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SPECIAL REPORT ON NONSTICK COATINGS AND HOUSEWARES FOR RETAILERS

Keeping Nonstick Coatings Honest: Whitford's Testing Equipment And Methodology

The application of nonstick coatings is not exactly cutting-edge technology. Yet it is remarkable how many mistakes can be (and are) made in the process.

When a problem occurs, it almost always manifests itself in the finished coating: blisters in the surface, coating peeling or flaking off, variations in color of the coating, low gloss, tiny bubbles (called "fish eyes"), nubbly appearance ("orange peel"), etc. This inevitably leads to the conclusion, "There is something wrong with the coating!" This, to the customer, means there's something wrong with the product, too.

Yet, with remarkably few exceptions, the problem is not the coating. It's the way in which the coating was applied.

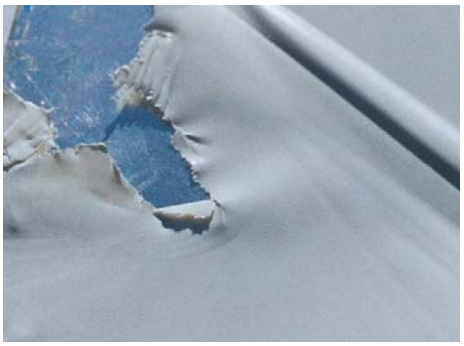
That's why Whitford Worldwide established the Quality Cooperative Program ("QCP"), which was discussed in depth in the previous issue of CoatingWorld.

The primary purpose of Whitford's QCP is to *achieve and maintain the highest quality possible by preventing problems from occurring before your product hits the selling floor*.

The QCP establishes certain quality standards that must be met by those who apply Whitford coatings. It also delineates three specific testing procedures that must be carried out on random samples of all coated products to make sure these high application standards are maintained.

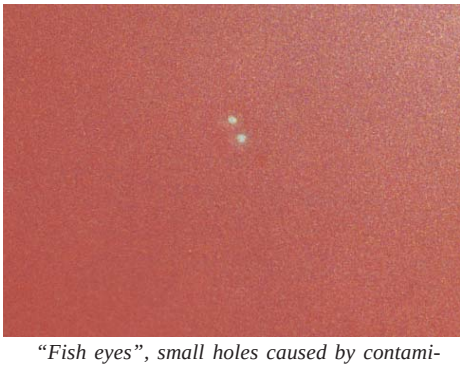
Avoiding failure and costly returns

Whitford performs more than 100 different tests to measure characteristics that include film thickness, completeness of film cure, gloss, opacity, hardness, adhesion, flexibility, impact, drawability, abrasion, mar resistance, etc. (Note: Even if you are *not* a member of the QCP, Whitford can still help [see page 4]. We can verify the tests you run, help interpret the results you obtain, talk with the quality team that runs your tests, offer them test methods, even test equipment.)



A severe case of coating failure due to improper cure time and temperature.

"Mud-cracking" caused by the application of too much coating.



"Fish eyes", small holes caused by contaminants (such as fingerprints) on the surface.

The most frequent problems occur because of three reasons:

• **Poor application:** This generally shows up as coating that does not adhere properly — peeling, flaking or scraping off easily.

• **Improper amount of coating applied:** The thickness of the final film has a lot to do with the durability of a coating. Some applicators cut corners by applying less than what is specified. Some put too much.

• **Improper cure:** A coating that is not cured ("baked") for enough time at the right temperature (or is cured for too much time) will not perform up to expectations.

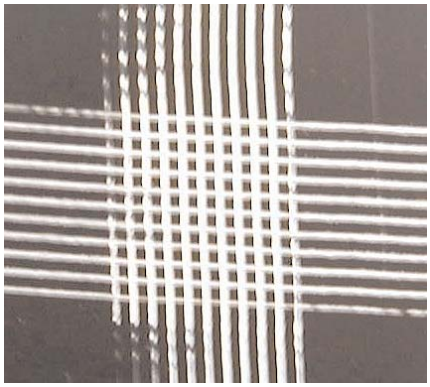
Here are some of the basic testing procedures called for by the QCP that identify problems such as these at the earliest possible stage:

1. Crosshatch and Boil Test (Whitford Test Method 132D): This procedure determines whether proper adhesion has been achieved, not only to the substrate but between coats.

Eleven parallel lines are scribed into the coated surface by a cutting

tool, all a millimeter/.040" or so apart. The surface is rotated 90 degrees, and eleven more parallel lines are cut into the surface, at right angles to the first eleven. These cuts must penetrate the coating, reaching the substrate beneath it. The result is a series of small squares of coating isolated from one another by the cuts.

Once scribed, the test piece is cleaned by brushing away any flakes or ribbons of coating removed by the cutting. Then the pan is immersed in boiling water for fifteen minutes (to heat the coating to cooking temperatures, at which peeling or flaking is more likely to occur).



Whitford Test Method 132D employs a scribed "crosshatch" to test the adhesion of the coating to the substrate.

Then, a six-inch piece of 3M Scotch Brand® #897 Strapping Tape is cut, applied over the scribed area and pressed hard to assure a complete bond. The tape is pulled quickly away from the coating at an angle of 180 degrees. Then the tape is replaced and the process is repeated four times.

A magnifying glass is used to inspect the scribed area to determine the amount of coating remaining in percentage terms. 100 percent means no coating has been removed by the tape, 50 percent means half the coating has been removed, etc. Whitford's definition of "pass" is 100 percent.

2. Film Thickness Test (Whitford Test Method 114A): While all nonstick coatings are "thin-film" coatings, there can be surprising variations in the thickness. Too little is just as problematic as too much.

Whitford's Test Method 114A (dry-film-thickness test) is fast and reliable, but does require having the right electronic equipment.

Too little coating leads to rapid wear of the nonstick. Too much coating can cause "mud-cracking" (much the same effect that occurs when a lake bed dries out and the mud separates, showing deep cracks). This leads to wear and occasional failure of the nonstick, since the cracks are easily penetrated by foodstuffs.

In this procedure, Whitford measures the dry-film thickness of a coating using a magnetic induction or eddy-current electronic gauge.

The instrument is calibrated to zero over the bare substrate of the item being tested (a small portion of the nonstick is removed to permit calibration on the same pan on which the thickness of the nonstick is to be measured), or the uncoated bottom is used.

Three to six measurements of coating thickness over an area of five inches square are taken, then averaged. The result is compared to the dry-film thickness specified in the application instructions (every Whitford coating is delivered to applicators with detailed specifications on how to apply the coating correctly).

On rare occasions, Whitford has found that a few applicators try to cut corners by applying the coating in a thinner film than what is specified. Were this to happen with a member of the QCP, the member would be notified immediately and told to remedy the situation (or be removed from the QCP Approved Applicators List).

3. Completeness of Cure Test (Whitford Test Method 115A): Nonstick coatings, because of their inherent characteristics, must be cured (baked) at high temperatures for a specific amount of time in order to achieve maximum performance. Both the time and temperature of the cure vary according to the coating.

In essence, it's the same principle as cooking food. Undercooked, the coating does not achieve the desired consistency. Overcooked, the coating can begin to degrade. Both reduce the performance of the coating.

This test, used primarily on one-coat nonsticks, verifies the cure by measuring the resistance of the coating to a specific solvent (methyl ethyl ketone, or "MEK").

Whitford uses a cheesecloth mesh of double thickness, which is wrapped around the index finger, then immersed in the solvent. The finger then

rubs the cloth over the coated surface in a straight line of three inches, back and forth, with moderate pressure. The rate is 100 double rubs (back and forth) per minute. Some discoloration of the cheesecloth is to be expected.

The rubs are counted until either the coating is penetrated or the required number of rubs is reached.

Whitford has tested all of its coatings by this method and each has a specific number of double rubs it must withstand. This information is provided to all applicators who purchase Whitford coatings.

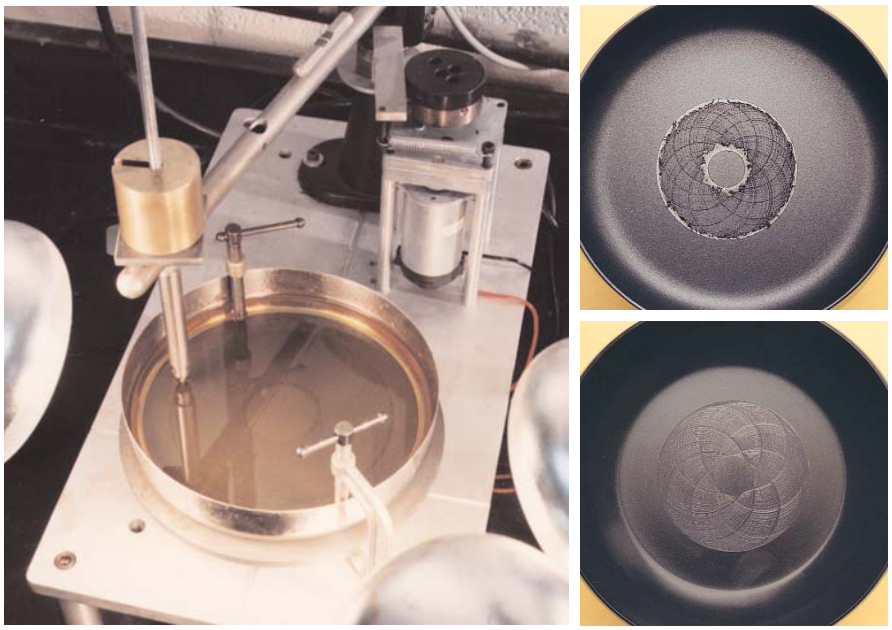
The Quality Cooperative Program doesn't stop here

If the samples you send pass the three basic QCP quality tests, you will receive a written report confirming the positive results. If there is a problem that requires attention, you will receive a technical report indicating what is wrong and what should be done to correct the problem.

Should these tests indicate a more complicated problem, Whitford would inform you of the situation and then subject the samples to one or more additional quality tests to define the problem and recommend a specific solution.

Of course, Whitford would be happy to work with your manufacturer (or coating applicator) to make sure that the proper course of action is communicated clearly and that any questions are answered.

With Whitford facilities in ten countries and a worldwide network of technicians, we are in a position to provide help wherever you (or your suppliers) may be.



Whitford's Gyrograph and the sophisticated results it can provide. In the upper right is a coating after 30 minutes whose poor intercoat adhesion reveals improper curing. The pan at bottom right shows the coating intact (good intercoat adhesion) after one full hour of wear under the Gyrograph.

Other tests and what they reveal

Years of experience in research and development have led Whitford technicians to develop certain test procedures and even design special test equipment to be able to determine characteristics which, previously, were not testable.

4. The Gyrograph Test (Whitford Test Method 137A): This test provides a highly sensitive measure of adhesion, particularly inter-coat adhesion (multi-coat systems).

Cookware coatings are frequently subjected to abuse by scratching and cutting inside the cookware with metal utensils. Ordinary test equipment can measure this, but tests take a long time, are difficult to control (because they are done manually) and are not easily reproducible.

Whitford's Gyrograph inflicts the same kind of abuse, but in a way that is fast, objective and reproducible.

A weighted ball-point-pen tip fixed to a balance arm is placed on the coated surface, which is revolving on a turntable. The balance arm also oscillates from side to side. By adjusting the speed of the turntable and the length of the oscillation, various scratch patterns can be obtained.

To further simulate real-life conditions, the pan is covered with oil and heated via infra-red lamps to 300˚F (150˚C). Each revolution of the turntable is recorded.

This procedure has led to highly sensitive readings previously unattainable, especially on inter-coat adhesion (how well two coats of nonstick bind together in a multicoat system).

5. The Knife Cut and Scrape Test (Whitford Test Method 137E): This simulates the cutting and scraping action of metal utensils, particularly spatulas, on a nonstick surface. It measures the resistance to slicing through the coatings as well as resistance to sideways scraping of a blade.

The pan is positioned onto the center of a turntable that rotates. An industry-standard Q-Panel is locked into place under an arm weighted with

Whitford's Knife Cut and Scrape Test: a fast, reliable way to measure the wear resistance of a coating.

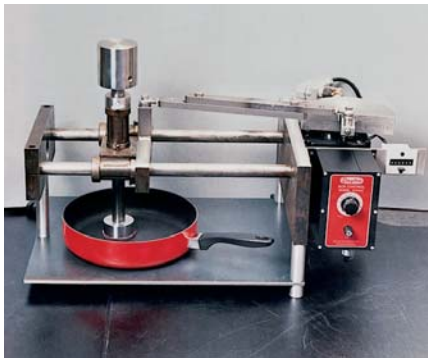
900 grams to simulate a knife. The turntable revolves at a speed of 15 rpm and the fixture arm oscillates at 21 rpm.

The blade is set gently onto the nonstick surface of the test piece and the test is begun. The test is run for two hours or until 10 percent of the area being abraded shows through to the substrate.

6. The Reciprocating Abrasion Test (Whitford Test Method 135C): This test is designed to measure the ability of a nonstick coating to withstand the abrasion created by scouring and similar forms of damage associated with cleaning pots and pans. The test apparatus was designed by Whitford technicians, but is applicable to similar test methods such as BS 7069-1988.

The test machine moves a weighted stylus in a straight line forward and backward over the coated surface. Fixed to the bottom of the stylus is a standard Scotch-Brite® abrasive pad, the exact size of the bottom of the stylus. Pads are changed every 1,000 cycles. The test apparatus has a counter to measure the number of cycles.

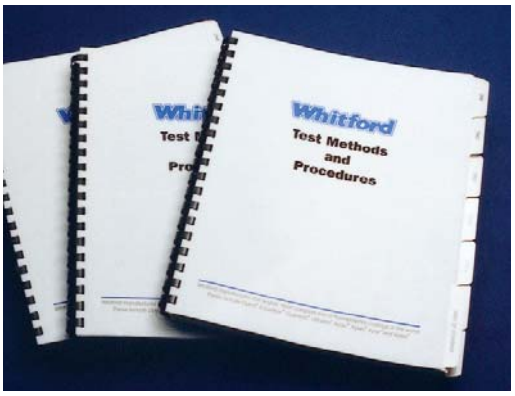
Whitford ends the test once 10 percent of the substrate is abraded by the pad, at which point the number of cycles is recorded for comparison.



The Reciprocating Abrasion Test replicates marring from scouring, stirring spoons, etc.

Comparing results

There are specific test results that every Whitford coating must meet and, when a coating tested does not measure up to specification, Whitford technicians can usually tell why. This information is passed on to customers and, if they request, to their suppliers.



Testing for quality is a way of life at Whitford. There is a manual which lists the test procedures and describes in precise detail how to execute them. For a free copy, contact Whitford (see address below).

Would you like to join?

If you'd like to join the QCP — and take advantage of Whitford's free testing program — please fill out the form that is included with this issue of CoatingWorld and return it to Whitford. We'll send you a membership kit and full instructions on how to arrange to send samples for testing. Of course, if there are any questions, please feel free to contact us at the address listed below.

We're here to help, whether you join the QCP or not. If you'd like to visit our headquarters in Pennsylvania (near Philadelphia), we'd be delighted to have you. Just let us know when.

Frequently Asked Questions

Question: *"What's the best way to clean off food that's been burned onto my nonstick frypan?"*

Answer: *"In most cases, you can remove the burned-on food by soaking the nonstick pan in hot, soapy water. Then wash the pan as usual. If this doesn't work, soak the pan again for a longer period, changing the hot, soapy water periodically. If this fails, try a good coffee cleaner (such as Dip It, sold in the USA) and follow the manufacturer's instructions."*

Send questions with your name, address (or email) to: Fran Attilio, Whitford Corp., Box 2347, West Chester, PA 19380-0110, or email: fattilio@whitfordww.com.

Coming in future issues:

- The " Simplified Guide to Nonstick Cookware" explained and offered free!
- How nonstick coatings are applied and how application methods affect the nonstick coatings.

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