PLASTICS CONSULTANCY NETWORK

Corona Discharge

by Peter Prentice - PolyTech Consultants

Introduction

Low energy plastics, such as polypropylene (PP), polyethylene (PE) and Teflon (PTFE) are essentially "non- stick" plastics. Their molecular structure inhibits the adhesion and printing processes - this molecular structure is basically inert or inactive – these polymers are said to have a low surface energy. The surface energy or the wettability of a particular substrate is measured in dynes/cm (or ergs/cm2) and, when tested, untreated PP and PE will have a low surface energy (usually 30 to 32 dynes/cm). The most common method of determining the surface energy is to measure the contact angle of a water droplet on the substrate surface. The contact angle between the solid and the fluid is the angle measured within the fluid, between the solid surface and the tangent plane to the liquid surface at the point of intersection (see Figure 1 below). A contact angle of greater than 90° indicates that the fluid (which is ink or adhesive in this case) has not wet the surface. Conversely an angle of less than 90° means that the fluid has wet the surface - if the angle approaches zero then the surface is completely wetted by the fluid.

Use of a corona, flame or other surface treatment will raise the surface energy level to values in excess of 42 dynes/cm. Ideally, the surface energy of the plastic should be 7 to 10 dynes/cm higher than the surface tension of the solvent or liquid. For example, a printing ink having a surface tension of 30 dynes/cm would not adequately wet or bond to a material having a surface energy less than 37 to 40 dynes/cm.

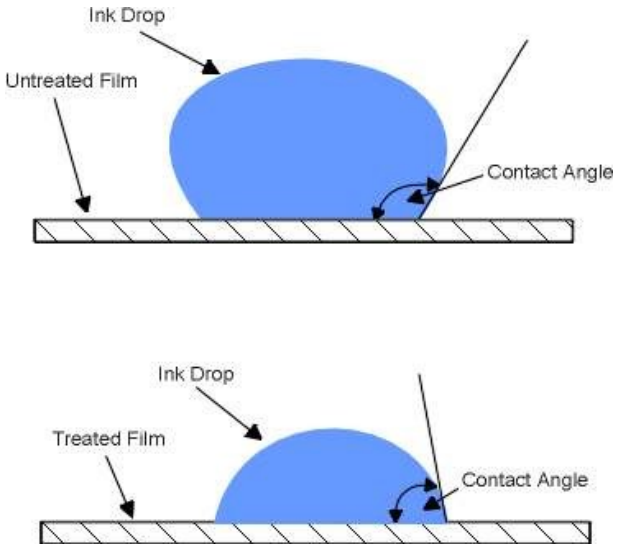

Figure 1: Schematic Representation of Surface Tension

Corona Discharge treatment is the most common method of increasing the energy level of PP and PE materials (see below). This process uses an electric current to create an ozone generating spark - a corona. The ozone within the corona reacts with the PP or PE surface to raise the energy level. While this method is very popular, it is not long lasting and the increase in the surface energy can disappear within weeks.

A corona treatment system in its simplest form can be thought of as a capacitor. Voltage is applied to the top plate which, in the case of corona treatment, would be the electrode (see Figure 2 below). The dielectric portion of the capacitor would be made up of some type of roll covering, air and the substrate (film or sheet). The final component, or bottom plate, would take the form of an electrically grounded roll. In the corona treatment system, the voltage build-up ionises the air in the air gap creating a corona, which modifies the surface and increases the surface energy of the substrate passing over the electrically grounded roll. The level of treatment is controlled by the energy of the discharge and the air gap. For health and safety reasons, the ozone generated in the corona must be removed from the working environment.

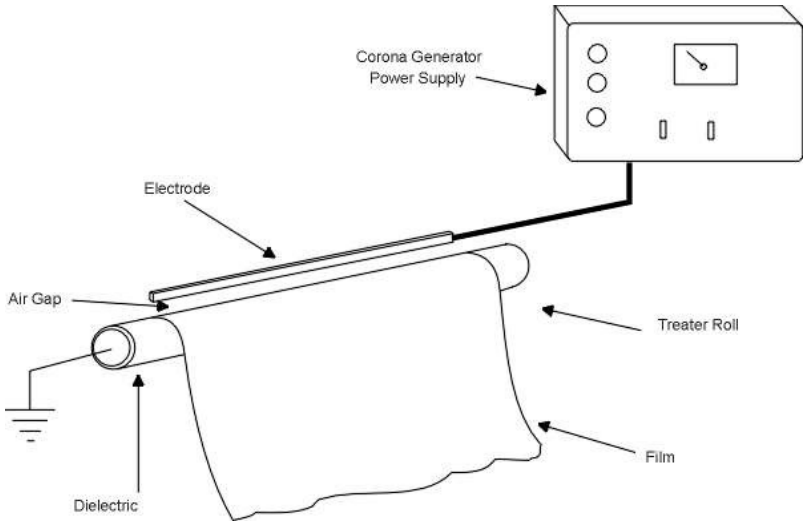

Figure 2: Corona Treatment System

The corona treatment system is introduced into the film blowing equipment usually at the top of the tower (see Figure 3 below), but not always. Some systems incorporate the treatment midway up the tower or at the base.

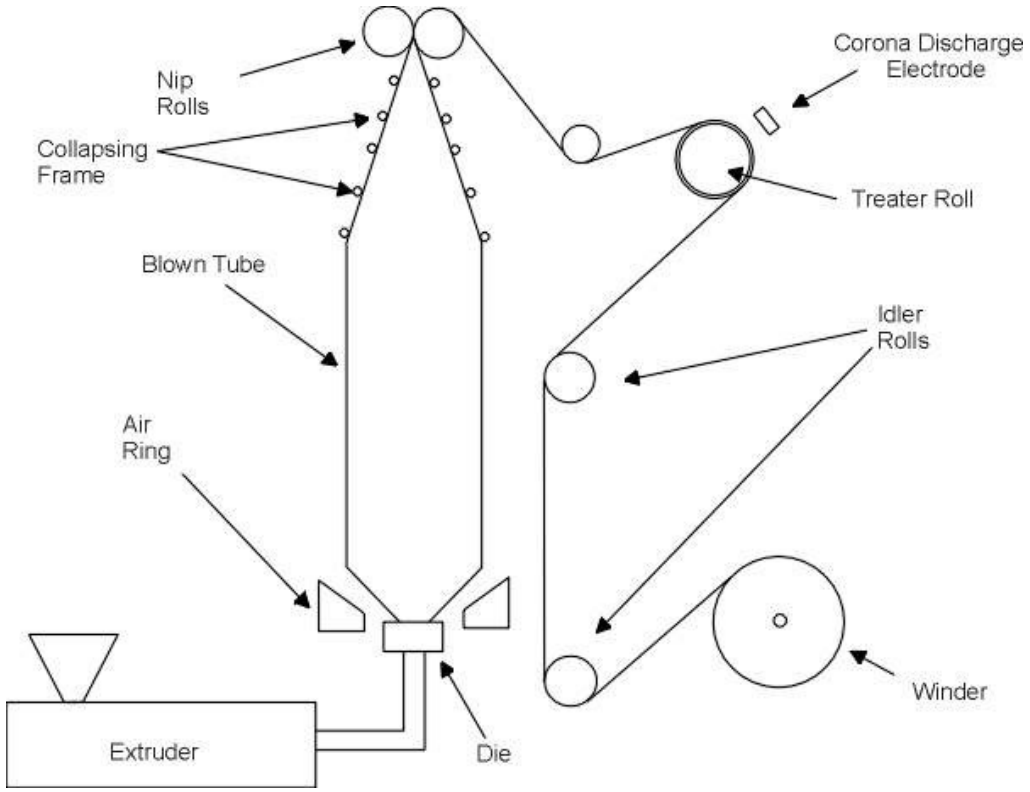

Figure 3: Line Schematic – Top of the Tower Treatment

Similarly, the corona treatment system would be included in the line of an extruded sheet line (see Figure 4) and stentered film.

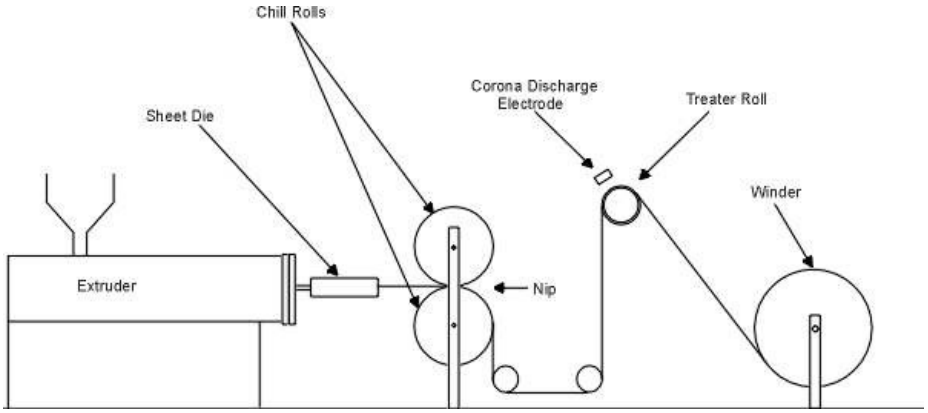

Figure 4: Sheet Extrusion Line

Backside Treating of the web occurs when the corona (oxidised air) is present at the surface of the material. So, if the wrap is insufficient on the treater roll (see Figure 5 below), backside treatment will occur. Solutions to backside treatment range from ensuring that there is more wrap on the roll to the use of nip rolls.

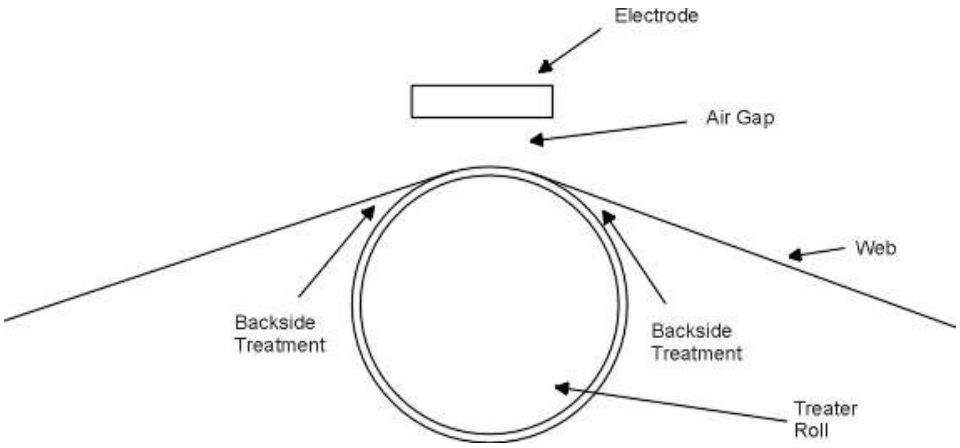

Figure 5: Insufficient Wrap leads to Backside Treatment

Flame treatment is also a common method of increasing the energy level of PP and PE materials. This process uses an oxygenated flame to create free oxygen. This free oxygen then reacts with the surface of the PP or PE and raises the surface energy level. As with corona treatment, this method is not long lasting and can disappear within weeks.

Problems you might find

Blocking. The greater the level of treatment, the higher the degree of oxidation of the surface. The polar groups formed by the corona have an attraction for the molecular layer on the other side of the web, and when the two sides come into contact when they are on the roll, a self-adhering condition exists. Sometimes this attraction can be greater than the internal bonds of the substrate so that delamination of the substrate can occur when the product is unrolled. The tighter the roll is wound and the longer it is in storage the more severe the problem becomes. Blocking is worse in the film at the centre of the roll.

Heat Sealing. Excessive treatment also leads to problems when attempting to heat seal the product.

Additives. If the polypropylene or polyethylene contain additional components, such as slip additives or some processing aids, the initial treatment is reduced over time as these additives bloom to the surface and partially mask the polar groups formed during treatment. For this reason, it is better to treat these films at the point of use rather than the point of manufacture.