Reliable solutions – corona treatment from simple to sophisticated

SOFTAL ■ Reliability, low cost, controllability and easy handling are the reasons for corona technology's wide acceptance as the leading process for surface treatment of plastics, paper, and metal foil in order to improve the adhesion of inks, lacquers, adhesives and coatings. This is because the efficiency and functionality of corona equipments have increased step by step over the past decades, keeping pace with the constantly developing, high-speed converting and extrusion machines.

Nowadays the range of corona treating equipment ranges from narrow web printing and blown film extrusion at moderate line speeds and film widths up to treating widths of more than 9 m for biaxial orientation lines and high speed printing and coating lines with line speeds of more than 1500 m/min. *Figure 1* shows two examples of medium size corona treaters.

Reliability is the key

Because corona treatment today is such an essential part of most production processes, there is no room for errors. Reliability starts with the optimization of the corona treater for the specific extrusion or converting process and the integration of the corona treater into the hardware and, becoming more and more important, the software of the line.

Whereas general mechanical and electrical engineering can nowadays cope with harsh environmental conditions as long as high quality materials are combined with the specific engineering know-how, humid environments pose very specific demands for corona treatment systems and can even lead to unexpected and costly down times if proper precautions are not taken. Reliable operation in humid environments requires an integrated approach on the mechanical, as well as the electrical engineering side to perfectly adapt the equipment to the environmental requirements.

The basis for reliable operation in humid environments is the high voltage insulation system of the corona electrodes. State of the art systems (*figure 2*) use special ceramic high voltage insulators, specifically designed for the frequencies and voltages of modern corona treaters. In addition with a software controlled, optimized start-up procedure this should be the basis of any system operating in a humid environment and ensures easy and reliable start-up of the corona treatment even in the case of condensation on high voltage carrying parts.

Especially in environments with a temperature and pressure drop from outside to inside, suitable measures have to be taken to avoid condensation of back flowing humid air inside the corona electrode when the equipment is turned off. Depending on the operating status, modern corona generators automatically control a stop flap within the exhaust system as well as the exhaust fan itself. In very humid production environments and after longer times with the corona turned off, extensive condensation on the still cold corona electrode during start-up can occur. This can be avoided by different technologies to raise the electrode temperature to operating conditions before start-up.

Similar to the attention that needs to be given to proper handling of humid environments, leading corona technology offers solutions for a wide range of demands in the field of surface treatment. From drastically reduced contamination of corona electrodes to quick and, most importantly, low maintenance strategies, from treatment of non-standard materials to specialised engineering and optimised integration of the equipment into the extrusion and converting lines and processes.

This is how it works

With suitable corona treatment, the wettability and adhesion of a polymer surface can be adjusted without altering the properties of the polymer matrix. A typical treating system consists of a high voltage electrode and a grounded counter electrode (*figure 3*). The counter electrode is usually a roller that also guides the treated web. As soon as the applied high voltage reaches the break down voltage in air, an electric discharge between the electrodes occurs and an atmospheric pressure plasma is produced. Dielectric coatings on the high voltage electrode and/or the counter electrode keep the discharge smooth and uniform and avoid transformation into a thermal arc.

The physical and chemical processes in a corona discharge are complex. Essentially, the plasma induces various chemical reactions within the gas phase, as well as on the polymer surface. As a result, chemical groups such as hydroxides, ketones, ethers, carbonic acids, and esters are chemically bound to the polymer surface. Those groups are polar, and hence increase the surface energy which, finally, improves adhesion of e.g. printing inks, lacquers, adhesives and various other kinds of coatings.

Corona treatment of boards and foams

A fast growing field is the treatment of polymer boards and foams. Due to the specific geometries of those materials, most notably the often considerable thickness, classical corona treatment in many cases is not feasible. Recently, *Softal* has developed a new type of atmospheric pressure plasma source, suitable for a large variety of materials and geometries that were previously not accessible to corona treatment. The system is compact, and

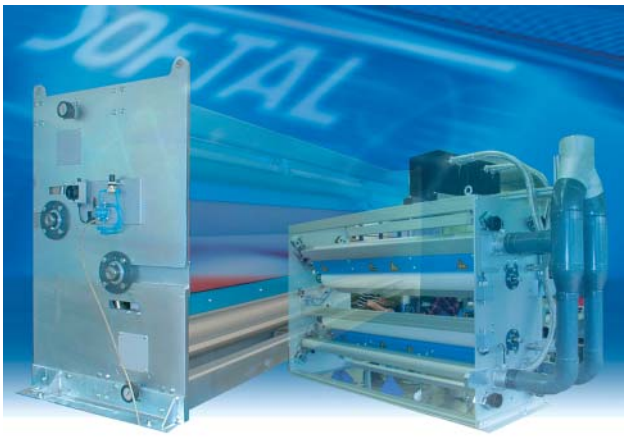
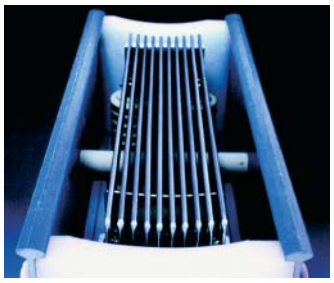


Figure 1:
Modern corona treating stations.

therefore easy to integrate into existing production lines and scaling to large treating widths is straight forward and hence affordable. Due to their high efficiency compared to plasma jet systems these new plasma sources are typically operated at power densities of only 10 W/cm^2. Treating widths of several metres are not only technically possible, but economically feasible. In addition to its easy adaptability to new geometries, a major application of the new plasma source is the treatment of thick foams. In open cell foams no preferential discharge channels occur, and closed cell foams are not pin holed also, the low power requirement allows treatment of temperature sensitive foams. In addition, the new system is ideally suited for treatment of honeycomb structures and reinforced materials.



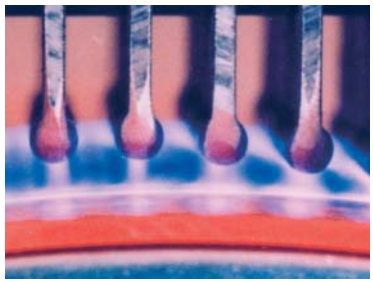


Figure 2 (left): Softal's Multi Blade electrode.

Figure 3 (right): Corona discharge.

Monolayer coatings

Many applications within the converting industry require the use of adhesion promoting primers. *Softal* and *Air Liquide* jointly developed *Aldyne*, a technology that replaces traditional liquid primers with a cost efficient (*figure 4*), and environmentally friendly, atmospheric pressure plasma process. In contrast to corona treatment, where the plasma process gas is ambient air, the *Aldyne* process is based on the use of a well defined and controlled gas atmosphere. This provides control over chemical reactions within the plasma as well as on the polymer surface. The results are functional coatings with a thickness of a molecular monolayer, typically 0.3 to 0.4 nm.

Since *Aldyne* does not use any liquid or solid substances, no residues can accumulate. Therefore, costly cleaning procedures are eliminated. Also, within the *Aldyne* treating process, a drying step is not required and the often associated problems regarding removal of organic solvents are not present. The molecular coatings can be adapted to the converting process. Amido, imido, and amino groups for example provide excellent adhesion to water-based, solvent based, and UV drying inks and lacquers as well as adhesives. *Aldyne* is an inline process and can be easily integrated into existing converting lines. Major components are a specially designed plasma source that enables control of the plasma gas at the ppm level, a gas delivery system, and a complete and fully automated process control system.

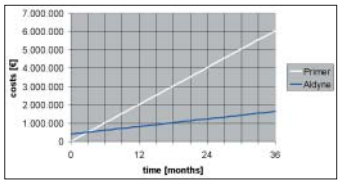


Figure 4: Cost comparison between classical liquid primer and Aldyne monolayer coating for a 2000 mm wide line at 200 m/min.

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