

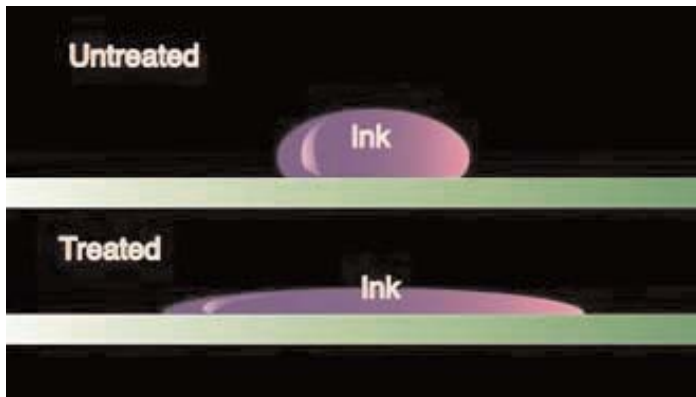
## Control your Substrate Surface Energy and Maximize Flexographic Printing Results



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The better you understand the process variables that effect flexographic printing the quicker you'll be able to remedy any problems that arise. The marriage between ink and film is subject to a slew of variables and in this article we will review application issue relative to the surface energy of the substrate.

The key equation for successful printing is the difference in the surface energy between the ink and the substrate. In order for a surface to be properly wet by a liquid, the surface energy of the substrate must be higher than the surface tension of the liquid. Surface energy is measured in dynes per centimeter. Ideally, the surface energy of the plastic should be higher than the surface tension of the ink. For example, a printing ink having a surface tension of 36 dynes/cm would not adequately wet or bond to an untreated material having a surface energy of 31 dynes/cm.



If a substrates surface energy is lower than the surface tension of an ink, it will bead up. Conversely when the substrates surface energy is higher than the ink, it will wet out.

Generally, plastics have chemically inert and nonporous surfaces with low surface tensions causing them to be non-receptive to bonding with printing inks. For example, polyethylene and polypropylene are known to have an extremely low surface energy.



This corona treatment system is designed to produce a larger operating window for flexographic printing operations.

To activate substrates and make them receptive to ink adhesion printers employ corona treaters. Corona treaters increase the surface energy of substrates by oxidizing the surface and creating positive and negative sites on the surface by adding and deleting electrons.

### Parameters that effect surface treatment success

It is important to have a documented quality control plan that calls for routinely measuring the surface energy of your substrate before and after corona treatment. Collection of this data will allow you to compare results should you ever find quality issues with your ink adhesion.

When you identify poor ink adhesion and suspect surface energy is the cause you should first ask the question “What has changed?” Is the ink the same? Is the substrate the same? Is the operating speed the same? Is the corona treater turned on? (Don't laugh, its happened)

Let's take an example where the ink is the same, but the substrate is somehow different. Realize that different doesn't necessarily mean a different type of film. A change in film suppliers or even a different batch of film might be yield different characteristics that effect its surface energy. This is where your recorded data from past jobs will come in handy.

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## **e** *Technically Speaking*

In some cases you may be working with the same type of film, but your initial dyne level reading is much lower than your recorded history. This can often be attributed to slip additives in the film rising to the surface. You probably know that slip additives are used by film extruders to ensure film transports smoothly through converting operations. What you may not be aware of is that film with a high percent of slip additives (measured in parts per million) has a significant impact on a film's ability to be treated, and to retain the effect of corona treatment. Higher additive loading requires increasing watt densities (treatment power) to raise the film's surface tension by a given amount. (see page 3 for more information on Watt Density)

Treatment power can be increased by either raising the power level of the treater or by slowing down your printing press to allow for more treatment dwell time. Keep in mind that your corona treater was designed for the application parameters that your company specified at the time of purchase. Printing on a different film or a film with a higher percentage of additives may or may not be possible. That's why it is critical to precisely define your application when requesting proposals from corona treater suppliers.

### **Other printing imperfections related to substrate surface energy**

The power of understanding your process and controlling variables is a huge benefit when it comes to troubleshooting. Take for example a situation where you notice ink picking after winding. If your team understands the corona treatment process they can immediately check dyne level readings to determine if the treater or treat level is the cause.

If the problem is occurring in only one spot you might suspect backside treatment. Backside treatment occurs when air is entrapped between the backside of the web and the ground roll. The air beneath the web becomes ionized & corona treatment occurs.

The cause of backside treatment can be attributed to either material imperfections or operational problems.



This image shows the flexographic printing results on a substrate where the upper portion was treated and the lower portion was not. The surface energy on the untreated area was too low for the ink to properly wet-out.

Wrinkles in film, scalloped edges or "bagging" are all material conditions that promote backside treatment.

Again a simple dyne test can tell you if you have backside treatment. Once you've determined that backside treatment isn't the cause of ink picking you can turn your attention to other potential causes; ink formulations, drying time and winding tension may be the culprit.

If backside treatment is an ongoing concern you should consult your corona treater supplier. They should be able to recommend in-field remedies as well as offer systems which are specifically designed to minimize the chances of backside treatment occurring.

### **Summary**

By controlling the substrate's surface energy flexographic printers can eliminate a variable from the ink to film equation. Surface energy issues can be quickly identified by measuring and documenting untreated and treated surface dyne levels. Some substrates are more receptive to treatment than others and a change in the percent of additives can have a significant impact on the treating power required. In some cases the treater can generate the increased power requirements in others alternate solutions may be required. Most importantly it is critical to provide your surface treater supplier with specific application criteria to ensure your system will be able to handle the range of materials and speeds your operation requires.

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## Using Watt Density to predict increased dyne level is not as simple as it appears

The ultimate goal of any surface treatment system is to increase surface tension measured in dynes which then increases the wettability and adhesion characteristics of the surface. This allows you to add value to the substrate through printing, laminating, coating etc...

Corona treating systems achieve this by applying a given level of power over a certain period of time to the surface. This power/time parameter is measured in watt density, which is defined as watts/ft<sup>2</sup> (or m<sup>2</sup>)/minute.

Although watt density applied is directly related to increases in dyne level (surface tension), the relationship is not linear, and the relationship is dependent on system and material parameters.

### System Parameters

Applied watt density is directly proportional to power supply size in watts and inversely proportional to station size (web width). Therefore if the web width is doubled the power supply must be doubled to maintain a required watt density. This simple relationship is complicated by two factors: line speed and the capacity of the electrode to handle a given level of applied power.

All electrodes, whether wire, metal bar, metal shoe or ceramic covered, have an upper limit on the amount of power they can accept per unit length. If, to achieve a given watt density, the power supply kW increases beyond the electrode's maximum rating, either the electrodes need to be upgraded or additional electrodes must be added. Further, on a covered roll system an increase in the number of electrodes normally require an increase in treater roll diameter.

Line speed also complicates the sizing calculation. On a given system, the higher the line speed, the lower the maximum watt density that can be achieved. Being inversely proportional to watt density, line speed has a significant

<b>Watt Density Formula</b>		
<b>Power Supply Output (Watts)</b>		
<b>Web Width(m) x Line Speed (m/min) x #Treat sides</b>		

<b>Typical Treat Levels and Watt Densities</b>			
<b>Substrate</b>	<b>Initial Level</b>	<b>Desired Level</b>	<b>Watt Density</b>
<b>Treated BOPP</b>	34-36	40-42	2.5-3.5
<b>Treated BOPET</b>	40-42	54-56	0.9-1.5
<b>Treated LDPE, high slip</b>	34-36	40-42	2.5-3.5
<b>Cast PP no slip</b>	38-40	40-42	1.5-2.5
<b>Low slip untreated LDPE</b>	30-31	Need to test	Need to test
Note: Variations in resin blend, additives or process will affect values.			

<b>Typical Watt Densities Printing, Coating Laminating</b>				
	<b>Solvent</b>	<b>Water</b>	<b>UV</b>	<b>Solventless</b>
<b>Pretreated LDPE</b>	1.5-2.0	2-2.5	2-2.5	1.0-1.3
<b>Pretreated LLDPE</b>	1.5-2.0	2-2.5	2-2.5	1.0-1.3
<b>PET</b>	1-1.5	1-1.5	1-1.5	1.0-1.3
<b>Pretreated BOPP</b>	2-2.5	2.5-3.0	2.5-3.0	1.0-1.3
Note: Variations in resin blend, additives or process will affect values.				

impact on system sizing and cost, which is why it's important to properly define your application.

### Material-Process Parameters

The most obvious material-process parameters are the basic substrate material composition and the process being performed (extrusion, extrusion coating, printing, etc.). Their impact on corona treating sizing is increasingly complex.

The tables above show immediate problems as most materials are defined by a range of typical surface tensions. The ultimate surface tension and amount of increase are dependent upon the material's starting surface tension.

In addition some materials, 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.

Finally, some materials, such as polypropylene, are difficult to treat and may exhibit only moderate increases in surface tension under relatively high levels of watt density, say 2.5 to 3. And untreated materials can be completely unpredictable.

So as you can see watt density is a valuable tool that must be balanced with system and operational parameters. And if you need a refresher on accurately determining dyne levels contact us for the recommended guidelines.



Printing presses benefit from integrated Watt Density Control which automatically maintains Watt Density over varying line speeds.

# Surface Treating Solutions

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