JOULES ANGSTROM

U.V. PRINTING INKS

FADE RESISTANCE OF INKS: SOME THINGS TO CONSIDER

Why do inks fade? The reason this occurs is because the UV components of sunlight and interior lighting eventually degrade pigments and cause them to lose their color.

We often get asked to certify our inks to a specific period of “lightfastness”. It goes something like this:

“Do your inks have one year lightfastness?”

This is a simple question with a very complex answer. Here are the reasons why:

First of all, nothing is lightfast. The term “lightfast” indicates that the product will not fade with light exposure, and frankly, there is nothing known that will not undergo some change when exposed to light. A more descriptive term is “fade resistant”.

Knowing this, the definition of what constitutes acceptable fade resistance needs to be determined and communicated to us. The reason for this is because what I might consider acceptable might be a failure in someone else’s eyes. The degree of acceptable fade resistance has to be specified. If your customer is asking YOU for prints that have “one year lightfastness”, ask them in return: “How do you define that?”

So, to modify the question above, a more meaningful way to ask the question would be:

“Can you certify that your process inks will fade no more than 3 delta E units in one year?”

However, this is still a problematic question. It does get specific about the inks being used and about the degree of acceptable fade, but……

……..note that without actually doing fade resistance testing under the proper exposure conditions for the entire length of the period of interest, printed on the substrate of interest -- it is impossible to guarantee a certain fade resistance for that period. The reason for this is that fade resistance is based on a number of parameters. The most important one is: most folks can’t afford to wait a year to see if the printed job will fade. So abbreviated/accelerated testing (in a Fadeometer or QUV device, typically) must be done - in which the prints are exposed to very concentrated UV illumination over a shorter period of time.

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And abbreviated/accelerated tests can only be an approximation of actual exposure. Look at how specific this approximation is:

LIGHTFASTNESS STANDARDS
AT
SEA LEVEL IN WASHINGTON, D.C.

TIME IN THE FADEOMETER	EQUALS	JUNE JULY AUGUST	APRIL MAY SEPTEMBER	MARCH OCTOBER NOVEMBER	JANUARY FEBRUARY DECEMBER
1 Hour	=	½ Day *	1 Day *	2 Days *	4 Days *
6 Hours	=	3 Days	6 Days	12 Days	24 Days
24 Hours	=	12 Days	24 Days	48 Days	96 Days
48 Hours	=	24 Days	48 Days	96 Days	192 Days
96 Hours	=	48 Days	96 Days	192 Days	384 Days
192 Hours	=	86 Days	172 Days	344 Days	688 Days

* A "Day" (in every category) is considered to be from 9:00 am to 3:00 pm – or six (6) hours of sunlight

When I note that this is "specific", I mean that the condition of sea level in Washington, DC is accounted for. How does one translate this into high altitude performance west of Denver? Or to the arid climate of Phoenix? That is not clear. Different geographic latitudes are going to demonstrate different UV intensities, so Washington, DC ≠ Phoenix, AZ. And different UV intensities are experienced during the year, due to the angle and duration of sunlight changing as the seasons change. Also very specific is the fact that a day is defined as the six hour period of sunlight from 9 am – 3 pm.

This makes the point that the degree of exposure to sunlight is crucial (stickers in windshields in AZ, for example, are going to fade at a higher rate than those in Seattle due to higher intensity and longer period of sun exposure).

So, realistically, in order to get a fully relevant answer, the above question to us needs to be modified even further to account for this:

“Can you certify that your process inks will fade no more than 3 delta E units in the Washington, DC equivalent of one year in a Fadeometer?”

(Of course, the difficulty of translating your customers’ requirements into a question that is as specific as the one posed above is understood! The point here is to stress how crucial the need for SOME definition is in being able to fulfill fade resistance requirements. The better and more specific the definition, the better will be the understanding of the actual ink and product performance in the application.)

Now, given some additional supporting data about the test conditions, and maybe some actual printed sample supplied for the testing – one could be in a position to certify to this *on the specific job being printed*! The reason we’d get the most accurate answer by using the printed job to do the testing is due to the next three variables below:

1. The film thickness of the inks applied to the substrate – thinner applied ink films are going to fade more quickly.

2. Influence of any topcoats also used – this is very important. You can apply a clear UV cured topcoat on our inks if you need extreme fade resistance. This special topcoat has materials in it that will filter out UV and lessen the degree to which it can affect the inks underneath. It’s like “sunscreen” for inks. Ask us about this product if you are looking to improve fade resistance beyond that which is offered by our L/F series inks. Again, use of this specialty topcoat will *improve* the fade resistance characteristics of the inks underneath. However, there is no way to determine that it will give you a *certain* period of additional fade resistance in the specific application.

3. Interaction between the substrate and the ink – one thing that comes to mind here is that the more reflective the substrate, the bigger the UV “hit” the pigments in the ink are going to take in a given period of time. The reason for this is that if some unabsorbed UV light makes it to the substrate and is reflected back through the ink film on its way out, the pigments will “see” this illumination again and it will accelerate the degradation of color.

These variables above are not controllable by the ink supplier.

Some additional variables that will affect fading of the printed product in service are:

4. Other environmental factors (humidity, for example, could play a part -- as could air pollution)

5. Whether the printed matter is exposed directly to the outdoors, or is instead in a window, or is indoors with exposure to fluorescent lights only – these are three very distinct conditions which will affect how much UV irradiation the prints receive.

Note that there are standard test methods to test fade resistance of printed materials. One common general test protocol is ASTM D3424-09. When specifying this procedure for testing of prints, one must also indicate which variables have to be included in the testing protocol (they are subparts under this procedure). The variables are items such as: exposure to humidity, cycles of light and dark, print exposed behind glass, print not glass shielded, exposure to UVA + UVB, or exposure only to UVA or only to UVB irradiation. It is very important when quoting results of a particular test to specify which variables were used during the test, because all of these have the potential to affect the results achieved.

One final variable is extremely important and is the only one controllable by the ink manufacturer:

6. The nature of the pigments in the inks themselves

To explain this further, there has been a lot of work done in CMYK pigment development to produce very high performance, high lightfastness pigments (Blue Wool Scale ranking of 7 - 8). The fade resistant inks we supply utilize these products.

These are the same pigments that are often used in automotive paints, which, as you would expect, need to be very fade resistant. Car colors do, indeed, fade – but you do not notice it since you never have a brand new version of your car next to your older one! However, extreme fading would be obvious to the eye even without a reference, and that is what car manufacturers are trying to avoid.

Due to the listed factors over which we have no control, we do not guarantee a specific term or degree of fade resistance - though some of our customers have reported acceptable one year fade resistance with our Polymatrix UV L/F series.

As an internal data point, we tested our Polymatrix Process L/F series in a QUV (340 nm) chamber for 250 and 500 hours with condensation cycles. The prints were not behind glass when exposed (i.e. this is worst case scenario) and were made on 80# coated paper. This type of testing protocol is considered severe service, insofar as the proofs were directly exposed to moisture and light. Printed matter behind glass or indoors under fluorescent light would be expected to experience color change on a much slower scale as a result.

The numbers shown are delta E differences vs the unexposed standard:

	250 hrs, CIE 1994	500 hrs, CIE 1994
K	2.27	3.82
C	4.38	5.26
M	1.91	1.47
Y	1.12	2.46

If you have further questions about this, please contact me for more information:

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