wilflex™
INK CURING TIPS

TIPS & TECHNIQUES

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THE INK CURING PROCESS AND BENEFITS OF LOW CURE INKS

Under-cured ink is a common problem found in screen printing shops today. The contributing factors are many, and the consequences can be severe. Understanding both the science and process of curing ink and how to test decorated garments for proper ink cure is important for every print shop.

SCIENCE OF CURE

There are typically three different types of cure equipment that are used in the textile screen printing industry: flash, electric ovens, and gas ovens, using three different heat transfer mechanisms: conduction, convection, and radiation.

Here we will look at the most popular, a gas conveyer oven, as an example to explain why both time and temperature are important to fully cure plastisol inks.

Curing plastisol inks is similar to baking cakes. Ovens are heated by gas and the air flows to conduct the heat to the ink (cakes) and the fabric (pan). In the heating/curing process, heat transfers to the ink by convection from the air but the heat is also transferred by conduction. Heat conduction comes from two sources: the adjacent ink (outer layer of cake) and the fabric.

Conduction is the reason to keep in mind that time is as important as the temperature setting. No matter how high a temperature your oven setting is, you still need time for the heat to be transferred to the middle of the ink. In baking, a pan is usually a good heat conductor, but for ink curing, the fabric is not a heat conductor but a heat sink. Fiber content and thickness as well as the amount of moisture in the fabric are all variables in determining the amount of heat sink. For example, moisture needs to be removed from the fabric before the fabric begins to heat up.

Heat does not reach inks that are printed into the fabric or the ink layers closest to the fabric as quickly as heat reaching the ink surface. However, all these ink layers are critical to your print quality. The surface ink layer could give you good crock while the inner layer ink gives stretchiness and wash durability. The diagram below shows the different temperature gradients of the ink layers.

PROCESS OF CURING

IMPORTANCE OF OVEN PROFILING

The fabric type, fabric color, fabric thickness, and ink deposit (thin vs. thick deposit) all play into different temperature profiles through the oven. Cotton shirts heat up slower than polyester, and a double sided polyester basketball jersey heats up slower than a light weight polyester shirt.

Understanding the rates at which ink heats up on different garments will help you manage your oven settings and belt speeds.

Check the ink temperature in your dryer religiously. It is important to keep records of mapped dryer temperatures at various times of the day, at different times of the year and during changing weather periods. It is also a good idea to check the cure at the beginning of each print run. It is highly recommended that you check ink film temperature when you are trying new types of inks, and new print parameters like high density or metallic printing. Use a graph to map the ink temperature to your specific process, oven settings, ink deposit, and garment type.

HOW DO I MEASURE OVEN TEMPERATURES?

Maintaining a consistent temperature inside the dryer is a challenge given the variables of ambient air temperature, humidity, uncalibrated equipment, changing belt speeds, fabrics, variable ink thicknesses and specialty products like metallics. Gaining control over cure temperatures requires the daily use of a thermoprobe for each production run. Please see our How to Use a Thermoprobe document for further information.

IS IT BETTER TO RUN YOUR OVEN FAST AND HOT, OR SLOW AND COOL?

It depends. Obtaining more shirts per hour with a faster belt speed is good but comes at a risk of damaging your fabric (scorching), shrinking, dye migration, and wasted energy. It does not make sense to set your belt speed too fast (and hence your oven set point too hot) that you can't keep the conveyor belt full of shirts from the print press. Slow your belt speed to match the rate at which you are printing your shirts. Anything faster is just wasting energy and increasing your risk of fabric distortion and dye migration.

MOST OF YOUR MONEY GOES RIGHT UP THE STACK IN THE CURE OVEN

Cure ovens are expensive to operate with the amount of gas or electricity needed for the oven interior to heat up and stay hot throughout the day. As shirts go through the oven, not only the shirts and ink are heating up but the air around the shirts also heats up which consumes energy. A typical 10 foot gas fired oven has an 1800 cfm (cubic feet per minute) exhaust fan, which means it is exhausting nearly 7,000 pounds of air per hour. In a fast production shop an oven will crank out 600–800 shirts per hour and with a shirt plus ink weighing about 6 ounces, this is only about 200–300 pounds per hour. Granted it takes less energy to heat up a pound of air than a pound of fabric made of cotton, but even taking that into consideration, it takes much more energy to heat up this amount of air.

For every 30 degrees you lower the oven set point you can save about 10% on gas per oven.

DWELL TIMES

Dwell time is defined as the time the shirt is in the oven chamber and exposed to heat. When figuring your oven dwell time it is important to only include the oven chamber section and exclude other sections such as cool down areas. Curing is a time and temperature process. Just like baking a cake, the thicker the cake the longer dwell time it needs in the oven to assure the middle is cooked. It is important not only to reach the recommended ink cure temperature but to maintain the ink at that temperature for a period of time. Ink films are normally thin and will cure all the way through in a manner of seconds. Maintaining the cure

ink temperature for at least 3–5 seconds is therefore recommended but of course, heavier ink deposits require longer time.

Typically a 60 second oven dwell time is adequate to ensure the ink is properly cured. Longer dwell times are OK but may not be necessary to reach the recommended ink cure temperature range. Shorter than 30 second dwell times are not recommended as this typically leads to excessive oven set points with steep temperature curves in order to just hit the ink cure temperature requirement. Oven processes can vary greatly; it is the printer's responsibility to determine the proper dwell time to reach the ink cure requirements.

DON'T FORGET THE TEMPERATURE OF YOUR FLASH UNITS

Over flashing or excessive temperatures during the flash process can be detrimental to fabric integrity, cause scorching defects, dye migration or poor inter-coat adhesion of your inks. Most of the Wilflex inks flash between 200°F–225°F (93°C–107°C) ink temperature for 2–5 seconds You only want to flash the ink until it is tack-free or nearly tack-free to the touch. Excessive flash times and flash temperatures can actually leave the inks tacky as the excess heat is re-melting the inks. Instead of turning up the heat to try and correct, turn down to get the tack-free surface you need.

NOT ALL FABRIC DYES ARE THE SAME

When it comes to controlling dye migration; the lower the temperature the better. Dye migration is not always predictable, but you do stand a better chance of controlling more dye migration by using the correct inks and lower temperatures in your decorating process. The types of dyes, the color of the dyes, the fabric type, the process used when dying the fabric, etc. are all variables to consider if you see dye migration during or after the decorating process.

We have all seen fabrics which are "bad bleeders". The most reliable method for controlling bad bleeders is to use an ink with bleed blocking capability as a first down that will absorb migrating dyes before they get to subsequent layers of ink and cause discoloration. An alternative is to use a quality low bleed white ink designed with bleed resistance capabilities. Low bleed white inks are different from blocking inks, they are designed to resist dye migration and are not always strong enough to block all of the worst migrating dyes. But using a low-bleed white ink in combination with lower cure process can tip the edge from a bad bleeder needing a blocker to only needing a low bleed white.

260°F (127°C)

290°F (143°C)

Here is an example of a white ink cured at different temperatures with a difference in bleed resistance.

The reason for this difference is that dyes migrate at different temperatures and using a low cure ink means you will resist more dyes.

Sublimation dyes are typically one of the worst culprits in the market today for dye migration. It is best to use a blocker when decorating a sublimated dyed fabric.

CHECKING FOR CURE

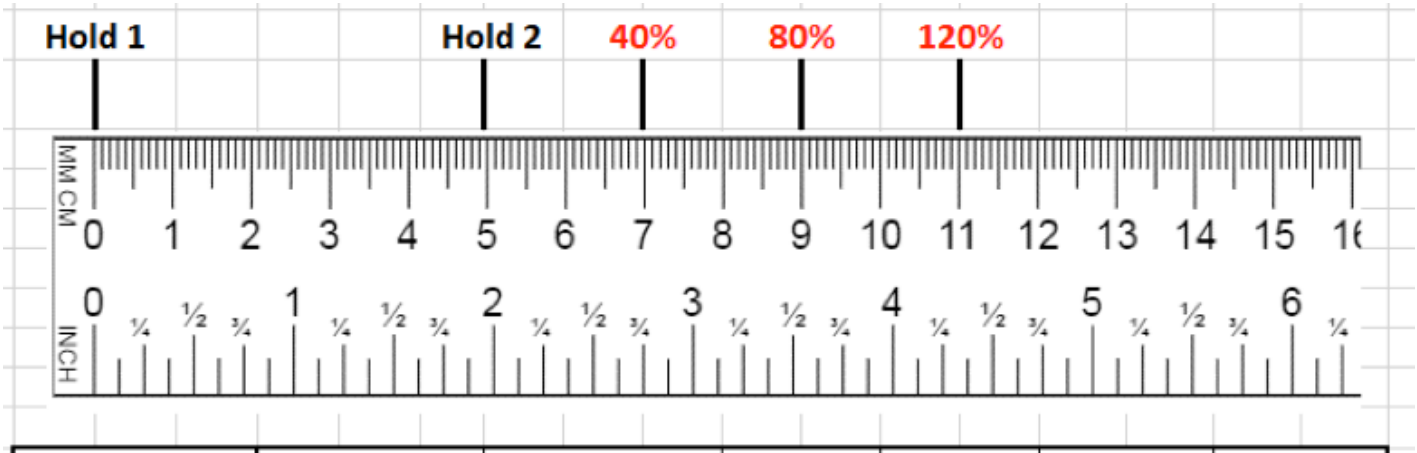
There are 3 basic ways to determine if a print is fully cured: stretch, crock/rub and wash.

Stretch test: The easiest way to test whether a print is fully cured is the stretch test. The test can be easily conducted during the printing process at the end of the dryer as part of quality control. To perform this test, you need to find out: a) What is the elasticity of the fabric? For example, 100% polyester jersey that has no elasticity is not suitable for this test as cure determination. And if your 100% ring-spun cotton has elongation at 40%, you will only be able to stretch the print up to 40%. And b) What is the inherent elasticity of the ink? Each ink is designed differently by manufacturers, some inks might focus on durability and toughness, and some might focus on softness and elongation. This information can be provided by the ink manufacturer.

The stretch test is quick and easy. After oven curing, wait for the print to cool down to room temperature. You may simply use a ruler, or refer to Figure 1 on the next page for the test. Find a print area that is 5 cm long, hold the fabric against the ruler, stretch it slowly until you see a crack on the image, record this number as your print's elongation.

As we mentioned before, different types of fabrics, fabric density and ink deposits will require a variation in the oven setting to allow the ink to achieve its cure temperature. You could also use Figure 1 on the next page to determine the best oven settings for the job.

Figure 1 Stretch test: determination of print performance and reasonable oven setting



	Oven temp (oF)	Dwell time (sec)	Test 1	Test 2	Test 3	Result
Fabric only						
Print 1						
Print 2						
Print 3						

CROCK/RUB TEST

The Colorfastness to Crocking Test (AATCC Test Method 8-2007) is a widely used criterion for assessing the quality of a plastisol ink. Typically, a colored test specimen is rubbed with a white crock test cloth under controlled conditions. Then, the color transferred to the white test cloth is assessed using the AATCC 9 Step Chromatic Transference Scale or Gray Scale (ISO International standard 105/A03), and a grade is assigned. Most countries and major brands require the crock dry at a scale of 4.0 and wet pass at a scale of 3.0.

As the crock test is simulating inks' resistant to rub, some print shops use a white cloth to manually rub the print a couple of times. This could be used as an early indication, but we highly recommend to test crock using standardized equipment. Standard equipment factors in weight control and will give you more meaningful results. The limitation of crock tests is that the results depend highly on color strength; lighter colors will show better results since they are not as visible and as a result, white inks should not be assessed by this test.

AATCC Gray Scale for evaluating staining

WASH

Wash durability test is a widely accepted test method as part of general garment qualification. The test will give you the most definitive assessment as to whether your prints are fully cured or not.

According to brand or country requirements, types of garments and types of prints (specialty inks), you may test garments using different types of washers and dryers, different temperatures, different cycle lengths and even different cycle numbers. You should contact your customers for their requirements, but in general, polyesters and specialty designs should be washed at 104°F (40°C), while cottons should be washed at 140°F (60°C), and each should undergo 5 wash and dry cycles.

To correctly perform the wash test, be sure to keep a print as quality control. If you don't have multiple prints, you may cut the print in half, using half as standard and the other half for testing. Make sure you have enough garments to act as ballast and to give enough rub during the wash. And after each drying process, wait for the print to cool down to room temperature before sending them to the washer again.

Print image cracking, prints sticking together in the washer/dryer, color changes after washing and any dramatic change of elongation are all signs the prints were under cured.

The most obvious failure will be print cracks and most of the time you will see these after 1 wash and usually start of the area where the print folds. The cracks will get more severe as wash cycles continue.

The least obvious failure is color change and this is why you need to keep a print or a half print for comparison purposes. In this case you will perform a color change assessment by using the same scale we have mentioned above and you should record the color contrast between your original garment and the washed one. Most countries and brands require color change to score better than 4 on the scale.

If you are printing stretch garments, stretchiness should be tested again after washing. Prints will always show a reduction of stretchiness after washing, but a dramatic reduction of print elongation is a good sign for and under cured garment. Remember you should only perform the post-wash stretch test after your final wash.

As you can see, the wash test is the most time consuming test of all but is also the most definitive test and is a requirement from most countries and brands.

HOW DO I SWITCH TO LOW CURE INKS?

Now that you understand the benefits of low cure inks and the best practices for minimizing heat on the garment, the question is how to get started? Many shops have been printing for years with inks that cure at 320°F (160°C) and have inventory of these high temperature inks.

One way to get started is to introduce low cure inks in combination with an underbase gray or black bleed blocker on your polyester fabrics and cure everything at 320°F (160°C). Since the blocker will act as a defense to dye migration at higher temperatures you could work down inventories of the high temperature inks using the blocker and then switch to full low cure ink systems by lowering your oven set points.

Another approach is to use your 320°F (160°C) inks on jobs that don't have bleeding issues such as cotton, and use the low cure inks for blends and polyesters where bleeding is a concern. This will require separating your ink inventories and changing oven settings depending on fabrics and inks used.

Wilflex offers a portfolio of low cure plasistol inks. Please see you local distributor for details.

Oven processes and fabric types vary greatly and printers are responsible of assuring proper ink cure on their production equipment and customer's garments. Having the knowledge and tools to properly cure ink and understanding the importance of protecting your garments during the cure process gives printers the confidence to deliver a quality decorated piece to their customers.

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