SOFTAL
CORONA & PLASMA

Corona and Plasma Treatment

An Overview

Adhesion Guaranteed!

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1. Introduction

Plastic processing companies, especially those producing and converting plastic films, are confronted every day with the problems of improving adhesion, product quality, and increasing the economic efficiency of their processing machines. This overview illustrates the technology behind corona and plasma treatment equipment, how it operates, and how it can be applied to production processes in these companies.

High-frequency (20 to 50 kHz) corona treatment is widely accepted as a process for improving the adhesion of printing ink, lacquer, glue and other coatings to plastic film, paper and metal foil. The reasons for its success include reliability of results, controllability and easy handling. Over time, the techniques and the effectiveness of the process have been improved to keep pace with the developments of the production machines. New plasma processes such as atmospheric gas pressure plasma will are also presented.

2. Measurement of treatment effect

Surface tension is the main indicator/measurement for surface treatment effect for adhesion and wettability. There are two main methods of measuring surface tension in the plastics processing industry, contact angle measurement and measurement using test inks.

Contact angle measurement method is used mainly in laboratories, but the test ink method is generally applied in practice and is common in factory applications.

In contact angle measurement, a defined drop of water is applied to the surface of the material to be measured. The smaller the contact angle, the higher the surface. An untreated PE for example has a contact angle of approximately 90°.

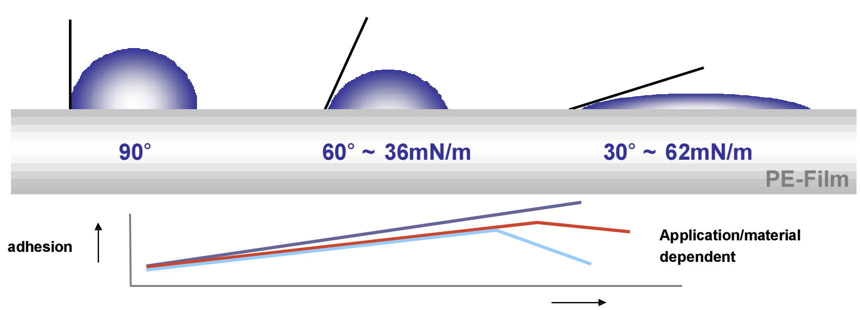


Fig 1. Contact angle

The SI unit of measurement for surface tension using test inks is mN/m, although the traditional dyne/cm designation is still in common use. There are different methods of applying and measuring using test inks, therefore results may not be the same for identical materials. One internationally recognised method is the DIN ISO 8296 for measuring polyethylene and polypropylene surfaces. In practice this method is also used for other polymers. Another measuring method is the American standard ASTM D 2578-04a.

The DIN ISO 8296 test method wets the surface of a plastic film with a liquid: A test ink of known surface tension is applied to 4 cm the material surface with a small brush. The edges of the strip of ink must remain intact for approximately 2 seconds. If this is the case, the surface tension of the film corresponds to the surface tension of the ink. If the edges of the liquid reticulate in less than 2 seconds after application, the surface tension of the material is lower than that of the ink, and the test must be repeated using ink with a lower surface tension. If the edges of the liquid remain intact for longer than 2 seconds the test is to be repeated using ink with a higher surface tension until the time of 2 seconds is obtained. Each test ink is supplied in a bottle with individual brush which must not be mixed with other inks.

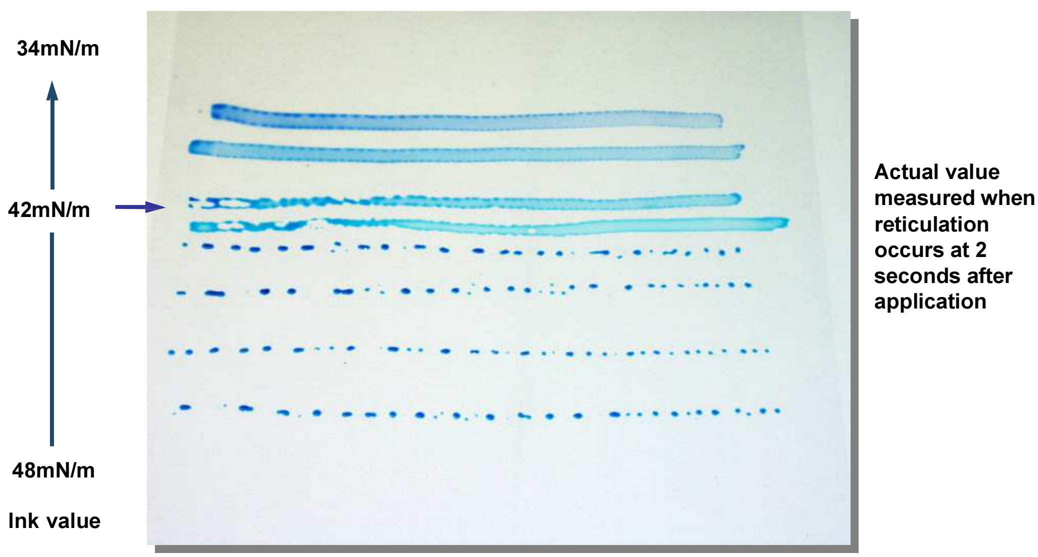


Fig 2. Test inks on Polypropylene treated to 42mN/m

The test ink bottles must be kept tightly closed and stored in a cool place. It is recommended that the inks be discarded and replaced 6 months after opening. If the inks are in constant use, water (humidity) may build up in the liquid and change its composition/value.

Unfortunately, in practice too little attention paid to handling, storing and replacing the test inks. This may lead to production waste or customer complaints.

Test inks are available in surface tension ranges from 30 – 56mN/m and as dyed distilled water of 72mN/m.

A simple method of ink test measurement is with a felt-tip pen. SOFTAL recommend this method only be used for surface tension of 38mN/m for a quick test on the production line, for example, to determine which side of a film has been treated before installing the roll of material in a printing, lamination or coating line. Felt-tip pens are unsuitable for accurate measurements as the tip can collect contamination from the film due to the pressure required to apply the tip. There are no international standards for measurement of surface tension using this method.

Measurement of corona treated paper is only possible within a limited range as the liquid is immediately absorbed by the paper or board. However, it is possible to measure the effect by measuring the period of absorption of a defined liquid drop. A treated material will absorb the liquid much faster than untreated material.

3. Corona

3.1. Principle of corona equipment

The main components of a corona system are a high-frequency generator, and a corona station comprised of an electrode configuration mounted at a nominal distance of 1.5 mm from an earthed base roll. See Fig.1. One or other, or both the electrode and the treater roll have a dielectric material, depending on the application, essential for the generation of the corona.

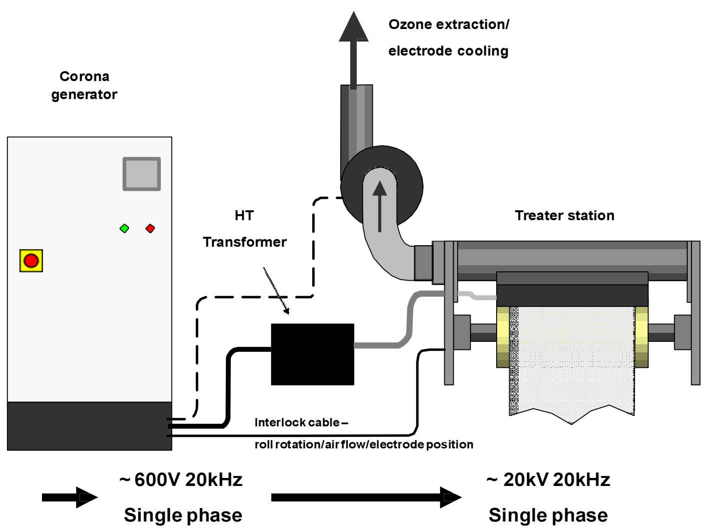


Fig. 3 Classic Corona Treatment System

The generators are usually equipped with IGBT power modules, and, in conjunction with a high voltage step-up transformer, produce a sinusoidal output up to 20 kV at frequencies between 20 and 50 kHz.

When the high voltage exceeds the breakdown potential of the air gap, the generated energy is discharged from the electrode system on to the surface of the material to be treated, as it passes through the corona station in the gap between the electrode and the supporting base roll.

SOFTAL generators are equipped with automatic power control to eliminate irregularities in production, to compensate for changes in temperature, electrode gap, electrode type, electrode width, material thickness and dielectric thickness. With this system it is possible to have a power turn down ratio of 10:1. Higher turn down ratios are possible with add on modules.

There are essentially, two variants of the electrode system, and their application depends on the properties of the material web to be treated. For non-conductive materials, for example plastic or paper, metal electrodes are used. SOFTAL developed the highly effective MM multi-blade electrode patented world-wide, and which has now been replaced by the Intelliblade™ system, also patented.

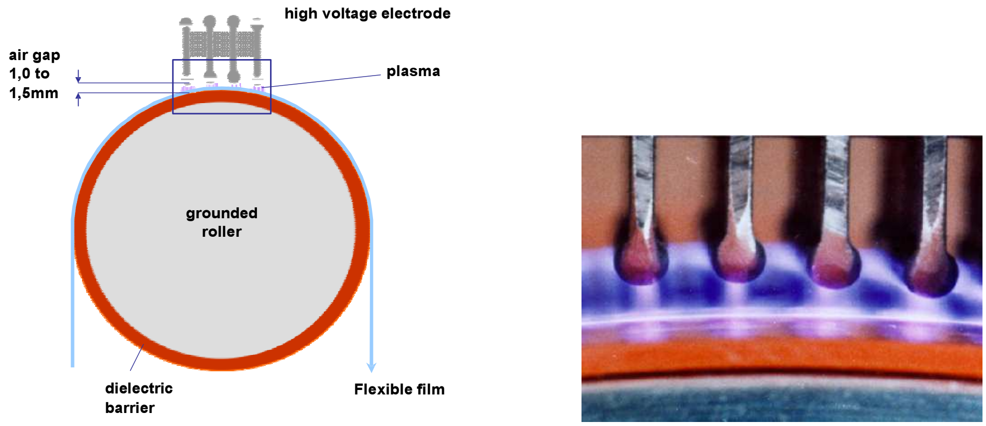


Fig. 4 Corona discharge from blade electrodes

With this electrode configuration the treater roll is coated with a dielectric material such as silicon or ceramic, essential to obtain regular, homogeneous corona discharge.

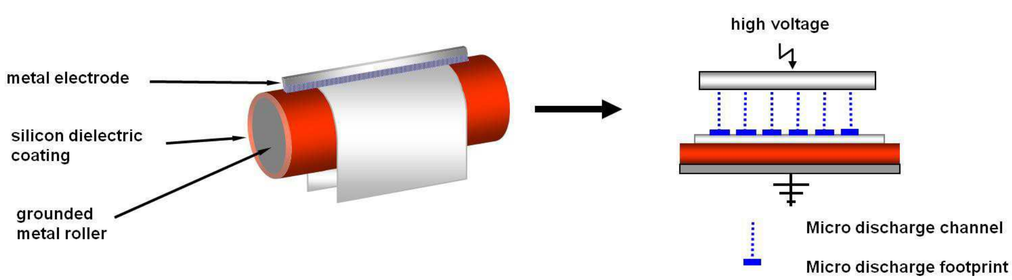


Fig. 5 Metal (MM or IB) electrodes with Silicon Dielectric Roll Coating

Where conductive materials such as aluminium, metallised paper, plastics and laminates containing conductive materials, are to be treated, the second variant of the electrode system must be applied.

The system for this application consists of dielectric electrodes, such as the SOFTAL KB ceramic electrodes. The treater roll does not necessarily have to have a dielectric coating, since the ceramic electrode itself provides the dielectric. The KB electrodes are patented design with a double chamber to prevent discharge at the electrode holding components.

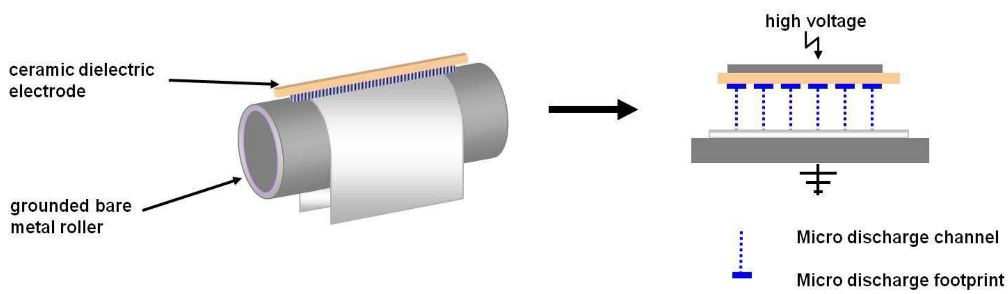


Fig. 6 Ceramic Electrode (KB) with Bare Roll

While metal electrodes can only be used for non-conductive materials, it is possible to use dielectric electrodes for the treatment of non-conductive as well as conductive webs. However, for the power rating of the corona equipment it is important to note that the effect of these electrodes on polymer, for example, is poorer than the effect of metal electrodes. This can be compensated for by increasing the output of the generator or alternatively by incorporating an additional dielectric coating on the roll.

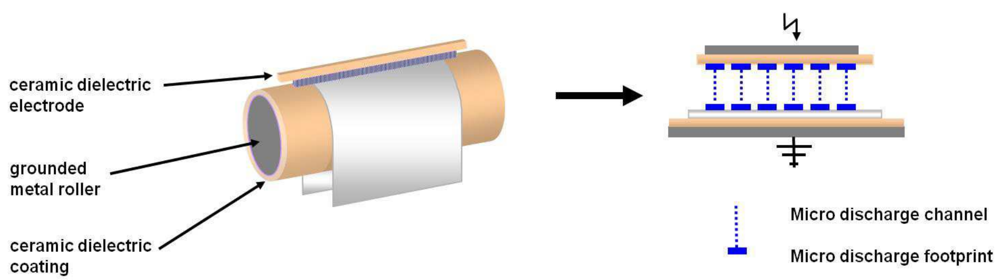


Fig. 7 Ceramic Electrode (KB) with Ceramic Dielectric Roll Coating

3.2. Electrode systems

The effect of corona treatment essentially depends on the electrode system. The most common electrodes are single blade electrodes, whose geometry and configuration have an important influence on the efficiency.

Through the years, SOFTAL has paid a great deal of attention to the development of electrodes as experience has shown that increasing generator output alone, to treat difficult materials, may bring as many disadvantages as advantages.

High generator outputs can only be obtained with a high ignition voltage which leads to a separation of the corona discharge into single streamers. This not only produces oxidation of the polymer surface but at the same time decomposition products are no longer bound to polymer chains, and adhesion problems occur, which is the opposite effect required from corona treatment.

SOFTAL electrode development concentrates on transferring the entire available load as evenly and gently as possible to the surface of the material. The objective is uniform discharge, avoiding long single sparks, cooling the surface of the web at the same time. This resulted in a completely new concept in electrodes, the MM multi-blade electrode and its successor the Intelliblade™ designated as IB.

Treating stations with IB or KB electrodes are manufactured to a safe, accessible design with integral ozone extraction and electrode cooling, which does not require a complete shrouding of the station. As a result, the threading of the web material is considerably easier and maintenance is simplified. The ozone is extracted through an extraction tube to which the insulated electrodes are mounted. Covers at the electrode ensure protection against touching, and ensure efficient ozone extraction, and cooling of the electrode system. The IB electrode is manufactured in different configurations, from 4 to 16 blades depending on the application. By design, the special shape of the electrode produces a smooth discharge which causes no damage to the material.

The advantage of the Intelliblade™ electrodes is shown in Fig. 5. Less than half of the generator output power is required, than with ceramic electrodes, to obtain a surface tension of 42mN/m on polypropylene films which are difficult to treat. Furthermore, the single blades, which heat up during operation, are allowed to expand independently to avoid distortion and maintain a uniform air gap.

The comparison with dielectric electrodes is significant. These electrodes are produced from ceramic. These are less effective and are recommended for use only in the corona treatment of metal foils or laminates containing metal, when used with a bare metal roll.

If the application requires that conductive materials and nonconductive materials are to be treated, a silicone or ceramic coating on the roller is recommended in order to improve the efficiency of the ceramic electrodes on non-conductive materials (see Fig. 5).

A more important benefit of Intelliblade™ electrodes lies in the fact that higher levels of surface tension can be obtained than have been possible with equivalent power levels on other electrodes. As Fig.5 illustrates, the relatively linear increase in surface tension approaches a threshold value, resulting that increased generator output will bring reduced improvement in treatment effect with increase in power.

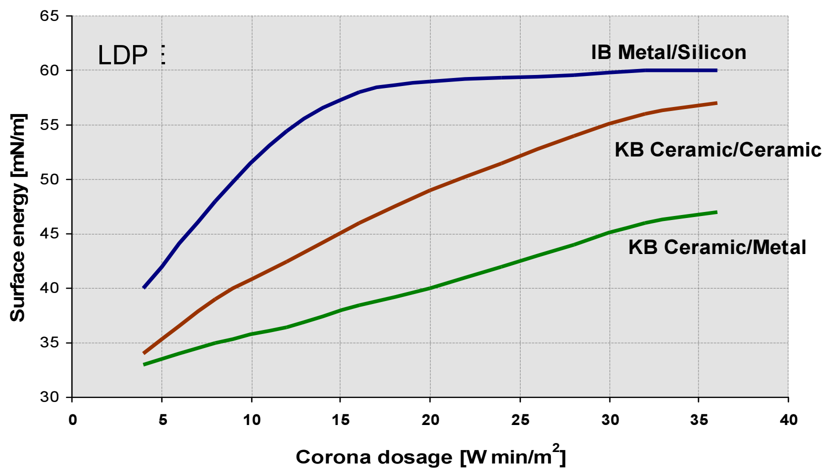


Fig. 8 Efficiency of Electrode/Dielectric configurations

This limitation can be reduced by the design of the electrodes. Evidence shows that the Intelliblade™ design has a positive effect on adhesion. It has also been shown that in the case of pure polymers, without significant slip additives, the surface effects obtained are more durable than with conventional electrode systems. In conclusion, there is a delay in the drop in surface tension over the storage period and the residual values are higher, when the film is treated using the Intelliblade™ electrode system.

3.3. Essential features of corona equipment

Ease of operation, maintenance and reliability are the main criteria for selecting corona equipment. One important aspect of high-tech production machines, with expensive downtimes, is that the user cannot accept failures caused by additional equipment. The first principle for the manufacturer of this equipment must be to realise these conditions and use every technical means available to pursue maximum operation reliability, easy maintenance and simple handling.

For this purpose the generators must be short-circuit-proof and incorporate practical functions and control features such as fault indication, power read out, and automatic generator tuning.

The corona system is delivered complete with connection cables allowing simple and speedy installation

The corona stations are designed with corrosion-proof materials such as aluminium, stainless steel, ceramic and high quality synthetic materials. Safety features such as zero-speed switch, ozone extraction monitoring and safety switches to control the electrode position are essential, as is the stability of the electrode gap during operation, and the expansion capability for electrodes on heating to prevent twisting and bending. All installation components of the station must be easily accessible for cleaning in order to prevent surface leakage current and short-circuits. The major insulation components of the SOFTAL corona station electrodes are produced from arc-resistant ceramic.

3.4. Dielectric

The dielectric is an essential part of the corona station and may be subject to frequent replacement and repair. This, however, can be influenced by the selection of the dielectric material and its maintenance. The two materials most commonly used as a dielectric for the treater roll are ceramic and silicone.

Ceramic is the best material with regard to wear resistance. However, investment cost is high compared to silicon. Additionally, some applications may require water-cooling of the treater roll. Therefore the application must be considered as to whether the added costs of ceramic coating can be justified by reducing expensive machine downtimes.

The most commonly used dielectric is synthetic silicone rubber which has been developed to such an extent that it can have a service life of 6-12 months and more, if well maintained.

Silicone is available in the form of sleeves for treater roll diameters from 100mm to 200mm, or as a coating. In particular, sleeves are inexpensive and easy to handle. Small defects can be repaired in minutes with silicone rubber.

3.5. Function of the corona process

The corona treatment effect is based on bombarding the surface of the polymer with electrons. These leave the electrode and are accelerated under high tension towards the passing material web. In doing this they collide with air molecules which transmit light and react in part to generate ozone and nitrogen oxide. When the electrons come into contact with a polymer surface they have so much energy that they break the bond between carbon-hydrogen and carbon-carbon molecules. Reactions with the corona take place at these free radicals, mainly towards oxidation. The functional groups thus formed are polar and so provide the basis for adhesion of applied printing inks, lacquers, etc.

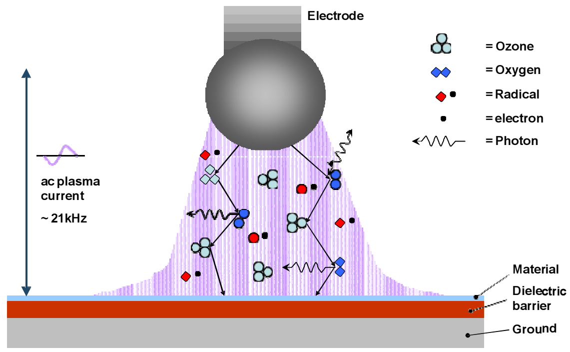


Fig. 9 Reactions in the corona discharge

In another application, the surface of aluminium foil, even when annealed, is not free from organic residue as petroleum fractions and additives are used as lubricants when rolling foils. Depending on the surface roughness, up to 20 mg/m² residue can be measured. During the annealing process the majority of the oil is removed by distillation and oxidation, but the surface is not in fact free from residue. In particular at the centre of the coil there remain rolling oil residues of some mg/m². They are oxidized and therefore wet out, but have a negative effect on adhesion.

By intensive corona treatment these substances will continue to oxidize and cross-link so that adhesion becomes more certain. The corona "equalizes" the aluminium surface in the machine and transverse directions, and helps to reduce wastage in the case of unevenly annealed foil.

3.6. Corona Power Factor (Corona Dosage)

The power rating required of the corona equipment depends on the type of material, width of web and the production speed. All three factors are equally important. As far as the material is concerned, it is very important to distinguish, for example, an untreated polymer film treated in-line with an extruder in the freshly extruded state or treated on a converting machine after a certain period of storage. Generally speaking, to corona treat on an extruder requires a lower treating power.

In the treatment of stored films on the other hand, an important factor is whether they have been treated at the time of manufacture on the extruder. Additionally, traces of slip additives have adverse effects on the required treatment level.

The width of web and the speed are a linear function of the power rating.

The unit of measurement for specific energy is watt.min/m² (W.min/m²). The following formula contains the necessary parameters such as generator output (W), processing width (m) and machine speed (m/min).

D [W.min/m²] **corona dosage**
w [m] **treating width**
v [m/min] **web speed**

(D is Material dependent)

→ **corona power**
$P = (D) \times (w) \times (v)$

At the SOFTAL technology centre in Hamburg, Germany we have simulators to assist in defining specific energy for any required material. When the specific energy necessary to treat a material to a defined surface tension is known, the required generator output can be extrapolated for any speed and treating width.

3.7. Applications

The applications of corona treatment are many, and range from treatment of drinking cups and yoghurt beakers in cup printing machines, to treatment in extrusion coating and laminating lines, and a wide range of extrusion line.

3.7.1. Bi-orientated extrusion

BOPP, BOPET and BOPA orientation lines produce these films at widths up to 10m at speeds in excess of 400 m/min.

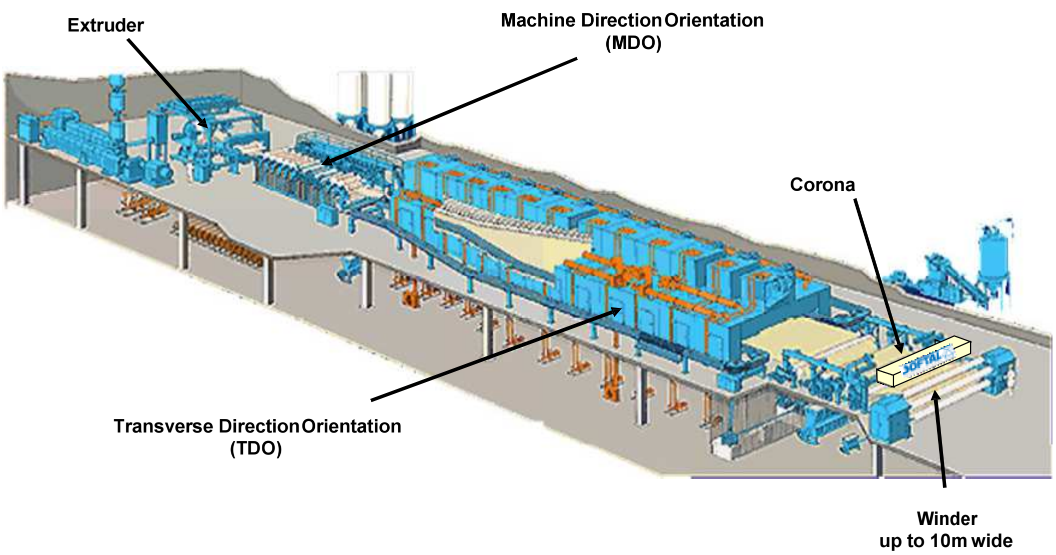


Fig. 10 BOPP line

SOFTAL treater stations for this application use Intelliblade™ electrode technology to corona treat films without inducing excessive heat into the film, thereby reducing the possibility of creasing and reverse side treatment. Maintaining a consisten air gap between the electrode and the surface of the material being treated is critical to the homogeneity of the surface treatment. The individual blades in the Intelliblade™ electrode allow individual expansion thereby preventing distortion of the electrode.

Mechanical stability of these wide stations is very important and strong, well designed cross members are pre-requisite.

Fig. 11 6m BOPP station with 3 electrode assemblies

3.7.2. Blown film extrusion

In the majority of cases the materials are polyethylene films. Although these films sometimes contain considerable amounts of slip additives, it does not normally pose a problem to obtain surface tensions of 44-46mN/m or higher. At the time of treatment the slip additives are still spread through the thickness of the film and therefore are not a major obstacle.

A negative effect of slip additives can be seen during storage, as they often lead to a rapid and dramatic drop in surface tension, especially with thicker films.

The reason for this is to be found in the fact that the slip additives which are intended to lubricate the surface of the film, migrate to the film surface within a few days and strongly reduce surface tension at the same time. It is therefore important to corona treat films containing slip additives on the extruder, since it is practically impossible to sufficiently treat an untreated film with high slip additive content after long periods of storage.

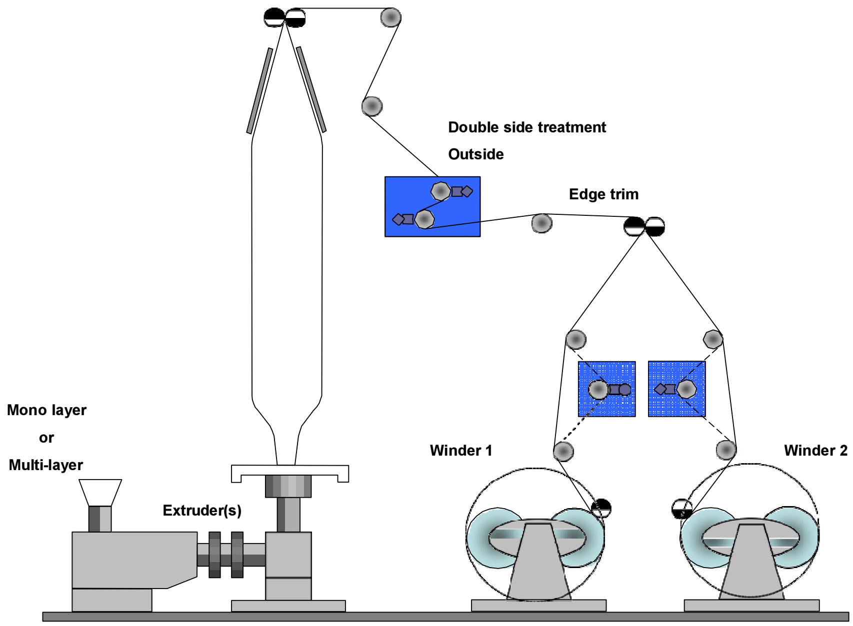


Fig. 12 Blown film extrusion line

The corona stations installed on blown film extruders have one electrode on each side in most cases. A variant of Intelliblade™ electrode with four blades is used for this application.

If required, the corona station can also be fitted with segment electrodes with 2, 5 or 10 mm segment raster, to leave the desired strip width untreated for heat sealing at a later stage. This is necessary as corona treated areas have poor heat sealing strength.

The construction of the SOFTAL corona station for blown film extruders offers the possibility of treating either the two inner sides or the outer sides, where the tube has been cut to provide two single films.

3.7.3. Cast film extrusion

Another area of application in the manufacture of films is cast film extrusion. Cast film extruders are often used in manufacturing polypropylene films which require a considerably higher specific energy than polyethylene films. Depending on the type of raw material, the difference can be as much as a factor of three. Also, cast film extruders usually produce at higher speeds of up to 300 m/min and more. This means that generators with higher output and electrode stations with 2 or more electrodes per side must be used.

SOFTAL offers corona stations with Intelliblade™ electrodes for this application.

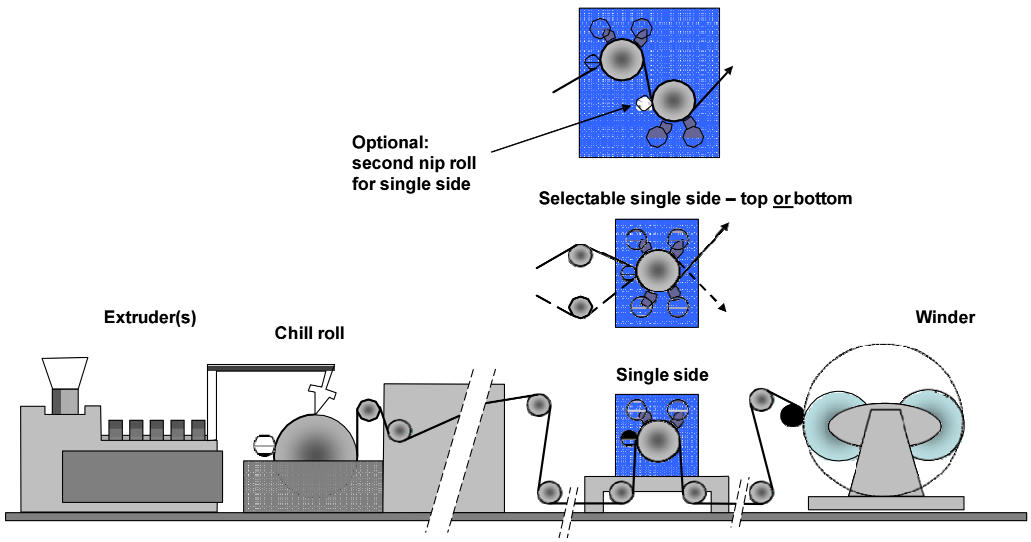


Fig. 13 Cast film extrusion line

For the power rating of the corona stations for blown film extruders and for cast film extruders it is certainly advisable to provide for a minimum surface tension of 42-44mN/m on polypropylene films and approximately 44-46mN/m on polyethylene films. These surface tensions ensure further processing without problems even after long storage times with low slip additive contents. They also provide a good basis for refreshing the surface tension in-line with further converting processes.

3.7.4. Printing

One such converting process is printing on polymer film or other webs of flexible material. A refresh corona treatment may be necessary even though materials are used which have already been corona treated during manufacture. Long periods of storage result in the surface tension being no longer high enough to guarantee satisfactory adhesion of the ink.

This process requires a surface tension of at least 38-40mN/m for printing with solvent based inks, 42mN/m for UV based inks, and 44-46mN/m for water based inks which are becoming more common in the printing industry for environmental reasons. If the surface tension falls below these values it is necessary to refresh the treatment before printing to ensure good adhesion between the film and the ink.

In addition to plastic films aluminium foils, usually soft, annealed aluminium, are also treated before printing. The use of KB ceramic electrodes in the corona stations, as described previously, is required for this purpose. In this case corona treatment can replace anchor coating which would otherwise be necessary to print on pure aluminium.

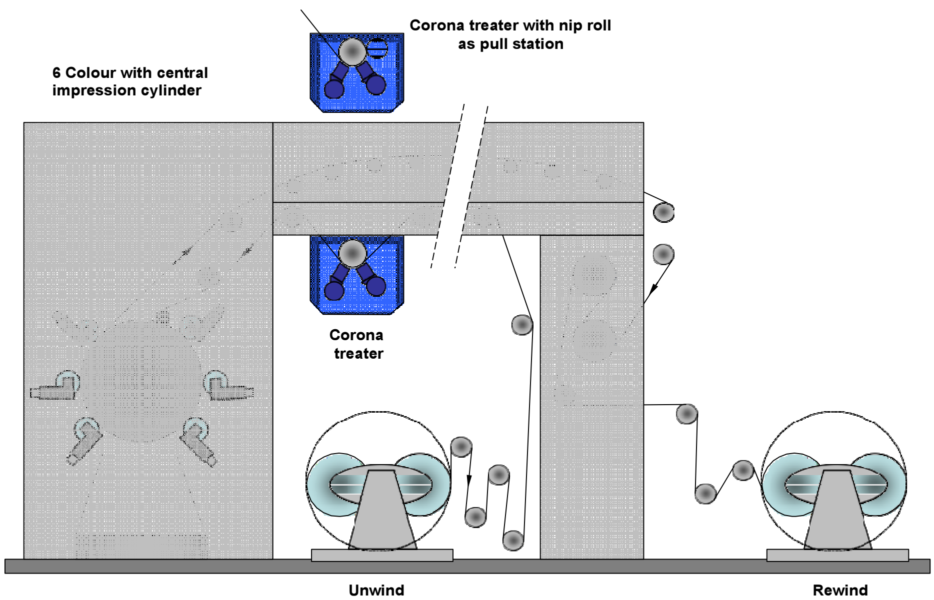


Fig. 14 Flexo printing

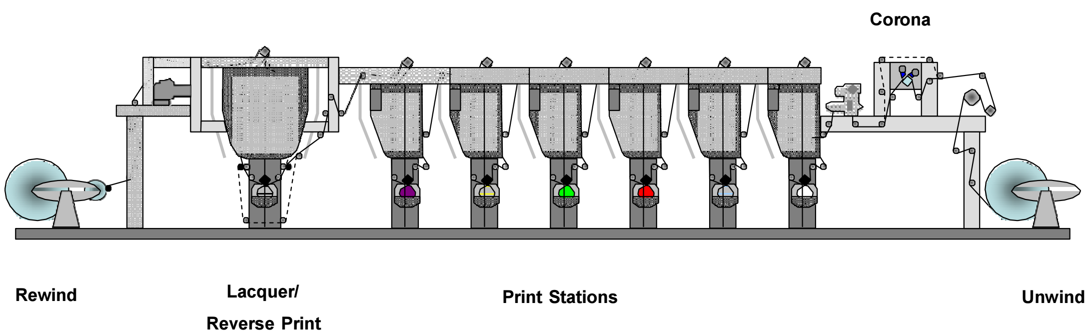


Fig. 15 Gravure printing

3.7.5. Laminating

The same rules apply to wet or dry laminating of flexible materials as to printing. It is recommended to treat the carrier web and the laminate web with corona since it is very important for both parts of the laminate to have good adhesive properties.

The corona station should be situated as close as possible to the coating or laminating unit in order to keep the risk of contamination of the treated surfaces from path rolls to a minimum.

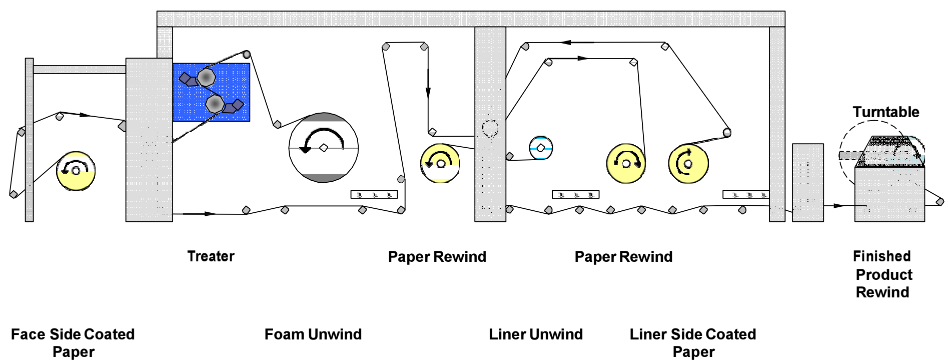


Fig. 16 Foam lamination for double side tape

3.7.6. Extrusion coating and laminating

Another important application of corona treatment is in extrusion coating and laminating. Base materials such as paper, cardboard, aluminium and plastic are used here in various forms. These are laminated or coated using a plastic melt, and all materials should be corona treated in-line before coating or laminating to achieve an acceptable degree of laminating strength.

In this case, the corona treater is installed as close as possible to the laminator prior to the anchor coating unit. Depending on the material and demand of bond strength, in some cases the LDPE coating can be carried out without anchor coating by use of the corona treatment with considerably lower costs.

In addition, it is often necessary to treat the plastic coating, usually LDPE, for further processing.

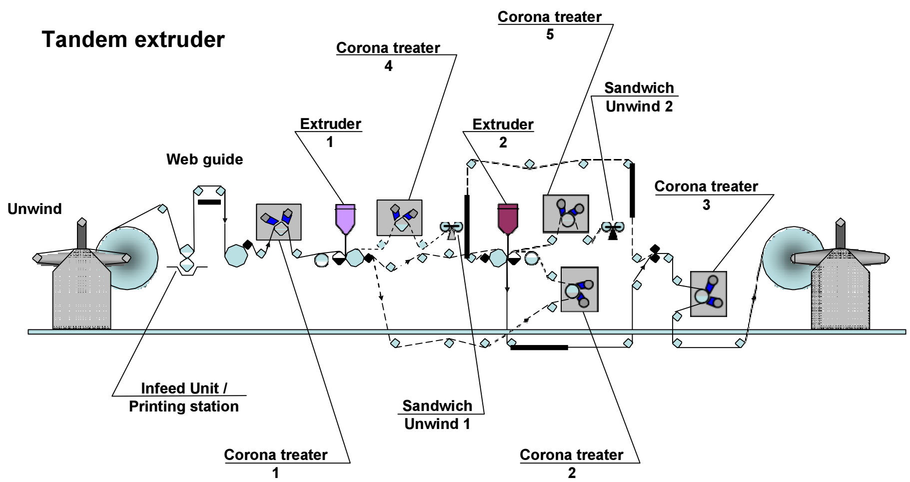


Fig. 17 Extrusion coating/Lamination

For the post treatment of LDPE coated paper and board the decrease of surface tension must be taken into consideration. Due to contamination of the LDPE coated side by the uncoated paper side the decrease of the surface tension is much higher than on paper or board coated on both sides. Depending on the period of the storage until further processing it may be necessary to carry out a second treatment in-line with the processing machine.

As mentioned earlier, corona treatment has a negative influence on the sealing strength in heat sealing. For materials which have to be printed and heat sealed on the printed side by further processing ,a uniform surface tension which must neither be higher nor lower than 37-38 dyne/cm is essential. This surface tension is sufficient for a good adhesion of solvent based printing inks as well as for good sealing strength. A uniform surface tension can only be achieved by a speed dependent power control of the generator in order to ensure the same surface tension at different speeds. This power control is an optional device in all SOFTAL generators.

3.7.7. Other applications

Apart from those already described, there are a number of other applications, such as cup printing combined with pin hole detector, coating machines for webs and sheets, cable printing, label printing, folding box machines and other special areas which are too numerous to be covered in this overview.

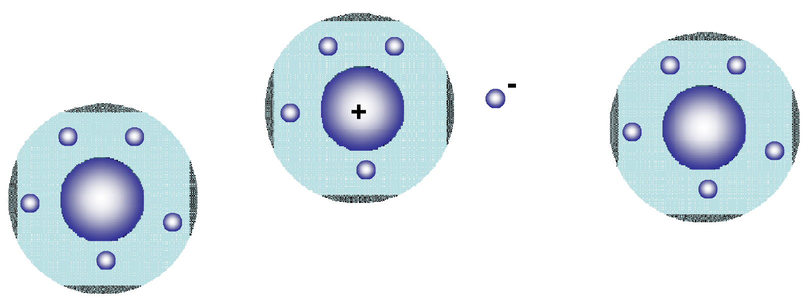
3.8. Outlook

For the future, the aim of further development of corona technology will be to optimise the generator technology and the electrode systems and in this way to increase the efficiency of the equipment. Users, machine manufacturers, and the manufacturers of raw materials make an important contribution by presenting their practical experiences, ideas and requests to the manufacturers of corona equipment so that this feedback may also be included in design reviews.

4. Plasma

4.1. What is plasma?

Generally speaking, plasma is a gas, in which atoms/molecules are ionized i.e. negative electrons are separated from positive ions.



This can be created by an electrical discharge, examples being, fluorescent tube lighting, automobile spark plugs, and corona discharge.

Plasma can be created in negative pressure i.e. vacuum or, for more practical use in continuous, non batch production applications at atmospheric pressure.

Atmospheric Pressure Plasma is highly suitable for treating the surfaces of thermally sensitive polymers. This method can also process materials of unlimited thickness. Another application, plasma in a controlled gas atmosphere offers a replacement for wet-chemical adhesion promoters.

Atmospheric-pressure plasma and corona technology have been widely used for many decades for surface treatment in the extrusion and converting of polymers. Atmospheric pressure plasmas continually open up new fields of application. The main focuses are the adaptation of the plasma sources to materials and geometries, and plasma-induced surface functionalisation. Against this background, SOFTAL Corona & Plasma GmbH, Hamburg, Germany, has developed Linear Plasma technology and ALDYNE™ atmospheric plasma treatment.

4.2. Plasma Initiates Chemical Reactions

The aim of corona treatment is to adjust the surface energy in a controlled process to improve adhesion of inks, lacquers, adhesives and coatings. The volume properties of the polymer matrix are not changed. Besides its good efficiency, its use is also favoured for its controllability, ease of handling and low operational costs.

During treatment, the plasma activates a large number of chemical reactions in the air within the electrode gap and on the polymer surface. The result is the chemical bonding of functional groups, such as hydroxides, ketones, ethers and carboxylic acids to the polymer surface. These are polar groups and increase the surface energy. In practice, conventional corona technology is limited to two-dimensional materials with thicknesses of a few millimetres.

4.3. Linear Plasma

Linear plasma surface technology allows materials of any thickness to be treated.

Fig. 18 Linear Plasma treating foam

Atmospheric-pressure plasma treatment modifies the surface of plastic sheets, polymer foams and composites in the sub nanometre range, so that adhesives, printing inks, lacquers and other coatings adhere reliably. This plasma source also allows the treatment of highly thermally sensitive materials.

Fig. 19 Multiwall and foam materials treatable with Linear Plasma

The surface of multiwall panels or honeycomb structures may also be activated in this way. In open structured foam, there is no risk of localized preferential discharges, and closed-structured foams are not perforated. Furthermore, the edges of the material webs are not damaged by the plasma discharge. Therefore it is not necessary to adapt the electrode width to the material width. The Linear Plasma system can be installed in existing extrusion and converting lines.

Fig. 20 Linear Plasma Station

4.4 Surface Treatment in a Controlled Gas Atmosphere

The ALDYNE™ process – used as surface treatment in a controlled gas atmosphere – achieves the efficiency of wet-chemical coating processes for a fraction of the costs. It permits targeted control of the chemical processes that take place in the plasma, and ultimately on the surface to be treated. As a result, functional coatings of the thickness of a monolayer (typically 0.3 to 0.4nm) comprising, for example, amide, imides and amino groups, are created which are covalently bound to the outermost polymer chains. These functional groups allow the polymer to bond with adhesives and other coatings.

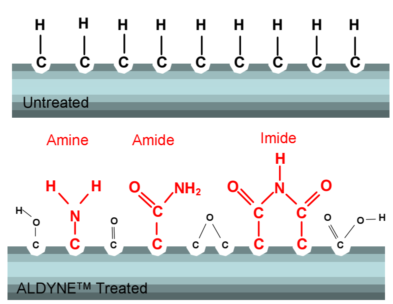


Fig. 21 ALDYNE™ Functionalisation of Polymer Surface

In certain applications, where adequate bonding using corona treatment is not possible, adhesion-promoting liquid primers are often used. These increase manufacturing costs for the substance, the application process and the removal of organic solvents. Treatment in a controlled gas atmosphere offers an alternative to liquid primers on polymer surfaces such as polypropylene (PP), polyethylene (PE) and polyethylene terephthalate (PET). In comparison, under normal production conditions, the ALDYNE™ process costs only one tenth of treatment using conventional primers.

As no liquid or solid materials are involved in the ALDYNE™ surface treatment, re no residues and contamination are created. And, since no solvents are utilised, there is no need for cleaning and drying, with associated downtimes. The process gases utilized in the process are harmless to health, non-hazardous and environmentally safe. The same applies to the layers created because of their composition and the small amounts of substance. Since a covalent bond is present, the adhesion promoter is also not volatile.

4.5. Water-cooled Electrodes for improved Plasma Output

The second generation equipment now incorporates water-cooled electrodes which allow high plasma outputs to be achieved with a reduction in station dimensions, and without harming the materials. The chemical processes at the material surface are intensified by the concentrated plasma discharge.

The second generation housing has been optimized and new sealing systems installed to reduce gas consumption and cut operating costs. Currently, systems up to 2.2 m wide with speed capability of 300 m/min are available. Further developments are being researched in the SOFTAL Plasma Centre.

Fig. 22 ALDYNE™ Station

5. Summary

Corona Treatment

- after more than 50 years, corona treatment remains an important part in surface treatment
- if corona treatment can do the job it remains the most economical solution
- investment and running costs are still unchallenged

Linear Plasma Treatment

- smooth treatment of sensitive films without direct discharge through the material
- treatment of thick materials where classic corona treatment is not feasible
- no material stress
- no edge damage in foam treatment

ALDYNE™ Atmospheric Plasma Treatment

- creates higher surface tension levels than corona treatment
- can substitute chemical primer and top coating in converting processes
- creates new functional groups

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