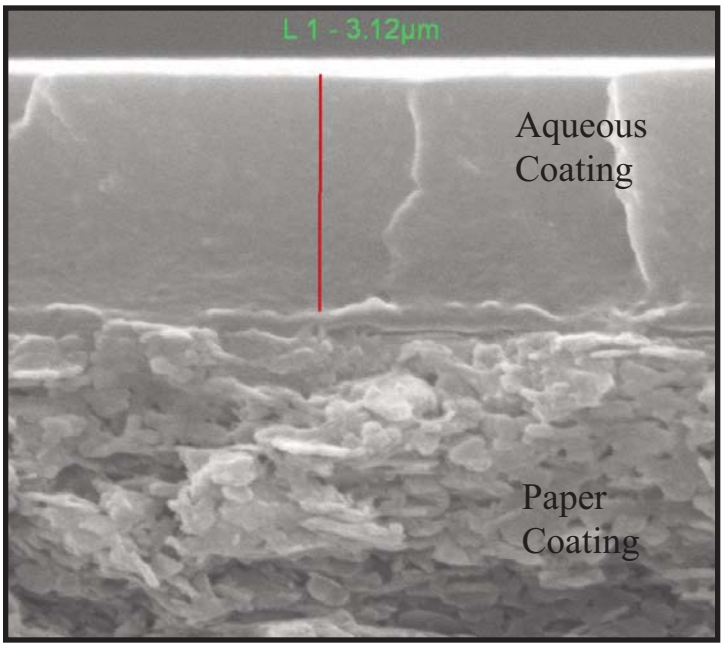
Technical Notes

NANCY PLOWMAN ASSOCIATES, INC.

www.npatest.com

Are Aqueous Coatings Permeable?

Years ago one of my "Print Clinic" articles (early 1990's) appeared in Graphic Arts Monthly that discussed adhesion problems seen on various jobs when aqueous coatings were used. Ever since I wrote that column, we have seen numerous printing and finishing problems that relate to the inability of the ink to dry beneath a layer of in-line aqueous coating material. Typical problems are marking, poor rub resistance, UV coating problems, and cases where the aqueous coating and ink rub off the paper's surface leaving with paper exposed.



A cross section of an aqueous coating (3.12 microns thick) on the surface of a printed press sheet. The ink film between these layers is so thin (less than 1 micron) it can't be seen. 12,500 X magnification

If you are using aqueous coatings in your pressroom, chances are you are unaware of either the composition of the mixture or the properties it has once it is "dried". In this article, we will deal with these two issues to give you a general understanding of these materials and the precautions that should be taken when using them in-line.

Aqueous coatings are made of these basic ingredients: water, polymers, ammonium hydroxide, wetting agents, and wax, or a slip agent. The key ingredient is the polymer, since when it dries, it forms a film, which adds protection to the job. Nearly all aqueous coatings are made from a co-polymer (two polymers) system of styrene and acrylate. The most simple analogy is Elmer's glue. This material is a milky white polymer that, when dried, becomes a clear resinous film. Blending the two polymers in an aqueous coating balances the gloss, flexibility and drying capabilities of the film.

These coatings are "water-based" so water is the primary ingredient, and allows the formulator to control viscosity, and the ammonium hydroxide is more volatile than water so it increases the evaporation rate and thus the drying rate of the film once it is applied to the printed sheet. The wetting agents lower the surface tension so that a thin film can be spread and the sheet, and the wax adds slip so the completed job won't scuff and mark. (Of course, wax is at reduced levels in a coating that is used as a primer before UV coating or a foil stamping process.)

Styrene-acrylate co-polymer require some heat to dry completely. Printed lift temperatures on press

30–32 Ray Avenue Burlington, MA 01803
(781) 272-7410 (888) NPA-TEST Fax (781) 273-1820

need to be in the range of 100°F to 110°F to dry most aqueous systems over a period of four to eight hours. Lift temperatures on the second side should be a bit lower, so that the first side will no resoften.

But how does the job dry? Once the aqueous coating is dry, can the ink continue to set and dry? And, can fountain solution materials penetrate through the dry aqueous coating?

In response to these questions, we asked our analytical lab to run permeability tests on films that are made with a typical aqueous coating. (Note that although several aqueous coating materials have been analyzed in our lab, their basic chemical makeup is the same. Therefore, we believe the data generated for this article can be used as representative of most coatings on the market at this time.)

Since the rates of permeability to water and hydrocarbon solvent can be different, we measured both. Distilled water was used for "water" and a sample of 500 ink oil was used as the hydrocarbon solvent.

A film was cast of the aqueous coating and cured at 100°F for four (4) hours. This produced a hard homogeneous film coating. The film was then tested on a Dohrman Envirotech Polymer Permeation Analyzer. The rate of water vapor transmission was measured on four separate samples of the film. The average of the four results was determined to be 28 g-mil/100 sq in/24 hours at 23°C (73°F).

The rate of hydrocarbon solvent oil transmission was measured on four separate samples of the film. The average of the four results was determined to be 0.4 g-mils/100 sq in/24 hours at 23°C (73°F). Is an aqueous coating permeable? Based on this experimental data, the answer is "Yes, and no."

Yes, aqueous coatings allow water-based materials (fountain solutions and some moisture from the ambient air in the pressroom) to penetrate through its film and escape into thin air. But no, the volatile solvents in an ink cannot penetrate the aqueous coating layer and escape to the air. They remain trapped beneath the coating for undetermined periods of time.This is because the aqueous coating allows water vapor to travel through it, but is impervious to ink solvent. Therefore, we conclude that any ink solvent retained in the ink film after the paper substrate has absorbed its limit of solvent from the ink film, will remain in the ink film for an extended period of time. In fact, ink oils/solvents may never totally leave the printed job.

Conclusions: we took a commercially printed job from a trial where both low-VOC and high-VOC inks were used, and then aqueous coated in-line. It had been three weeks since the job was printed and in-line aqueous coated.

On each sample, we tested the ink film beneath the coating to determine if our data holds true under production conditions. On each sample the aqueous coating layer was shaved from the surface by microtoming; this process can actually remove the aqueous coating, exposing the printed ink film beneath it. A sample of the ink film sample was then analyzed.

We found the presence of hydrocarbon oil in the ink film on the job printed with the high-VOC inks, but found a lower concentration of oils retained when low-VOC ink was used on the same job. And we found no fountain solution (water) materials in any of the ink films that we tested.

We believe that this is important information, and that printers should be aware that, contrary to current available product information, these films **DO NOT** breath and they inhibit the ability of the ink to dry once the

aqueous coating is applied and dried.

How can you avoid problems in this area?

- ❑ Use ink with a mid-level VOC range. We recommend no more than 15%

- ❑ Run inks that have good, strong pigment concentrations so that a thin ink film thickness is printed.

- ❑ Know the ink absorption rate of the paper or board being printed, since some of the solvent will penetrate the paper's surface. The more absorbent the paper or board, the less solvent retained in the ink film.

- ❑ On a heavy coverage job apply the aqueous coating off-line, to give the ink time to dry prior to coating.

- ❑ Place additional air knives or predrying units on press prior to the coater station, to evaporate as much solvent from the printed ink film as possible.

- ❑ Avoid running an aqueous primer coating before UV coating by using wax-free, solvent-free, oxidative inks inks.

In printing, each time you gain knowledge about the materials you use, you decrease the probability of having a failed job in your pressroom. Know your raw materials. And educate your press crews.