Blame the Corona Treater

– the truth about watt density, dyne levels & adhesion

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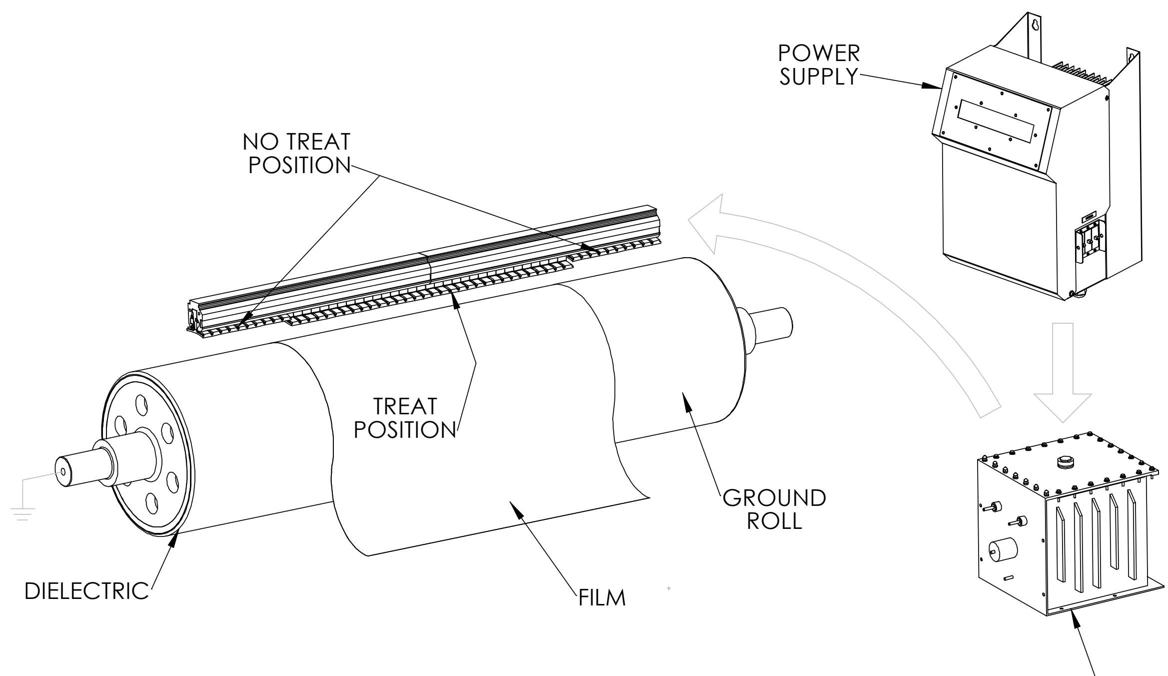
When you consider all the variables that need to work together for successful adhesion, it can be mind boggling. So, rather than take a PHD's approach to adhesion, we're going to take a very practical look at this sometimes frustrating and perplexing topic.

This article looks into the relationship between the corona treater and adhesion. We'll dive into topics such as: what a corona treater really does, how to measure applied treatment (watt density), ways to measure effectiveness of treatment (dyne levels), effects of small changes in material and processes, and how all of these items play a role in providing you with successful adhesion.

How a treater generates corona and what it does to a film's surface

First, we must properly define what a corona treater is, what it's designed to do, and how it operates. In its simplest form, a corona treater is a capacitor. We apply high frequency and high voltage energy to the top plate of the capacitor. The bottom plate of the capacitor is ground, or in common terminology, a grounded roller.

In between the two electrodes is a dielectric or insulator. The dielectric can be the treater roll, the electrode, or it can actually be in both places. The film, many times, can also act as an insulator. In the image below, you'll see that the power supply takes plant utility power, modifies it, and sends that energy to a high voltage transformer, which changes the energy again and amps it up to 10,000 volts at somewhere between 20 and 30 kilohertz.



That power is then applied to either a ceramic or metal electrode. The air in the gap between the electrode and the roll is ionized and corona is generated. Technically, corona is nothing more than ionized air.

Corona treatment forms low molecular weight material on the film surface, it oxidizes the film surface, and forms positive and negative sites by adding and deleting electrons. It also rids the film of organic and inorganic contaminants that can interfere with adhesion. We also know from Electrochemical Strain Microscopy (ESM) imaging techniques that corona treatment can microscopically increase the surface area of films. This increases bonding sites, which promote adhesion.

Measuring applied surface treatment

Knowing how much treatment you have applied to a surface is more complicated than reading the kilowatt indicator on your power supply. Applied surface treatment is measured in watt density (WD). The watt density formula takes into consideration the corona treater's kilowatt output, the width of the treatment area, the number of sides being treated and the speed of the film being treated.

$$2.0\ \text{Wd} = \frac{10{,}000\text{w}}{5\text{ft} \times 1000\ \text{fpm} \times 1}$$

Where:

Wd = Watt Density (watts/ft²/minute)
PS = Power Supply (watts)
WW = Web Width (feet)
LS = Line Speed (feet/minute)
NST = Number of Sides Treated

This example shows a calculation for an application with an applied treatment value of 2.0 WD (watt density). The line is operating at 1000 fpm, with a width of 5 feet, treating one side with 10,000w. As a point of reference, most corona treating systems for converting applications require a watt density of two and three watts per square foot per minute.

It's important to understand the difference between the power supply's output and the actual watt density being applied to the film. If your line speed fluctuates while you are treating the film and the kW power output remains the same, then the film is being treated at different watt density levels because of the speed variation. To compensate for changes in line speeds, corona treater manufacturers offer watt density controllers, which automatically adjust the output power to ensure consistent treatment levels.

It's also important to recognize that a corona treater is not a magic box. It doesn't know what type of film you are treating. It cannot overcome substrate maladies like poor treatment or no pretreatment. It can't solve things like bags, wrinkles, or high additive loads. All the corona treater station knows is that you've asked it to dissipate a certain amount of energy.

Measuring surface energy

Films that pass through a corona treater are visibly unchanged. So, how can you tell if the corona treater actually did anything? The primary way to do this is to look for a change in dyne level. A dyne is a unit of measurement used to determine the energy of a surface. In general, the higher the surface energy the better chances for adhesion success.

Dyne level testing kits are a fantastic tool to measure the surface energy of a substrate. However, dyne levels do not guarantee adhesion and there are best practices to keep in mind when conducting these tests.

First and foremost, it is important that the person conducting the test and interpreting the results is well-versed with the required best practices. Dyne levels are traditionally measured in one of two ways: either with a dyne pen, or with dyne solution using a cotton swab or a Meyer Rod. Dyne pens are good for quick testing, but the pen tips can become contaminated. So, take care when interpreting their results.

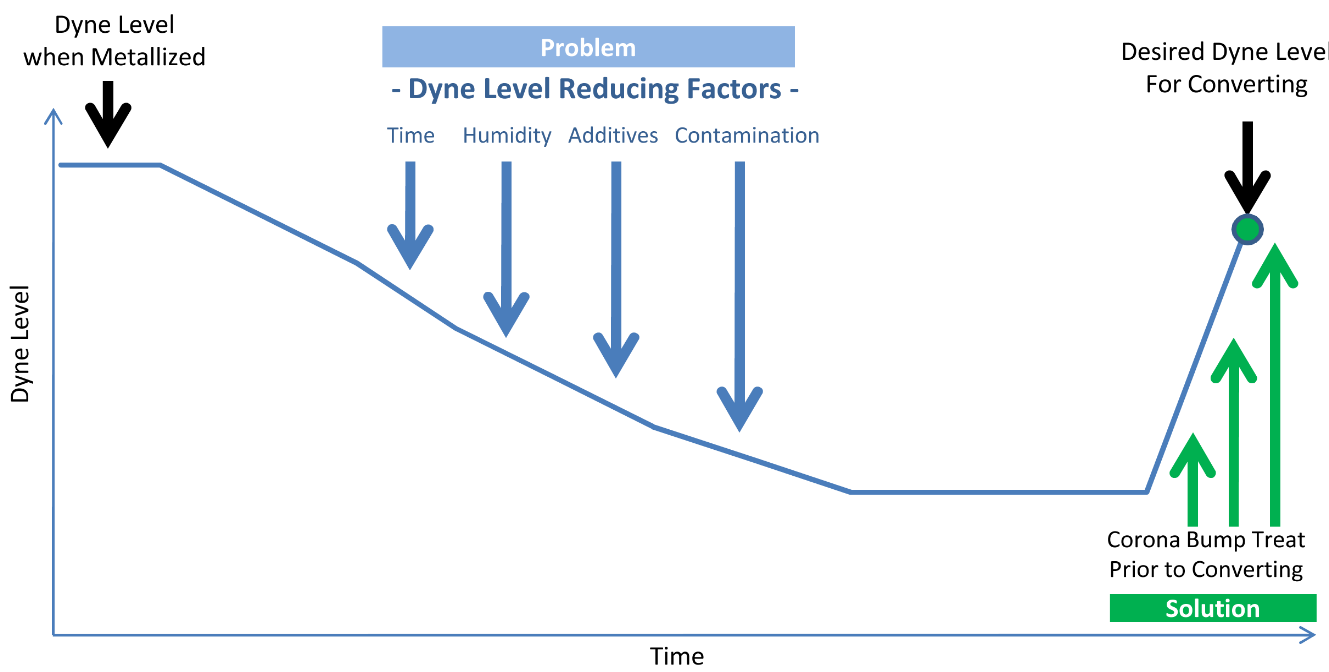
Your staff should be sure to follow ASTM's guidelines for using dyne testing solutions. The cotton tipped swab is the most convenient, but the Meyer Rod method is more accurate and is much more repeatable. It is important that dyne testing is conducted in a way where the results are repeatable.

Potential pitfalls of dyne level

What are the potential pitfalls of dyne levels? The biggest issue with dyne testing is consistency between those conducting the dyne level tests. Dyne testing is ALWAYS subject to the individual's interpretation. It is not uncommon for two competent people, who understand how to conduct dyne tests, to interpret the same result differently. Therefore, it is not uncommon to see a discrepancy of one to three dynes on any given sample. Be careful of putting too much emphasis on the exact dyne test value.

Another pitfall of dyne level readings is the fact that it only measures a small portion of the film. In most cases, dyne readings will be consistent over the entire film, but again, take care to recognize that the test only provides feedback on a small portion of film.

Surface energy or dyne levels will be subject to changes from time and environment. Additives migrating to the film surface, contamination, humidity and time itself have proven to lower surface energy. The takeaway is that freshly treated film generally provides better adhesion than film that you may have purchased out of old storage in a warehouse.



Ultimately, dyne level is an indicator of your chance of adhesion success, but it does not guarantee adhesion. Therefore, a dyne test should be used in conjunction with other test methods that focus on the result, such as peel adhesion testing for coating and printing applications.

How watt density and dyne levels relate

In general, higher watt densities produce higher dyne levels. However, the relationship is not linear and the relationship is dependent on system and material parameters. Therefore, you cannot use watt density to predict dyne levels. Why is that? A corona treating system is not an intelligent device. For example, it has no idea if the film running today is new or old, or if it has more or less additives than the film that ran previously.

Next consider the film composition. Films, such as some polyesters, accept treatment readily and exhibit rapid increases in surface tension under relatively low watt density levels, say 0.9 to 1.2. Other materials, such as polyethylene, accept treatment less readily but will exhibit a significant increase in surface tension under moderate watt density levels, say 2.0 to 2.5.

The amount of additives added into the film to enable processing can also be a barrier to adhesion success. Additives migrating to a film's surface will create a need for higher watt densities to achieve a change in surface energy.

Recipe for success

To prepare yourself for troubleshooting adhesion issues, make sure you document the application variables that have previously produced successful results.

For surface treating, think in terms of the following: material specification (material supplier, age of film, storage conditions of film, etc.), line speed, watt density or kW setting, air gap, web width, initial dyne level, and post treatment dyne level. Additionally, look at your recipe for success with your post treatment converting operation whether it be printing, coating or laminating.

When you run into an adhesion issue, ask the all-important question: "What has changed?" Answering this question should help you identify the reason you are seeing a change in your adhesion success.

If there is a problem with the corona treater, it is usually a straightforward process to identify the cause. If you need assistance in this area or any other application area, please contact Enercon Industries. Learn more at www.enerconind.com/web-treating.

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