Proper Dyne Testing: How, Why, and When To Perform

An Overview of Dyne Testing Methods, Surface Tension Measurement, and Corona Treating
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INTRODUCTION

The ability of a substrate to adhere inks, coatings, or adhesives is directly related to its surface energy. If the substrate surface energy does not significantly exceed the surface tension of the fluid which is to cover it, wetting will be impeded and a poor bond will result. In a dyne test, wetting tension liquids are spread over a film surface to determine printability, coating laydown, and heat sealability of treated films. Solutions of increasing wetting tensions are applied to the polymer film until a solution is found that just wets the polymer surface.

The term "surface energy," or wetting, is normally used to describe the reactivity of the surface of a solid substrate, while "surface tension" is used in reference to a liquid. Frequently, the two terms are used interchangeably, since both refer to the same force at which molecules at the surface of the substrate ultimately cling to one another.

The phenomenon of surface energy is based on the relative energies of the solid substrate and the liquid in contact with it. For converters of plastic films, knowing the surface energy of a polymer surface is critical in assuring good coating and print quality, as well as the adhesion of laminated films - particularly with the growing popularity of water-based inks, coatings, and adhesives.

The surface energy of a solid polymer cannot be measured directly because solids typically show no reaction to the exertion of surface energy. Consequently, practical measurements of surface energy involve the interaction of the solid with a test liquid to determine wetting tension as a measure of surface energy.

The surface energy of a film should be between 3 dynes/cm and 10 dynes/cm greater than the surface tension of the ink in order to ensure acceptable performance. Thus, even pretreated films should be checked before use to make sure proper dyne energy is present.

Surface tension is expressed in units of force per unit of width, similar to web tension. However, since surface tension forces are so much smaller, it is more convenient to express them in dynes per centimeter, rather than pounds per inch. Hence, the act of measuring surface energy, or tension, is typically known as a "dyne test."

DYNE TESTING OPTIONS

Cotton-swab applicators (part #N001-007), solution-tipped "dyne pens" (part #N001-002), or full-etch drawdown rods (part #N008-005) are typically used to smoothly apply wetting solutions across polymer surfaces. The generally accepted solution to verify dyne levels or surface energy is a mixture of Ethyl Cellosolve and Formamide. This solution contains a dye to make it easier to see. When using these wetting tension solutions, all safety precautions as listed on the labels should be observed, as there are specific hazards associated with using them. These solutions also have an average shelf life of only six months, so they should be properly dated at time of use and replaced when the expiration date has been reached. If this isn't done, false dyne information could result, along with a rejection of printed material by the customer.
The three methods that are generally used to check the surface energy of a substrate (cotton-swab applicators, dyne-pens, and drawdown rods) are detailed here:

**Cotton Swab Applicator method:** Dyne solutions of various levels (part #N001-011) are placed on the substrate until a solution is found that only wets the surface of the film. The tip of the applicator (part #N001-007) is dipped in the test solution from a calibrated dyne-level solution stock container. The solution is spread lightly over approximately one square inch of the test material. A minimum amount of solution should be used because an excess can distort readings.

If the wetting solution stays intact (doesn't break into droplets) for two seconds, the treat level is at least as high as the dyne level recorded on the bottle of solution. Repeat the procedure until a solution is used that beads up on the surface of the material being tested. The film treat level would then be identified as the last solution tested that remains wetted out on the surface. A clean cotton applicator must be used for each test repeated to avoid contamination of the different solutions and possible distortion of results. Do not repeat the test in the same area of the film.

This method has been a standard for years but is still somewhat subjective and inconsistent because of the personnel involved in the application of the fluid to the substrate. This procedure should be done in a lab environment because there is always a risk of spilling the contents of the bottles or leaving the used swabs lying around that could lead to skin contact.

The greatest advantage of the cotton swab applicator method is its speed and simplicity. For example, it can be used on the converting room floor to easily identify problems with corona treaters. Though it provides an established procedure for determining surface tension, this method presents several challenges for reliability and consistency of results:

- Care must be taken to limit evaporation of solutions, since it changes concentrations and, consequently, changes dyne level values.

- One problem may be that lab personnel using cotton swabs have a tendency to vary the amount that is picked up by the cotton swab, thus varying the results of the test. Also, the method of rubbing the liquid onto the polyolefin surface with a cotton-tipped applicator varies from person to person. This rubbing also tends to give erratic dyne level results.

**Dyne-pen method:** This is a press-side method that is usually used by the operator to check the treat level of a substrate just prior to print. Pens with built-in applicators (part #N001-002, #N001-001, or #N001-010) are pulled across the entire web in a straight line. The pens have their dyne level listed on them. As the pen is drawn across the web, the operator looks to see that the solid line does not break for two seconds. This method is not highly accurate because of possible contamination of the tip by multiple uses. The advantages are that it is a quick method, shows the operator which side is treated, and checks for the condition known as back-treat. These pens must also be dated when first used, the tip must be sealed immediately after use, and the pens thrown away when the six-month expiration date has been reached.

For most solvent based printing, plastics need to be treated to 36 to 40 dynes/cm; water based inks usually require 40 to 44 dynes/cm; some laminating and coating applications require surface energies of 50 dynes/cm or more. Clearly, surface energy must be assessed before printing, coating, or laminating is attempted.
Dyne pens perform well on most non-absorptive materials. It is critical that the test fluid does not alter the surface properties of the substrate. For example, if the test fluid permeates a fiber substrate (such as paper) and causes swelling, results will indicate unrealistically easy wetting. A chemical reaction between the test fluid and the substrate invalidates results altogether.

**Drawdown Test method:** This is the most accurate of the 3 measurement systems. A substrate sample, usually measuring 8½ x 11 inches, is clamped to a clipboard. At the top, a drop of three different dyne solutions (part #N001-011) that bracket the desired treatment level are placed next to each other. A wire wrapped metering rod (part #N008-005) is then placed just above the droplets and pulled down. Typically, a #5 or #6 rod is used for this test. When a film of liquid breaks within the two-second period the tester knows that the treat level of the film is below that of the dyne solution. This test tends to be more accurate because the metering rod lays the solutions down at the same relative thickness. The rod must be thoroughly cleaned after each use.

**Potential Problems**
- Exposures to extremes in temperature or humidity should be avoided. Standardization of ambient, substrate, and test solution temperature is critical, as is inspection methodology. Have one trainer instruct all testers to minimize variability. Relative humidity should not be excessive; higher RH tends to increase data variability.
- The elapsed time between extrusion or coating to test (or from test to printing, etc.) should be controlled.

It is important to note that while these methods are generally effective for shop floor measurements of dyne levels, they can be subject to contamination and operator influence and therefore may not be 100% accurate. For example, in round-robin testing by the Flexible Packaging Assn., results of measurements of identical materials tested by different labs using dyne liquids varied by as much as 11 to 15 dynes/cm.

In addition, contaminants could affect the test. Possible contaminants could include impurities on the polymer surface itself, or, in the case of dyne pens, on the surface of the pen tip from a previous test. A dyne pen can also become contaminated (and ruined) if it is run over a finger print while testing. Surfactants incorporated with certain polymers to change their characteristics can also change the results. That’s why it is critical that polymer films being tested not be touched or rubbed prior to the test to prevent contamination. Also, a polymer surface that has been unevenly treated will deliver different readings in different test areas, rendering the test useless.

Because of these potential problems, some converters favor the drawdown test method rather than a cotton swab or dyne pen to establish a uniform thickness of wetting tension solution on the polyolefin sample.
Dyne testing has found countless applications throughout industry, in functions as varied as basic research, product development, process control, incoming inspection, finished product dispositioning, sales, and marketing. Typically, it measures the treatment level of polymers which have been exposed to flame or corona surface modification; but many less traditional applications have also been explored.

- Cleaning systems can be monitored by the dyne test. The surface energy of metals is much higher than that of surface contaminants; thus, the higher the dyne level, the cleaner the part is. Always use test fluids to measure cleanliness - even the spring-loaded Liquid Dyne Pens (part #N001-002) will eventually be overwhelmed by repeated exposure to contamination.

- The presence of mold release on many plastic parts can be similarly identified. Again, test fluids are indicated for this application.

- It is often possible to identify patterns of treatment variation on a sample piece by doing a full-size drawdown. Methodical troubleshooting analysis will often lead back to the specific cause. For example, increasing treatment across the roll suggests the treater electrode is misaligned to the roll; periodic variations along the web may relate to non-concentricity.

- An easy test for back-treat on PE or PP is to use a 34 dyne/cm Liquid Dyne Pen. Any wetting - even for less than two seconds - indicates some treatment.
• Polyester film which reads consistently below 42 dynes/cm is almost certainly "print primed." This chemical process actually decreases the surface energy a bit, but makes the surface attractive to a far broader range of compounds used in inks and coatings.

• Whenever feasible, test with supplies, samples, and ambient temperature at 20° to 25°C. If this is impossible, it is advised that a test study be run to relate temperature variations to numerical results. Keep test supplies at ambient temperature at all times.

• Remember that dyne level decay is extremely rapid directly after corona treatment. A virtually immediate loss of 10 dynes/cm is possible! This is due to contact with process rolls (especially heated metal ones), surface blooming of additives, and interfacial transfers between treated and untreated surfaces within the finished, wound roll. If you are a slitter, rewinder, or extruder, either test far downstream in the process, or increase your specification to account for greater losses before your customer tests at incoming inspection.

• Film extruders should test extensively - every roll from every machine without fail. Potential product liability and customer satisfaction losses far exceed the cost of an effective QC program.

• Printers, coaters, and laminators should pull samples and perform the test as soon before the print station (or similar) as possible. It may be worthwhile to dyne test the roll before it goes on the machine, and compare these results to material which has run through the web handling process to the print station. This will indicate the treat loss attributable to process roll contact and web handling.

• Never leave bottles or markers uncapped! Evaporation, water vapor, and airborne contaminants all affect dyne level, and can invalidate them long before expiration.

• Test fluids or markers which have turned green are no longer reliable. The recommended expiration date for dyne pens is 6 months after receipt of the product.
DYNE TESTING PROCEDURE

**Important Safety Notice:** Dyne testing fluids are considered hazardous materials demanding appropriate handling and disposal requirements. Avoid contact with skin. Use with adequate ventilation. Avoid contact with eyes. Pregnant women should not perform this test. For further information, refer to product MSDS.

*For the results of this test to be meaningful, the following four points are absolutely essential and must be followed:*
1. Do not touch or in any way contaminate the surface to be tested. Dirty surfaces lose their wettability.
2. Do not use contaminated or outdated dyne solution.
3. Never retest the same location on a sample; move along the sample, or use a new one.
4. Store and use your dyne testing materials at room temperature.

**Materials/Equipment**
- Dyne Testing materials
- Subject Material
- Clean, Level Test Area
- Thermometer and Hygrometer

**Method**
1. Create a test sample. Be sure to select a good specimen; surface aberrations cause poor results. For extruded film, one entire web cross-section should suffice. Do not touch the surface.
2. Place the sample on a clean, level surface. If necessary, anchor the edges to avoid curling or other deformation.
3. Record ambient temperature and relative humidity. If sample temperature differs from ambient, allow it to stabilize.
4. Test at least three points across the sample; 1/4, 1/2, and 3/4 across the film section. It is good practice to test the outer edges as well. For non-film materials, test locations must be determined in-house.

**Determination of Wetting**
1. Choose a middle of the range dyne level that you have available (38 dynes/cm is advised).
2. Use a light touch to draw the dyne solution across the test sample in two or three parallel passes. Disregard the first pass(es); to flush any contamination from previous testing. In order to ensure that the test fluid layer is thin enough for accurate measurement, evaluate only the last pass.
3. If the ink swath holds for three seconds or more before losing its integrity, repeat step 2 with the next higher dyne level marker. This process should be repeated using dyne levels of increasing values until the solution beads up after approximately 2 seconds of application. If the ink swath beads up, tears apart, or shrinks into a thin line within one second or less, repeat step 2 with the next lower dyne level marker. **If the ink swath wets the surface for approximately 2 seconds and then breaks into beads, the dyne level of the marker closely matches that of the sample.**
This is a relatively accurate surface energy measurement technique; used in standard 2 dyne/cm increments, dyne solutions can generally produce results with a precision of +/- 2.0 dynes/cm. Repeated use this method should enable testers to estimate surface energy to within +/- 1.0 dyne/cm.

Dyne level testing can be subjective. It is not uncommon for individual interpretations to vary beyond the typical accuracy range. To minimize interpretation error, Dyne level testing should be performed in accordance the testing methods described by the American Society of Testing and Materials (ASTM D2578-04a).

To investigate discrepancies between obtained and expected results, a more precise measurement method should be considered; application of either Liquid Dyne Pens (part #N001-002) or Dyne Test Solutions (part #N001-011) with cotton swabs (part #N001-007) or by use of a drawdown rod (part #N008-005) is recommended. Alternatively, if results are suspect, replicate the test with a set of unused markers. The effect of all changeovers from one substrate to another should be monitored especially closely. Slip and other additives tend to bloom to the surface of extruded sheets and films; transferring surface-active additives from one material to another can have a profound effect on surface energy measurement. In general, once you demonstrate that a switch from substrate A to substrate B has no effect, it is safe to assume that future changeovers from A to B will act similarly.
CONTACT ANGLE MEASUREMENT- An Alternative to Dyne Testing

Contact Angle Measurement is the most accurate (and expensive) method for determining the surface energy of a plastic object. It relies on the use of a dynamic contact-angle tester (part #N001-014) with a liquid of known surface tension (distilled water is typically used). The measurement process involves placing a drop of liquid on the substrate to be tested, then measuring certain angles that the bead forms with the substrate's surface. To ensure precise and accurate readings, the unit should measure both advancing and receding contact angles, as well as the static contact angle (some simpler, less accurate testers only measure static contact angle). The resulting angles will equate with the wettability of the substrate's surface.

The emergence of the ASTM-certified method of measuring surface energy, called the Water Contact Angle Test (WCAT) method (ASTM #D5946), offers converters another alternative. The standard is an analytical technique that uses an instrument to measure the contact angle of a water droplet placed on the surface of a film. Unlike dyne tests, the WCAT method also allows for materials outside of the PE and PP "families," such as PET, ethylene vinyl acetate, and colored and holographic materials, to have their surface energies determined.

Against a droplet of liquid placed on the surface of a polyolefin substrate, the gas pressure in the surrounding atmosphere applies a certain force, causing it to have a particular shape as it rests on the surface of the material. Its surface tension and its interaction with the polyolefin surface determine the eventual bond.

The WCAT test method is based on a simple concept: the higher the surface energy of the treated film, the smaller the contact angle of water placed on the surface. Contact angle is determined through direct measurements.

To conduct the contact angle test, a test liquid is applied to the treated surface. When a droplet is placed on a solid substrate, its contact angle has a single value for smooth surfaces. In general, the droplet of any liquid will have an angle of contact determined by the surface energy of the substrate. The higher the surface energy of the solid substrate in relation to the surface tension of the liquid, the smaller the contact angle.

For example, a water droplet on PE, which exhibits a low surface energy, will "stand up" on the material at an angle of greater than 90 deg. The same droplet on a high-energy surface will lay down or cling more closely to the surface, resulting in a contact angle of less than 60 deg.

Factors to Consider

There are two factors to consider regarding the WCAT method of wetting tension: the accuracy of the contact angle measurements and the correlation between the wetting tension plot data and the data generated with dyne solutions.

Generally, the accuracy of contact angle measurements is not limited by the experiment technique but rather by the reproducibility of the surfaces measured. Accurate measurements of a contact angle are simple enough: Accuracy and precision depend on several factors, such as droplet deposition technique, droplet size and consistency, and the presence of electrostatic charges on the sample.
There is the question of how closely wetting tension values obtained using WCAT correlate with the dyne liquid test. In fact, results of both tests on the same substrate rarely offer the same results. Why? One reason is that different test methods give different surface values. Plus, accuracy and precision of the two test methods depend on film type and the presence of additives.

Proponents of the WCAT method point to a number of "advantages" over the more traditional dyne tests: It can test practically any material, can be used for time studies of corona treatment aging, can be used to quantify uniformity of corona treatment, can detect overtreatment, can measure backside treatment, can accurately measure embossed films and does not use toxic materials.

A "goniometer" (part #N001-014), the instrument used to measure the surface energy in the WCAT method, is typically used to directly measure the contact angle of a liquid. Common applications include the analysis of the degree of surface hydrophilicity (i.e. wettability) and hydrophobicity (non-wettability). The unit offers the user the visual appearance of a microscope, but the easy-to-read scales require no adjustments due to magnification problems. Because the instrument is a reflective type, it provides greater accuracy and precision than other measurement instruments, such as the "Optical Comparator."

**Contact Angle vs. Dyne Testing**
The contact angle which a liquid forms on a smooth, homogeneous surface is dependent on the solid's surface energy; higher energy surfaces exhibit a smaller contact angle, and offer better wettability. Contact angle meters work best to test films and flats, as well as curved or cylindrical objects.

Whereas carefully performed dyne tests are generally best advised for production-oriented testing (due to low initial and operating cost, quick turnaround time, adequate precision and replicability, and excellent modeling of the actual interfacial dynamics manifest in most manufacturing operations), the contact angle test is by far preferred for more basic laboratory research. It is ideal for R&D projects which require ultimate precision and replicability.
POLYMER SURFACE TREATMENT

Plastic surfaces have little free energy and are essentially inert. This is most notably true of fluorocarbons, silicones, polyolefins, and vinyls. Unlike high energy materials (such as metals and ceramics), plastics lack the available bond sites offered by charged ions distributed over the surface. Without this molecular attraction, liquids fail to wet the surface, resulting in poor adhesion and coverage. This problem, while universal, is especially troublesome to printers and converters who work with fast-moving webs; in these processes, the free energy (ability to attract a liquid) of the surface must significantly exceed the surface tension (resistance to spreading) of the liquid, or dewetting occurs readily, producing waste. Worst of all, some problems, like on-the-shelf delamination or ink liftoff, cannot be seen until a job is finished and shipped to the customer.

Corona treatment is the commonest choice for converters. A corona treating system can be thought of as a capacitor. High voltage is applied to the electrode. Between the electrode and the ground roll is a dielectric, comprised of the web, air, and an insulator such as silicone or ceramic. The voltage buildup on the electrode ionizes the air in the electrode/web gap, creating the highly energized corona. This excites the air molecules, re-forming them into a variety of free radicals, which then bombard the surface, increasing its polarity by distributing free bond sites across it.

There are two basic treater designs; conventional (dielectric covered roll) and bare-roll (dielectric covered electrode). Only bare-roll systems can be used on conductive webs; conventional systems short out. But, conventional systems are more efficient, and have fewer problems associated with heat build-up on the electrodes. Therefore, they are preferred by film extruders and extrusion coaters. Bare-roll systems are ideal for converters who process various materials, especially foils and plastics which were pre-treated initially. They are well suited to "bump" treating - subjecting the web to treatment immediately prior to printing, coating, laminating, or metallizing. This not only re-energizes the surface, it also removes contaminants or bloomed additives which may have invaded it. Several manufacturers also offer convertible systems, which can be operated in either configuration.

Corona treaters are easy to install and use, can usually be adjusted for varying web widths, produce uniform treatment when operated properly, and are quite cost-effective. But there is a downside: Backtreatment can cause blocking and poor heat-sealing; corona treatment decays rapidly with handling and age, especially in heat and humidity; static buildup can require in-line deionization; attempting to increase surface energy by more than 10-12 dynes/cm is often inadvisable - pinholing, surface degradation, and accelerated treatment decay rate can result from overtreatment. Finally, the process produces ozone, which must be neutralized before release to the atmosphere.

Flame treatment is commonest for molded pieces such as bottles, tubing, and automotive parts. However, it is also widely used to treat films, foils, coated board, and other substrates. Like corona, it induces an ionized airstream, which alters the surface as it impinges upon it. This is accomplished by burning an ultra-lean gas mixture, whose excess oxygen is rendered reactive by the high temperature.

Advantages of flame treatment include freedom from ozone, pinholing, and backtreatment. Also, flame treating can achieve treatment levels above 70 dynes/cm even on polyolefins. Moreover, flame treatment is far more stable than is corona; dyne level decay is much slower. A slight hazing may preclude use on optical grade films and some packaging materials.
Cold plasma treatment is typically run in batch mode, but recent improvements are making it more attractive to producers of high-end specialty substrates. Traditional cold plasma treatment requires a partial vacuum; a selected gas is introduced into an evacuated chamber and ionized by a radio frequency (RF) field. The RF field excites the gas molecules, creating a blend of neutral atoms and reactive radicals formed from free electrons. Three processes occur when these free radicals bombard the surface: ablation ("cleaning" it by removing its outer molecular layer); crosslinking (interconnection of long-chain molecules); and activation (impartation of reactive molecules, which, in an oxygen-rich atmosphere, increases surface energy).

SURFACE TREATMENT FOR THREE-DIMENSIONAL OBJECTS

If you've attempted to print, label, or otherwise decorate a three-dimensional (3-D) product, you've probably been frustrated by an ink or adhesive that refused to adhere to the part's surface. You may have tried different types of ink or adhesive formulations to get the job done, perhaps even used chemical primers or batch-treating processes. Still, the ink refused to bond with the material. What you experienced was low surface energy, making the material repel printing inks and other coating materials.

Contending with low-surface-energy substrates is a frequent concern for screen- and pad-printing businesses that decorate 3-D parts. But it's an obstacle that can be overcome most easily with in-line surface-treatment technology.

Why is Surface Treatment Necessary?

Surface treatment is frequently used in printing and other converting processes to alter the surface characteristics of a material. Treatment processes may be designed to improve a substrate's wetting properties, which influence how well inks and coatings will flow out over the material's surface. Treatments may also be used to enhance the bonding between the substrate and the applied material or eliminate static charges that have accumulated on the substrate surface. Surface-treatment technologies play a key role in preparing the surfaces of many commonly used packaging materials (paper, plastic, foil, etc.) for subsequent processing steps.

Most inks, paints, coatings, and adhesives resist wetting on the surface of virgin-plastic parts, which are newly thermoformed or molded items characterized by an inert, non-porous, low-energy surface. Virgin-plastic parts that screen and pad printers typically work with include items made from polyethylene, polypropylene, and other polyolefins. These materials tend to be very slippery and feel greasy to the touch. Getting coatings to permanently adhere to such materials is unlikely without the intimate contact created through wetting.

Where is In-Line Surface Treatment Useful?

In-line surface treatment of 3-D objects helps enhance product quality and facilitate efficient production in a vast array of applications and industries. The goal of surface treatment is to ensure a durable print or coating that will withstand any conditions or environments that the part might face. These conditions may include exposure to the elements outdoors, regular cleaning with harsh detergents, and extremes in temperature, to name a few. Five of the most common industries or application areas in which in-line surface-treatment systems are used include the following:
**Printing** This segment includes industries and technologies such as screen printing and pad printing. Surface treating parts prior to printing ensures proper and complete ink adhesion and can often make the printing process run more efficiently. Some materials are impossible to print unless they have undergone surface treatment.

**Painting** Painting 3-D parts occurs mainly in the automotive industry. Injection-molded or thermoformed parts are surface treated prior to painting. Surface treatment not only encourages the paint to adhere to the substrate surface, but also increases the life and durability of the paint.

**Coating** Some parts require surface treatment before they'll accept a coating. Doors, frames, extrusions/profiles, and medical devices are examples of such products. The coatings themselves may be used to provide protection from harsh environments, serve as finishes that produce a more decorative appearance, or meet certain industrial standards. The medical industry, for example, requires certain plastic devices to support adhesion of antimicrobial/antibiotic coatings that reduce patient exposure to bacteria.

**Bonding** Surface treatment in bonding applications is generally used to increase adhesive strength between the parts to be joined. In the medical industry, surface treatments are applied to increase the bond strength of needle hubs and other surfaces requiring a dependable joint. The automotive industry uses surface treatments to increase the bond strength of seal housings, panels, side moldings, and trim.

**Labeling** The continual introduction of new plastics and adhesives in the packaging industry forces label producers to use surface treatment to promote label adhesion. Surface treating caps, bottles, and lids ensures that labels will not peel off earlier than desired.

After establishing what surface-energy level you need, treating the substrates to achieve this surface energy, and printing the parts, you should test the finished product to make sure the print will withstand the handling and abuse it might be subjected to in the real world. If you know what conditions the part might face, try to duplicate them. Depending on the application, your tests might include submerging parts in water or other chemicals, exposing them to extremes in temperature, or storing them for extended periods.

Surface energy is critically important to many converting operations. Unfortunately, it is not the sole determinant of product suitability. Other factors, such as surface topography, coating rheology, and chemical incompatibility, must also be considered. This is why broad-based communications with vendors and customers is so important. But at least by systematically measuring substrate surface energy, you will have a sound starting point from which to resolve other problems which may arise.
CON-TROL CURE® FELT TIP DYNE PENS
Measure printability of plastic substrates and other non-porous surfaces with the CON-TROL CURE® Felt Tip Dyne Pens. These chisel-tip markers provide a quick, clean and easy method of testing treatment levels on polymer plastics. The simple application of a dyne pen to the surface or printing side of the tested material will determine its surface tension value, which proves if the wettability of the pen's designated dyne level has been reached. Once surface tension is known, the tested material's printability and adhesion properties may then be quantified. The Felt Tip Dyne Pens are tube color-coded for easy identification. Each set contains 8 pens in standard levels: 30, 32, 34, 36, 38, 40, 42, 44 dynes/cm. 6 month shelf life.

Dyne Test Pens are color-coded for the easy identification of a pen with a specific dyne/cm level. The color coding of the tubes is as follows:

30 dynes/cm    white
32 dynes/cm    orange
34 dynes/cm    light grey
36 dynes/cm    green
38 dynes/cm    red
40 dynes/cm    light blue
42 dynes/cm    dark blue
44 dynes/cm    black

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CON-TROL CURE® LIQUID DYNE PENS
The CON-TROL-CURE® Liquid Dyne Pen's spring-valve tip design keeps the pen's applicator away from the dyne fluid storage to prevent contamination. Press the tip firmly down to open the valve and flood the tip with fresh fluid. Available in sets of 8 pens from 30 to 44 dynes/cm (30, 32, 34, 36, 38, 40, 42, 44) and from 46 to 60 dynes/cm (46, 48, 50, 52, 54, 56, 58, 60). 6 month shelf life.

CON-TROL-CURE® Liquid Dyne Pens are also available by special order at any level from 30-70 dynes/cm. For all orders, there is an 8 pen minimum.

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<td>N001-013</td>
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DYNE PEN TEST SET
This 6 pen magic marker-type pen set quickly and effectively verifies whether a substrate is treated from 36 up to 48 dynes/cm. If the material is properly treated, the applied dyne mark is uniform, resulting in a continuous and homogenous colored line. If the material is insufficiently treated, the line of the dyne test retracts in the form of small globules until the mark nearly disappears. Set includes pens in 6 levels: 36, 38, 40, 42, 44 and 48 dynes/cm. 6 month shelf life.

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DYNE TEST SOLUTIONS
Dyne Test Solutions are another way printers, converters and extruders can determine surface energy levels. Ranging from 30-70 dynes/cm, these solutions offer an easy and effective method of testing. By wetting the tip of a cotton applicator with one of the mixtures and spreading a line over the test specimen, users can verify treatment within 2 seconds. If the continuous line holds for 2 seconds or more, users can be assured that the material is treated to within 1 dyne of that specific solution.

Continuing to test different levels in ascending order will allow the user to ultimately determine the appropriate level of treatment. If the continuous film breaks into droplets in less than 2 seconds, the material is insufficiently treated. Users must continue to test in a descending sequence to determine treatment level. Applicator must be changed after each test.

FEATURES:
• Wide variety of testing levels
• 30-70 dynes/cm
• Applies easily with cotton applicator
• 6 month shelf life
• Sold/100cc bottle

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<tr>
<td>N001-011</td>
<td>DYNE TEST SOLUTIONS</td>
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COTTON APPLICATORS
Avoid contamination of your dyne testers and your test area when performing dyne testing. Use these disposable, highly absorbent 6 inch cotton swabs rather than the pen tip to mark substrates. Available in a box of 1000.

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<td>N001-007</td>
<td>COTTON APPLICATORS</td>
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LABORATORY CORONA TREATER
The Laboratory Corona Treater is designed for research and test laboratories and low volume production work for treating very small parts. This unit changes the surface energy of certain substrates by exposing them to highly charged electrical ions. The two opposing high voltage electrodes create an arc of electrons from one to the other. The electrons change the wettability of the material surface so that the inks, coatings, and adhesives cross-link with the polymer surface. Hence, the inks, coatings, and adhesives adhere properly to the part.

The material being treated is exposed to an electrical discharge, or "corona." Oxygen molecules within the discharge area break into their atomic form and are free to bond to the ends of the molecules in the material being treated, resulting in a chemically activated surface.

Corona treating is a very effective way to increase the surface tension of virtually any material. When properly applied to your substrate, corona treating produces the higher surface dyne levels needed for good adhesion even on the more difficult-to-treat materials like polypropylene and polyethylene. Other common corona treating applications include nylon, vinyl, PVC, PET, metallized surfaces, foils, paper, paperboard stock, and other materials.

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<td>N001-020</td>
<td>LABORATORY CORONA TREATER</td>
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POCKET GONIOMETER

The Pocket Goniometer is a battery operated instrument that measures static contact angle and dynamic surface hysteresis for laboratory and field applications related to gluing, printing and surface-related problems. It is an ideal tool for checking contamination of a specimen and the effects from cleaning and surface treatments.

By placing a liquid droplet on a specimen surface a contact angle is formed at the contact area. A droplet that "beads up" is non-wetting and a contact angle greater than 90° is displayed. When the droplet "wets out" across the surface, wetting is obtained and the contact angle is less than 90°.

A 6x magnified image of the droplet is displayed on the built-in screen. A reading is quickly made by rotating the protractor until the lines are parallel to the tangent at the contact point. An optional eye-piece provides 7x magnification of the test sample for very accurate readings.

FEATURES:
• Portable unit high quality lens system
• Battery operated long life light source (expected lifetime of 70,000 hours)
• Additional syringes are available separately
• Industry Standards: ASTM D724, TAPPI T458, SCAN P 18

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<td>N001-014</td>
<td>POCKET GONIOMETER</td>
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DRAWDOWN ROD/BARS

These rods give users the ability to fine-tune coating thickness quickly and easily, without altering the chemistry of their coating material, and without time-consum ing and expensive changeovers.

For users that require a coating path of up to 12", use the standard Laboratory Drawdown Rods (N008-005, N008-005A). With an overall length of 16", these rods are longer than the Jr. variety. Available in standard rod diameters of 1/4", 3/8", and 1/2".

The Accu-Lab Jr. Laboratory Drawdown Rods (N008-026, N008-026A) are designed for users producing test samples up to 8½" wide. These stainless steel rods are 4" shorter (12" overall length) than conventional lab rods and offer an additional savings.

The market for wire-wound rods has grown rapidly during the past few decades, because they provide predictable, accurate coatings time after time, at a minimal cost. Although the technology goes back almost a century, today's high quality materials, multi-wire designs and special wire surfaces have made this system more popular than ever before.

Standard Lab Rods (N008-056, 057 & 058) are less expensive due to a different manufacturing process and all of these are 16" long with a centered wound length of 12".

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<td>N008-026</td>
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<td>N008-058</td>
<td>DRAWDOWN ROD:16&quot;L x 12&quot;CWL x 1/2&quot;D</td>
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