KNOWING **SURFACE** TREATMENT

An Industrial Reference Book
by IEEC POWER ELECTRONICS PVT. LTD.

IEEC
Corona • Plasma • Ozone

50 YEARS OF EXCELLENCE IN CORONA PLASMA OZONE

PREFACE

In the Surface Treatment industry, as in any other shifting business landscape today, acquiring the best technology available is a vital move. But it may not be adequate. Only a thorough technical understanding helps you pick the right product that adds value to business. It helps increase productivity, raise overall efficiency of your production processes, minimize downtimes, produce less waste, return fewer customer rejections, and creates an overall smooth running operation. You get better RoI and most importantly, customer satisfaction. But how do you gain this technical know-how?

Armed with 50 years of experience and knowledge gathered through extensive research, we at IEEC, feel that it is our responsibility to share our technological prowess with you, our customers. Having covered the principles, types, and working of surface treatment technologies available today, we have created this handy reference book. For customers involved in the business of extrusion and conversion of plastic films, this book will provide answers to: Why do plastic materials need surface treatment? What are different types of surface treatments depending on the application? How to measure the amount of treatment required? How to configure the treatment equipment and basic troubleshooting and maintenance? Learn tips that will prevent your equipment from failing, and more.

We hope that this book can work as a valuable industrial reference, enabling you to understand surface treatment better and gain from it.

WOULD YOU LEAVE YOUR BUSINESS TO CHANCE?

WITHOUT A CORONA TREATER:

Your order from a prestigious company is getting printed. But ink is coming off from the latest batch. The deadline is fast approaching. Unfortunately, your order is now at stake.

WITH A CORONA TREATER:

Your regular client has suddenly placed a huge order. You know that your ink will pass the tape test and material will not delaminate. You can print with confidence and bag the opportunity.

THAT'S WHY
CORONA TREATMENT
JUST BEFORE PRINTING,
LAMINATING OR COATING
IS A MUST.

BENEFITS OF A CORONA TREATER

1

INCREASES SURFACE ENERGY OF THE SUBSTRATE

2

IMPROVES ITS WET-ABILITY ALLOWING ADHESION OF INKS

3

RIDS THE SURFACE OF CONTAMINANTS THAT CAN INTERFERE WITH ADHESION

4

ALLOWS FOR A CLEAN AND CONDUCIVE PRINTING SURFACE

DON'T DEPEND ON CHANCE.
INSURE DEPENDABLE QUALITY.

IEEC
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50
YEARS
OF EXCELLENCE IN
CORONA
PLASMA
OZONE

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CHAPTER 1

SURFACE TREATMENT: WHAT & HOW

From transportation to clothing, nutrition to medication - it is impossible to imagine human life without polymeric materials. Riding high on the many benefits of this material, many emerging industries now manufacture them. However, industries that process plastic, especially those in the business of extruding or converting plastic films, woven fabric or other films face the problem of poor bonding of inks, coatings or adhesives with the substrate. Surface treatment technologies like Corona or Plasma Treatment play a vital role in tackling this.

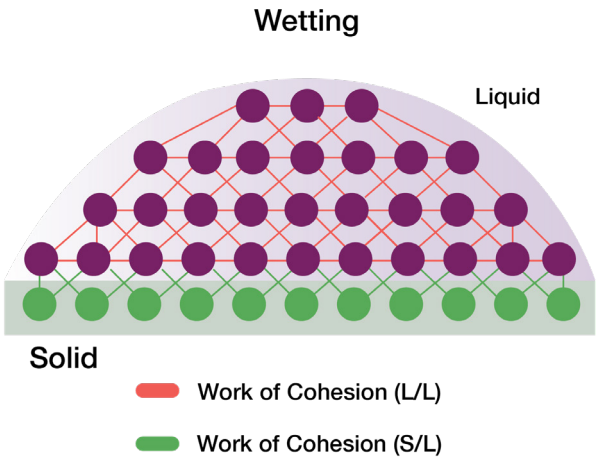


Fig 1: Understanding Adhesion

HOW CORONA AND PLASMA TREATMENT WORKS

Surface tension (surface energy) of polymeric materials is described as the reactivity of the surface of a solid substrate. It is measured in Dynes / cm in liquids or solids. For liquids, it is the measure of the intermolecular forces between molecules of the liquid. Molecules at the surface of a drop of liquid exhibit a net force that attracts them to the interior. The reaction when a drop of liquid comes in contact with the surface of a substrate is vital.

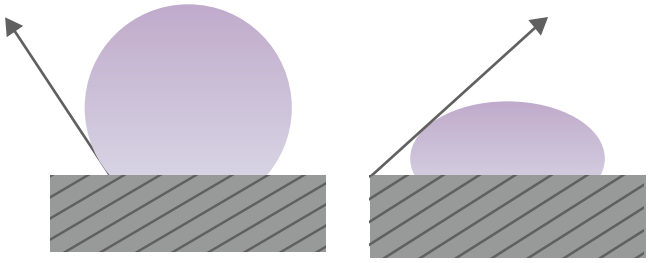


Fig 2: Understanding Wettability

POOR WETTABILITY OF POLYMERIC MATERIALS

Due to chemically inert and non-porous surfaces of plastic materials, liquids exhibit poor ability to spread completely on flat and horizontal surfaces of plastic materials. This makes plastic materials non-receptive to the adhesion of printing inks, coating, adhesives, etc. The contact angle formed between a drop of liquid and a solid defines wettability exhibited by the polymeric material.

A drop of liquid can wet the surface of solids very differently based on its surface tension. The contact angle gets smaller with the increase in surface tension of solids. Similarly, liquids with decreasing surface tension wets the solids better. The extent to which a liquid can wet a solid depends on the boundary and surface tension of both the liquid and the solid.
In many applications including printing, coating

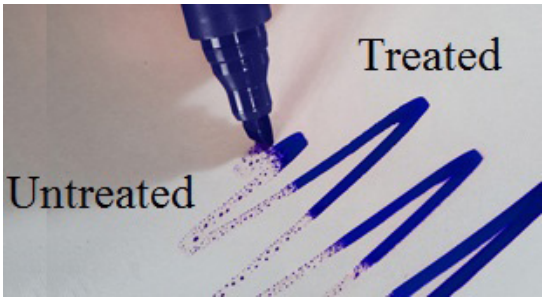
and lamination, it is important to have the smallest possible contact angle to enable the inks, coatings or adhesives to completely wet the plastic material. Surface treatment makes plastic material receptive to liquids, thus, decreasing the contact angle. Hence, it is important to understand what goes into surface treatment.

As a rule of thumb, the dyne level of the substrate has to be at least 10 points higher than the dyne level of the liquid being applied. The best method to determine the treatment level required for the application is through trial and error. The 10 point rule is a good foundation to begin trials. The dyne level of the ink is known as it is provided by the ink supplier but the dyne level of substrates is important to determine as the treatment levels change with time.

Dyne levels of commonly used materials in the converting industry based on particular applications are given below.

GOOD2KNOW

Smaller the contact angle, higher the surface tension of the substrate.



TIPS4TREATMENT

FOR BETTER WETTABILITY

Surface Tension of Solid> Surface Tension of Liquid

SUGGESTED SURFACE TREATMENT LEVELS (DYNES/CM)

	FLEXO PRINTING			SCREEN PRINTING			COATING/ LAMINATING	
Material	**Solvent**	**Water**	**UV**	**Solvent**	**Water**	**UV**	**Solvent**	**Water**
LDPE	36-40	39-44	40-50	39-44	42-48	46-60	38-45	42-50
HDPE	35-40	38-44	38-50	38-44	42-48	46-56	38-44	42-50
PET	40-46	44-52	42-52	42-48	48-60	44-62	42-48	42-60
PP	36-40	38-44	40-50	38-44	42-48	44-60	38-44	42-50
PVC	36-40	38-44	36-50	38-44	42-48	42-60	38-45	40-48

Table 1: Values are for reference only and actual required values may differ as the slip and other additives, physical handling and storage conditions also affect adhesion properties.

CHAPTER 2

CORE TECHNOLOGIES

Knowledge is power. In this section, we will shed some light on the different technologies used in Surface Treatment so you may understand it more deeply and use each technology with greater benefit.

CORONA TREATMENT

In Corona Treatment, the film is passed over a roller through the air gap between the fixed electrode and the dielectric. Here the film is exposed to a very high voltage potential at a very high frequency, which causes ionization of air. The equipment used to achieve this comprises a generator, which converts the available 230V / 415V, 50Hz power supply to a high voltage transformer and the treating station itself. Now under the influence of the electric field, the ionized air molecules are made to move about. As the electric field increases, so does the speed and hence the kinetic energy of the ionized air molecules. The random collision of these ions with other charged ions result in increase in the number of ions. Thus, when sufficient electric field is developed, the air gap can be said to have broken down into an ionized current carrying conductor. During this process, the atmospheric oxygen is broken down into nascent oxygen and Ozone.

$$2O_2 \rightarrow O + O_3$$

The ozone is extracted out of the system whereas the active nascent oxygen immediately oxidizes the film.

In a nutshell, energy of the corona breaks the molecular bonds on the surface of the non-polar substrate. The broken bonds recombine with free radicals in the corona environment to form additional polar groups on the surface of the film. These polar groups have a strong attraction towards the polar inks and adhesives, resulting in improved adhesion.

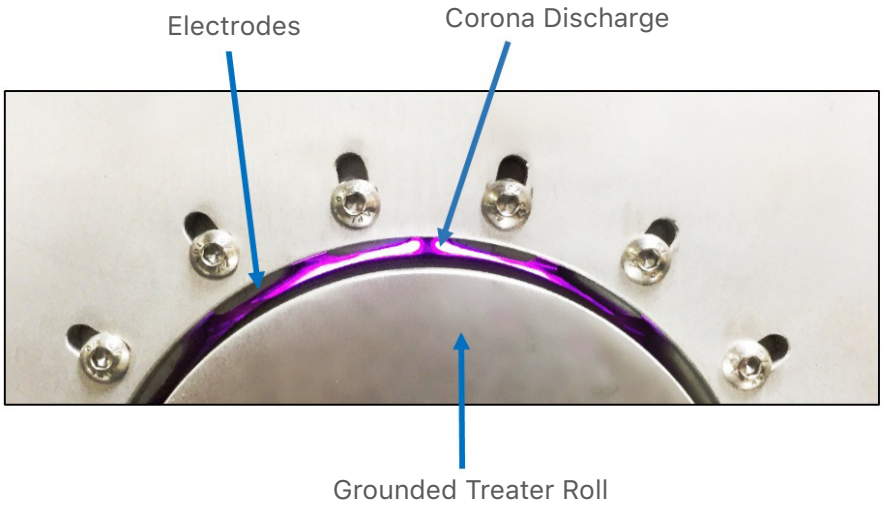


Fig 3: Understanding Treater Roll

A. COMPONENTS OF A CORONA TREATMENT SYSTEM

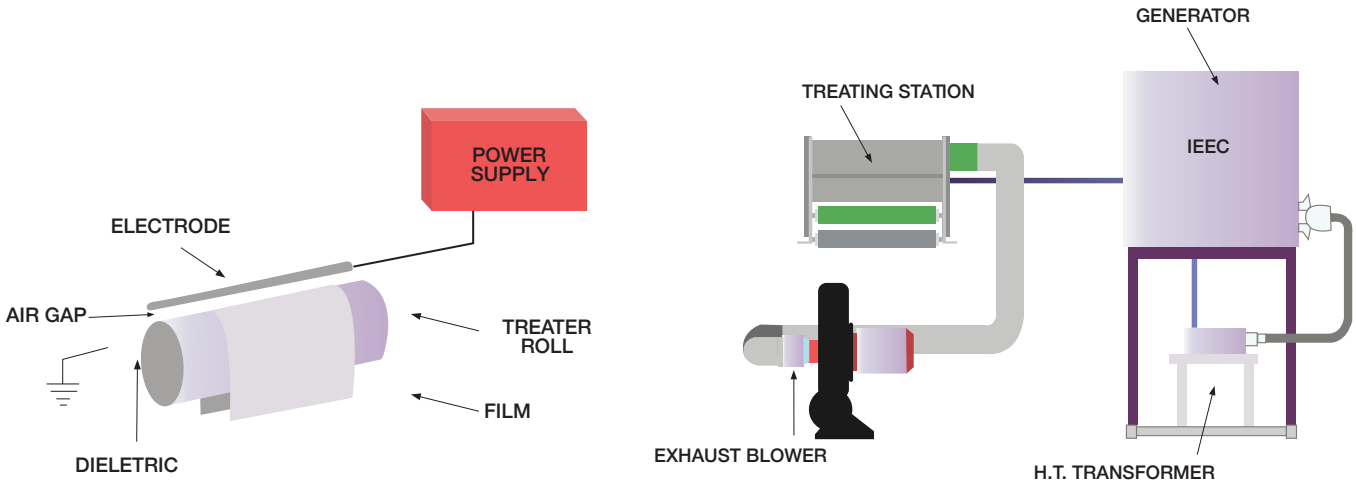


Fig 4: Power Generating Source + Treating Station

POWER GENERATING SOURCE:

Comprises a high frequency generator and a high voltage output transformer

The function of the power source is to raise the normally available 230V / 415V. 50Hz mains power supply to a very high frequency (40-50 KHz) and high voltage (20 kV). Power generators are rated in kilowatts (kW) and range from 500W to 60kW depending on the application.

Fig 5: Power Generating Source

TREATING STATION:

Comprises a high voltage electrode and a grounded roll

To produce a conducting atmosphere, either the electrode or the ground roll should have a dielectric covering.

Fig 6A: Coating

Fig 6B: Narrow Web & Labels

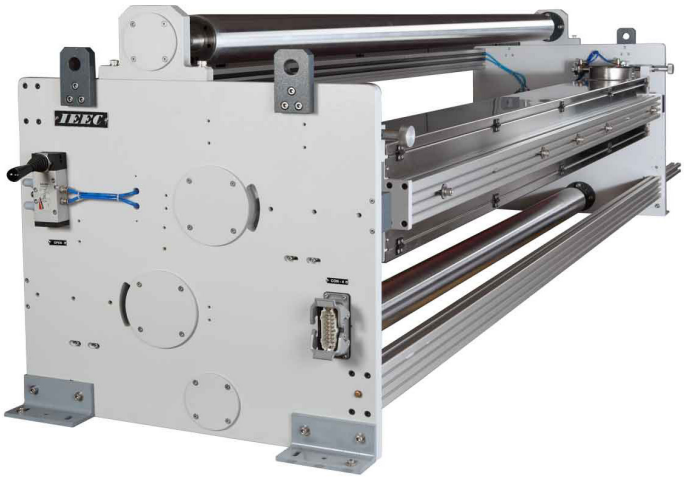


Fig 6C: Extrusion Blown Film

Fig 6D: Converting

Fig 6: IEEC Corona Treating Stations for Different Applications

Treating Stations are broadly classified into Covered Roll and Bare Roll.

COVERED ROLL - The ground roll is provided with a dielectric covering whereas the other high voltage electrode is a bare metal.

Why use a covered roll treating station?

- Specifically designed for non-conducting substrates.
- Substrates with high slip are agents, difficult to treat, are treated by using covered roll treatment stations.
- Depending upon customer specifications, a variety of dielectric coverings are used.

Disdvantages of covered roll treating station

- Metallized substrates cannot be treated.
- Field repairability caused by the dielectric failures is very difficult.

BARE ROLL - The dielectric covering is provided on the high voltage electrode whereas the ground roll is just a bare metal.

Why use a bare roll treating station?

- No need of dielectric roller sleeve or a dielectric coating, which frequently needs to be replaced or repaired in case of puncture - increasing the downtime. In case of bare roll, a bare stainless steel/aluminium roller is used as a treater roller.
- Uniform Corona Treatment across the transverse width of the substrate.
- This system can treat metallized (conductive) and non-metallized (non- conductive) substrates.
- Perforated webs can be easily treated in these systems.
- The electrode width need not be adjusted as per the substrate width.
- The High Dielectric constant and Low Electrical Resistance of the ceramic electrode help in achieving higher dyne levels of treatment. This is because high dielectric strength helps in discharging high electrical power / sq. inch.

Disadvantages of a bare roll treating station

- High volume of air is required to cool electrodes.
- Certain substrates with high slip agents cannot be treated.
- Efficiency is low compared to covered roll electrode.
- Cost of the bare roll treating station is high.

B. DIELECTRICS IN CORONA TREATMENT

Corona Treatment has been an integral part of the flexible packaging industry. Yet, the correct selection of dielectrics is something to ponder upon. The final treatment on to the substrate depends upon various factors. One important factor is the air gap maintained between the electrode and the substrate. "More the power, more the treatment" is not always valid. Because of the losses, not all of the power leaving the generator is converted into required corona.

GOOD2KNOW

It is critical for the transformer to match impedances of the treater assembly system with the generator.

The mismatch of these impedances causes the generated power to reflect back to the generator in the form of heat. This in turn affects the overall power factor of the system. Poor Power Factor means that the voltage and the current are getting out of phase. The high current drags down output voltage, thereby reducing the power in the air gap, causing heat losses in the high tension cable. The treater station configuration is often referred to as the load, which is made up of the structure, and the type of electrode, the air gap maintained, the type of substrate, and the dielectric sleeves/coatings used on the grounded roller.

If there is any change in the load, it is necessary to tune the frequency accordingly. To match the correct impedances it, is very important to select the correct dielectric coverings.

TIPS4TREATMENT

It is important to match the output power with the load in order to achieve the required efficient treatment.

DIELECTRIC MATERIALS

Your specific applications and priorities as a user will determine which dielectric materials will be ideal for what purpose.. A brief description of the strengths and weaknesses of each material may help your decision. Before comparing the dielectric materials, let's understand some definitions.

DIELECTRIC STRENGTH: It is the ability of the material to withstand the applied potential difference without causing the arcing across the insulator. More the dielectric strength, less is the cross sectional area of the electrode. As the thickness of the electrode is reduced, less will be the power required for efficient Corona Treatment.

DIELECTRIC CONSTANT: It is an indicative ability of an insulator to deliver electrical charge. The capacitive impedance of the dielectric is directly related to the dielectric constant. The voltage gradient induced through the dielectric layer is inversely proportional to the dielectric constant.

RESISTANT TO PHYSICAL ABUSES: The material should withstand harsh environmental operating conditions of the corona treater. Splices, knife cuts, web friction, moisture contamination, lump bangs etc. can lead to dielectric failure.

OZONE RESISTANCE: Ozone, which is a by-product of the Corona Treatment, is highly corrosive and affects most kinds of materials. Corrosion causes structural damage of materials, which in turn reduces the dielectric strength and causes abrupt failure of the system. It is always advisable to use a material with excellent resistance to ozone.

HEAT DISSIPATION: A material that easily dissipates heat should be selected.

POROSITY: Porosity leads to air entrapment and absorption of moisture, which can cause tracking of the electrical discharge to the ground. A material with low porosity is recommended.

FIELD REPARABILITY: Whenever there is a premature arcing in the dielectric material, the treating system is non-functional until replaced by a new one. It is advisable to keep a spare dielectric roller or electrode in order to minimize the production losses.

MAXIMUM SERVICE TEMPERATURE: High temperature often causes the burning of dielectric coverings. This can be reduced by optimizing the temperature in the system by force cooling in case of dielectric sleeved rolls and by creating a negative pressure in the ozone exhaust duct in case of dielectric electrodes.

HARDNESS: Surface hardness prevents abrasion.

COSTS: Each application should be analyzed to determine the best material for that particular purpose.. The cost depends on the selection of the treatment system.

Three types of dielectric materials are available:

- **ELASTOMERIC:** Such as silicone, bonded silicone and hypalon, and some special blends
- **INORGANICS:** Such as glass, glassed steel, quartz, and ceramics
- **PLASTICS:** Unsaturated polyester and epoxy pose good dielectrics

THREE MOST WIDELY USED DIELECTRIC MATERIALS ARE:

SILICON can be offered in a sleeve design instead of coating, which translates to less roll repair time. Sleeves are readily available in commonly used roller diameters. Instead of sending rollers for reworking when there is failure, Silicon Sleeves can be easily removed and replaced with relatively inexpensive replacement sleeves. Downtime is significantly reduced for a properly designed treating station. A spare roll is normally recommended in addition. These benefits along with excellent electrical strength of silicon, makes it a popular dielectric material.

Fig 7: Silicon

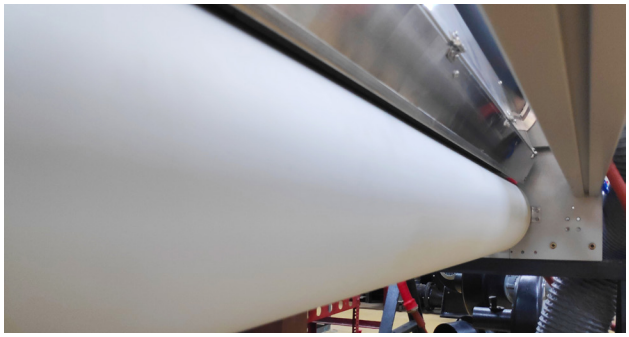


Fig 7: Silicon Coated Roller

SILICON COATING, unlike silicon sleeve, is applied directly on the bare roller and vulcanized. Coated silicon usually exhibits very good temperature resistance and high dielectric strength, but it often displays much lower tear strength and is more prone to mechanical damage.

CERAMICS, being the most expensive dielectric materials, perform the best. They have excellent electrical and mechanical properties. The extremely high dielectric strength of ceramic material allows for thinner wall thickness compared to other materials. It is preferred when very high surface treatment levels are required. Because of its hardness, it is excellent for harsh environments and shows more durable performance than any other material.

Fig 8: Ceramic Coated Roller

COMPARISON OF DIELECTRICS

Table 2: Dielectric Comparison

	Dielectric Constant	Dielectric Strength (kv/m)	Ozone Resistance	Heat Dissipation	Resistance to physical abuses
Epoxy	3-4	17716	Good	Fair	Excellent
Hypalon	5-6	15748	Good	Fair	Poor
Silicone	4-5	17716	Good	Good	Poor
Ceramic	8-10	19685	Excellent	Excellent	Excellent
	Field Operability	**Porosity**	**Maximum Service Temperature (C)**	**Hardness (Shore A) Rockwell C**	**Costs**
Epoxy	Excellent	Good	87-120	70-80	Low
Hypalon	Fair	Excellent	65-150	60-90	Low
Silicone	Fair	Excellent	120	60-90	Medium
Ceramic	Poor	Good	175	55	High

C. TYPES OF ELECTRODES

There are two types of electrodes and the choice depends upon specific applications, and the material being treated.

METAL ELECTRODES

In metal electrodes, the extrusion process is not restricted by the conductive materials – giving a greater choice of electrodes. Usage of fixed width or segmented electrodes made from aluminium or stainless steel depends upon the widths that the film manufacturer is producing. Most film manufacturers prefer using segmented electrodes, as it allows them to run their extrusion lines for a longer period of time without modifying the Corona Treatment system.

Fig 9: Aluminium/Steel - Fixed/ Segmented Width Electrodes

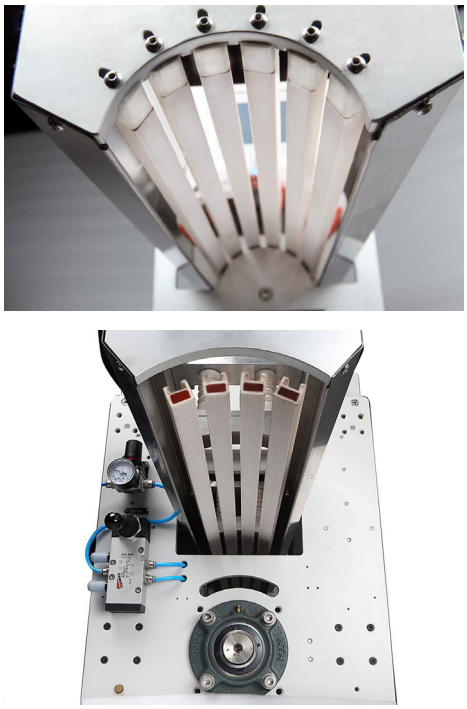


Fig 10: Ceramic Electrodes

CERAMIC ELECTRODES

Ceramic electrodes offer the flexibility to treat conductive and non-conductive films, but are rarely used in extrusion blown film or cast film lines. The most common application of ceramic electrodes is converting lines where more flexibility is required to treat a variety of materials. Ceramic electrodes are fixed length electrodes and cannot be configured in segmented form. They require proper cooling as the chances of breakage increase due to overheating. Hence proper heat/ozone extraction is vital in this configuration.

D. PROBLEMS CAUSED DUE TO CORONA TREATMENT

Problems with adhesion on extrusion and converting lines can be traced back to corona treater and film, ink, coating and adhesives. This could be because of a limit to which a material can reach a certain dyne level. Here are some common problems in extrusion and converting faced by companies around the world, assuming that the corona treater is correctly specified in terms of number of electrodes and power:

IDEAL LOCATION

Location plays an important role when configuring your Corona Treatment system. It is necessary to be as specific as possible about the location of the system. Whether installed at the top of the tower or at the bottom of the extrusion blown film line, this will define the configuration of the Corona Treatment system. The film has high temperature at the top so treating becomes easy (high slip film has high treatment decay rate). Even on converting lines, the distance of the corona treater from the printing station, coating unit, lamination nip, extrusion T-die etc. will result in different challenges.

BLOCKING

The degree of oxidation of substrate is directly proportional to the level of treatment. The polar groups, formed during the Corona Treatment, attract the molecular layer present on the other side of the web. As a result of this, when two sides that are in roll form come in contact with each other, self-adhesion between the two sides take place. The adhesive force between the two sides is sometimes greater than the internal bond strength of the substrate; as a result of which when the product is unrolled, delamination of the substrate takes place.

GOOD2KNOW

Keep an optimum winding tension in the roll - as greater the tension, more the blocking. Blocking increases towards centre of the roll.

BACKSIDE TREATMENT

When the air on the other side of the film which is to be untreated get ionized, it leads to the treatment of that side and the phenomenon is called as the backside treatment. This takes place because of the venturi effect. The film moving at a very high speed carries along with itself, a cushion of air on both its sides. This trapped air can be removed from the untreated surface by providing higher tensions in the films and by increasing the diameter of the roller thereby, increasing the wrap angle of the film with the roller. The other option is by providing a nip roller before the entry of the film into the treater roller.

SCRATCHES

During Corona Treatment, high amount of heat is generated leading to thermal expansion of the electrodes. As a result, the air gap between the electrodes and the roller is disturbed. This increases the chances of the electrodes touching the film surface, resulting in scratches. This can be prevented by increasing the air gap, but it may result in areas with uneven treatment levels. That is why, it is important to extract heat out of the system properly. Using ceramic electrodes instead of metal electrodes can also solve this problem.

MARKING

After undergoing a very potent Corona Treatment, the surface of the film develops marks when in contact with idler rollers and winder drums. This results in loss in gloss and rough surface finish when looked under magnification. This can be prevented with the use of ceramic electrodes.

OVERTREATMENT

Higher treatment levels create polar groups which may attract moisture or excessive water from the adhesive/ink/coating, resulting in poor bond layer at the surface. Overtreatment can take place with most of the substrates; some being more vulnerable than the rest. Materials like PET and LDPE (low slip) require less power to treat and are more likely to be over treated. On the other hand, materials like BOPP, CPP, and HDPE, which are difficult to treat, exhibit poor adhesion even with dyne levels. This holds true for every surface treatment method, Corona, Flame, Plasma, Chemical, etc. Depending on the treatment process, pin-holing, surface/treatment decay are some of the signs of overtreatment. Observing and learning how to manage the treater power with respect to film performance as a function of line speed and other process parameters, is key. Once a good understanding of treater power management is achieved, overtreatment can be toned down.

HEAT SEAL-ABILITY

Excessive treatment onto the film may hamper the heat sealing property of some materials.

PINHOLES

If the substrate contains traces of moisture or some conductivity, a heavy dosage of corona may get short through the spot, thereby burning a small hole through the substrate.

HOW TO MANAGE THESE CONCERNS

There is a need to pay special attention to power management with respect to additive loading in each polymer during extrusion. Two main influencers of the adhesion results are the mechanical features and the correct location of the treater.

TIPS4TREATMENT

For blown film lines, it is necessary to equip the treater correctly to achieve lane treatment — such as segmented electrodes.

For converting applications we can run trials on your films and help you achieve your desired results. Write to us on info@ieecpe.com to know how.

E. BOOST TREATMENT

Corona Treatment is a process primarily done on the extrusion blown film lines by the film manufacturers to enhance the surface properties of their films. Treatment levels also tend to decay with time, the decay rate being more visible for films with high slip content. The decay rate and high slip content does not permit the film manufacturers to store the films for longer duration or until the converter needs it. Furthermore, the decayed treatment levels create adhesion issues at the converting stages.

Film manufacturers have tried upgrading their treatment systems, but factors like slip content and decay rate have always challenged them in retaining high treatment levels. To overcome this issue, film manufacturers have also tried treating the material to 50+ dynes instead of usual treatment values like 38-40 dynes. But that has only resulted in more problems like faster decay rates, overtreatment, blocking and degradation of the film characteristics.

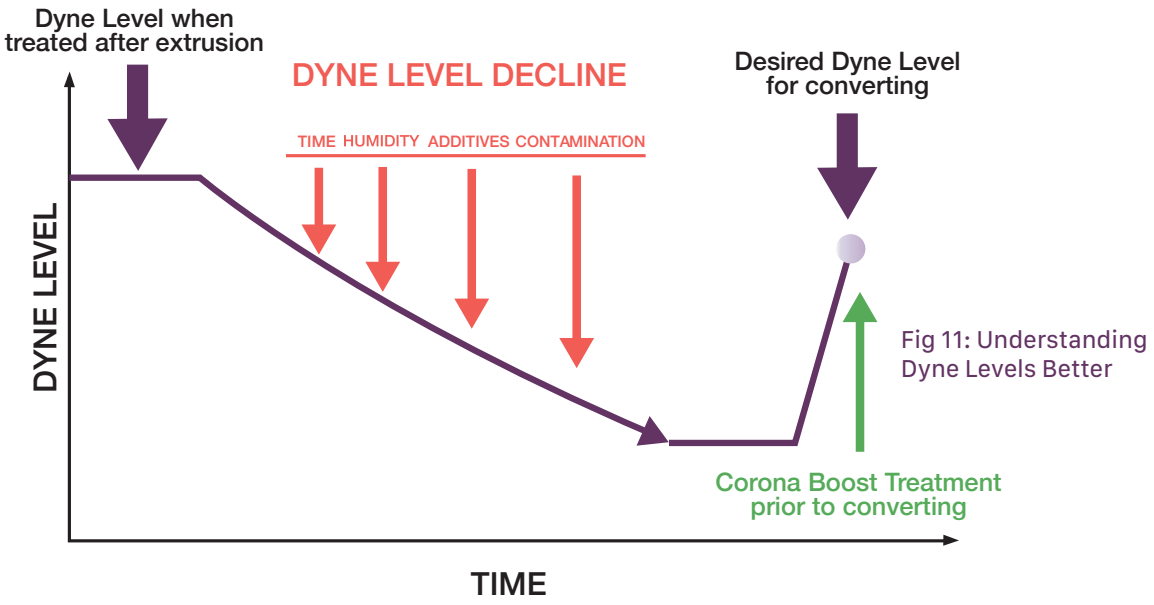


Fig 11: Understanding Dyne Levels Better

SOLVING THE ADHESION CHALLENGE

Solvent based inks do not face much of an adhesion challenge during printing as the required treatment levels are not too high. Films treated during extrusion suffice. But, increasing use of food-safe and water-based inks and frequent use of PP, BOPP and high slip films have changed all that. To overcome the adhesion challenge, it is a common practice to source a film that is treated during extrusion and then refresh the treatment levels by boost treating it before printing. Film suppliers treat the films to 38- 40 dynes during extrusion and expect converters to boost treat it before printing.

TIPS4TREATMENT

Install the corona treater right after unwinding the printing press to facilitate online Corona Treatment, eliminating the need to add one more offline operation in the printing process.

Even with other converting applications, Corona Treater is installed on extrusion coater/ laminator, solvent less and solvent base laminators and printing presses with a simple intention to boost treat the material to bring treatment levels to the original level.

The conversion to water-based inks and adhesives has had a significant impact on the converting industry. The use of Corona Treater and the need to understand surface treatment measurement is important for such applications.

BENEFITS OF BOOST TREATMENT

Less power, more impact: Boost treatment commands less power compared to that required to treat the films during extrusion, as it is only refreshing the original treatment levels. The most common example of boost treatment is the printer sourcing pre-treated films. Many factors including time, weather and storage conditions govern the decay of originally treated films. Converters prefer installing a corona treater on their machine that acts as an "insurance" against the rejections faced due to quality issues.

Easy to use and maintain: As boost treatment requires less power, corona treaters designed for these applications are relatively compact, and offer ease of operation and maintenance. Usually, bare roll treaters with ceramic electrodes are used for these applications as they are compact to install on most converting lines, low on maintenance and easy to use. Additionally, this configuration allows treatment on conductive as well as non-conductive films, enabling for experimentation with water based inks or coatings.

However, the use of difficult-to-treat materials coupled with water based inks and coatings calls for higher treatment levels and greater flexibility. So the Corona Treatment systems used for these applications are bigger and employ special coverings on the roller that provides improved treatment for films. Additionally, the use of reliable roll covering materials like ceramic reduces the maintenance issues and increases the life of the equipment.

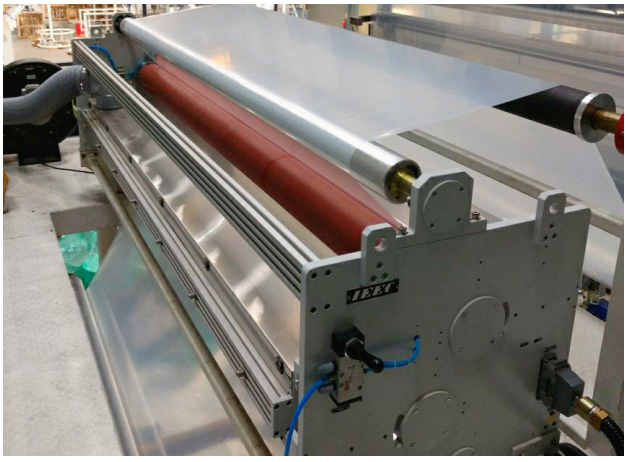
F. APPLICATIONS OF CORONA TREATMENT

Within the Flexible Packaging Umbrella, Corona Treatment is used:

In Extrusion: Only polymeric materials are treated: these are non-conductive films.	**In Converting :** The materials under treatment can be categorized into two types - conductive materials which include metallized films and aluminium foils and non-conductive films referred to as polymeric materials.

There are three main converting processes - printing, lamination and coating.

Based on the type of ink or coating, further considerations are made to configure the suitable equipment for a particular application. Other factors to be considered while configuring a Corona Treatment system are line speed, treatment sides (single/double), treatment level, and treatment width.



I. Corona Treatment for Extrusion Blown Film

All films need Corona Treatment during extrusion to prevent adhesion issues during converting. As a film is hot during extrusion, the resulting treatment on the film is more efficient and long lasting as compared to the treatment done on a cold film. Yet, the treatment levels on all films decay with time.

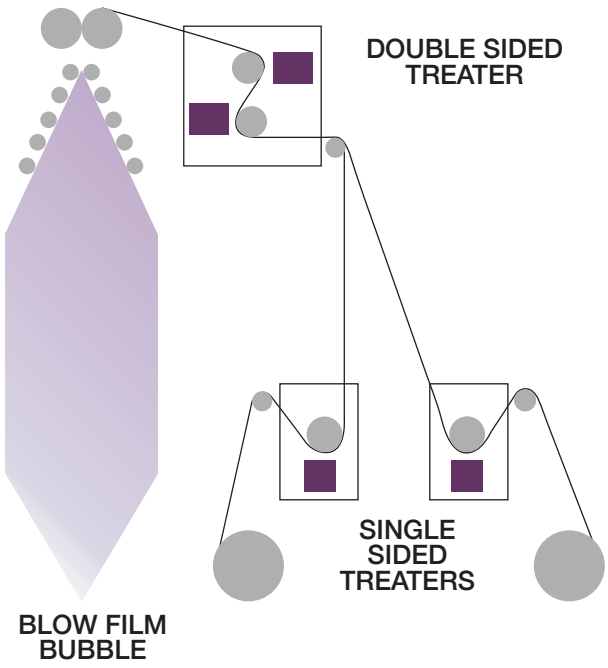


Fig 12: How a treater works

GOOD2KNOW

When specifying a corona treater for extrusion blown film line, the key parameter that affects the treatment is the additive content.

Let us look at the influence of additive content on treatment levels (additive content should be mentioned as a part of material description while configuring a corona treater)

INFLUENCE OF ADDITIVE CONTENT

Additives are added in the film to obtain certain desired characteristics. The amount of additive content is measured in parts per million (ppm). The film's capability for treatment and the amount of time the film will retain the dyne level depends upon the ppm of additive contained in the film. The amount of additive content varies as per the thickness of the film and C.O.F desired.

Additive Slip Content	C.O.F.
Very low (200 ppm)	Above 0.5
Low (500 ppm)	Between 0.3 to 0.4
Medium (1000 ppm)	Between 0.2 to 0.4
High (1500 ppm)	Between 0.1 to 0.4

Table 3: Typical classification of additive load

Most problems faced with Corona Treatment on extrusion blown film lines are due to the influence of additives. Not considering the amount of slip additive load used is one of the top reasons for low dyne levels after treatment. However, this can be corrected by running lower line speeds, which also lowers the production rate. The extrusion plants should be running at maximum capacity and not be restricted by the amount of slip additive content.

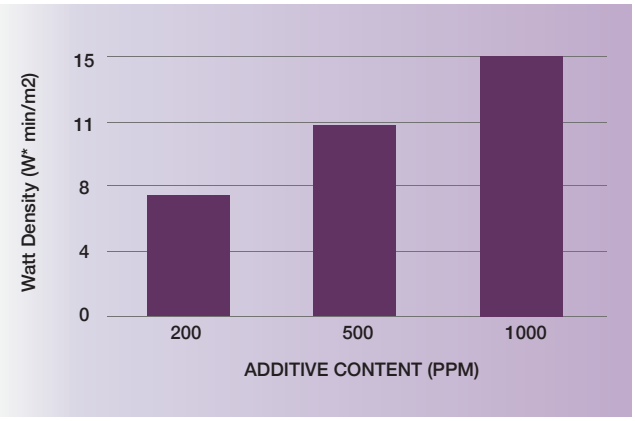


Fig 13: Influence of additives on extrusion plants

TIPS4TREATMENT

Take additive load into account while configuring your Corona Treatment system.

If your production is limited by the treater configuration, there are two options:

-If the treating station can handle more power, adding an additional generator will provide more power.

-Another way is to install your Corona Treater to the top of the extruder where the temperature of the film is high. Longer exposure to Corona discharge before the winding unit results in higher dyne values.

Both these solutions are effective in significantly increasing dyne levels.

CORONA TREATMENT FOR CONVERTING

Treatment level decays over time. Hence, using a Corona Treater on converting lines helps to boost treat the materials. Boost Treatment refreshes the treatment levels of previously treated films during extrusion which has lost its treatment over time during storage or transit.

TIPS4TREATMENT

Even for converting films right after extrusion, check the treatment levels on the entire roll of film as well as the treat width. This is your best insurance against rejection due to adhesion issues.

The rate and amount of decay depends upon the type of film, amount of time, treatment level, and the type of treatment. Within the first week of extrusion, Polyethylene with high slip content and Polypropylene can lose up to 6 dynes/cm, and PE with high treatment level can lose up to 5 dynes/cm. Within the first month, the treatment level of high slip can go as low as 36 dynes/cm, a point at which the material will face adhesion issues.

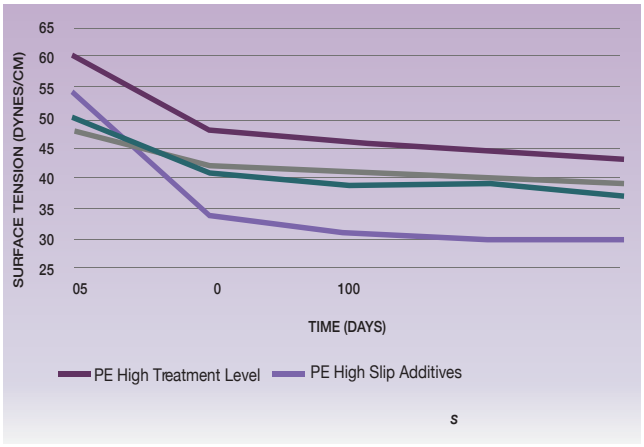


Fig 14: Influence of time on treatment levels

Converting lines run at much higher line speeds compared to extrusion lines. So they require more power (kW) to achieve comparable results to extrusion. Boost treatment can only increase the treatment levels by 3-5 dynes/cm. In order to achieve higher dyne level on a film with decayed treatment, a treater with more power and larger size is required. IEEC's range of Corona Treatment Systems are tailored for specific converting applications and offer easy installation and mounting, even for high power and large size requirements.

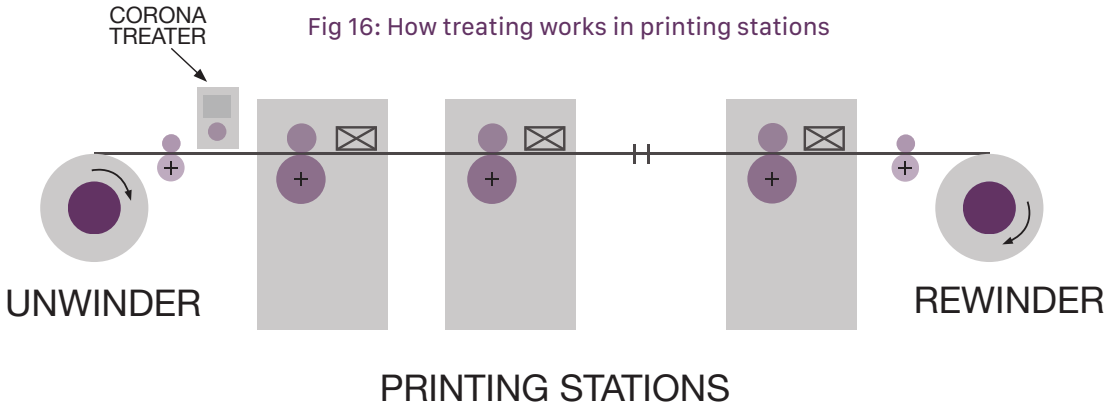
CORONA TREATMENT FOR PRINTING

Most converters assume that pre-treated films do not require retreatment or boost treatment on the printing line, specifically when solvent-based inks are used. But more and more converters now understand the benefits of boost treating on the printing line – such as improved wettability and adhesion of ink on the film. It also eliminates pinholes in solid colors, improving print quality. Thus, boost Corona Treatment gives better control over the process. Whether Rotogravure or Flexographic, both printing technologies demand boost treatment for better results.

Fig 15: Understanding the effect of treating

Inks have a wide range of consistencies. Ink composition consists of mainly three major components: binding agents that glue the pigments in the substrate, inorganic and organic pigments, and solvents which control the viscosity of the ink. Usually, extruded films are supplied with treatment levels 38-42 dynes/cm which are adequate for printing that uses solvent based inks. But these films will show poor adhesion when water based inks are used. Hence, they require online boost treatment on printing machines.

Fig 16: How treating works in printing stations



TIPS4TREATMENT

Apply a minimum amount of Corona Treatment needed to achieve desired results. This will eliminate the variable of surface energy from the printing process and provide quality insurance.

The amount of treatment required ultimately depends upon adhesion results. If you are facing failure during tape test, the following measures can help in resolving the problem:

i. Slow down the line and run the Corona Treater at maximum power (kW).
ii. Begin with target dyne levels and then check if the dyne levels have improved.
iii. Check if the material has changed or if any process parameter has been altered.
iv. Consult with ink supplier to resolve this issue.
v. Verify if the treater configuration is suitable for your application.

Fig 17: Running Corona Treatment

CORONA TREATMENT FOR SOLVENT LESS & SOLVENT BASED LAMINATION

In the flexible packaging industry, the use of single ply of a material does not produce all vital characteristics necessary to obtain desired performance for the product. Hence, using two or more layers of same or different materials provides the desired performance from the product. The most common process to create such structures is by laminating the layers together using an adhesive. This method provides the end products with desired characteristics such as tensile strength or barrier properties. Depending on the application, the lamination can be done between two, three or four materials in a single pass. The most common laminate structures of laminated films are as follows:

1. Reverse printed PET + PE
2. Reverse printed PET + AL + PE
3. Reverse printed PET + MET PET + PE
4. Reverse printed BOPP + PE
5. Reverse printed OPP + metallized OPP
6. Reverse printed PET + Paper + metallized BOPP

GOOD2KNOW

Adhesives are supplied in various viscosities, solid concentrations, and technologies. But the primary function of these adhesives is to increase the peel strength within the bond.

Adhesives are also required to perform other functions such as barrier properties, thermoforming capability, chemical and heat resistance, optical clarity in case of transparent structures and conductivity. The specific composition of the adhesive compound depends upon the lamination process, the nature of film materials being used, and the desired physical or chemical properties desired from the end product.

All these vast compositions of adhesives require the substrate surface preparation to guarantee a satisfactory bond between the substrates of those that have to be laminated. Proper surface preparation warrants a long lasting bond and eliminates the possibility of delamination. For efficient wetting and bonding with the substrate, the surface energy of the substrates being coated should be at least 10 dynes/cm higher than the surface energy of the adhesive.

The perfect configuration of lamination line to laminate two materials (say A & B) in a single pass is equipped with two Corona Treatment systems. Corona treater for the treatment of

1. Material A (primary side) which bears the coating of the adhesive
2. Material B (sandwich/secondary side) which has to be laminated

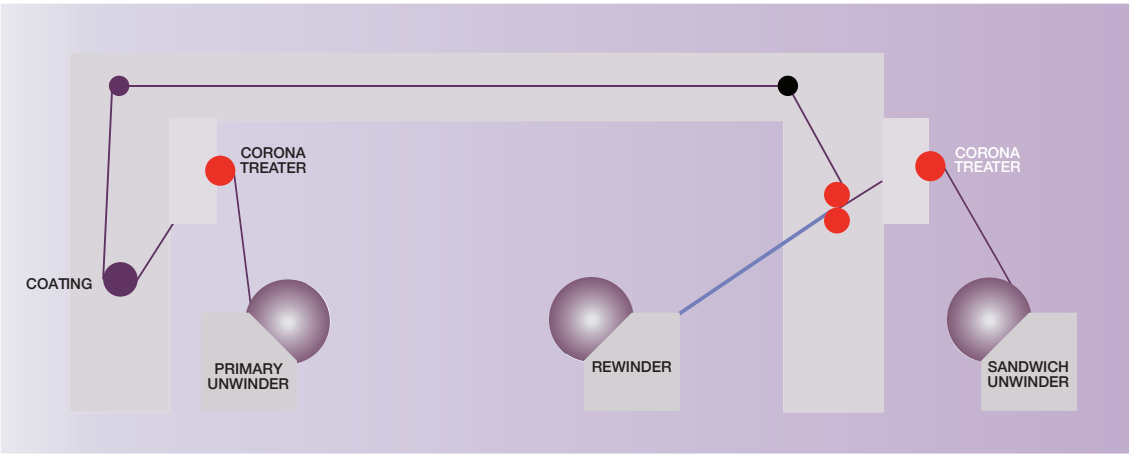


Fig 18: Configuration of lamination line

TIPS4TREATMENT

Surface treatment using Corona Treatment ensures proper bonding between the laminates, thereby improving the overall efficiency of the lamination process.

Even with pre-treated films, the surface energy of the substrate decays with time and hence, Corona Treatment should be done online during lamination.

Adhesives used for a perfect lamination between two webs of materials can be solvent-based or solvent-less (water based). In the last few years, the trend towards using solvent less adhesives has increased as it allows for significant power saving compared to solvent based lamination lines. This is because the drying oven is not used. However, both types of lamination methods require Corona Treatment systems for surface treatment.

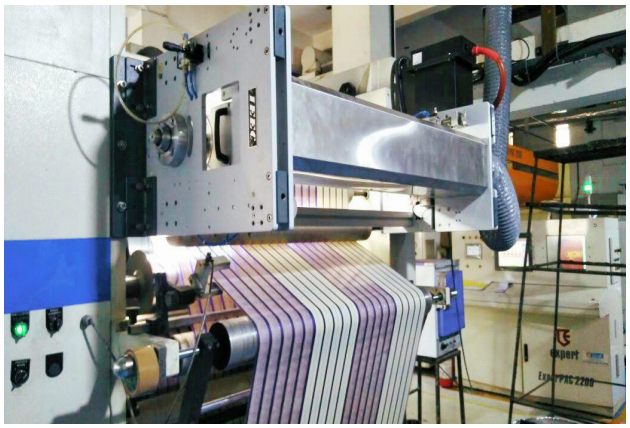


Fig 19: Treatment machines

CORONA TREATMENT FOR EXTRUSION COATING & LAMINATION

In Extrusion Coating, molten web of synthetic resin is applied onto a substrate. This coating method is highly economical compared to solvent-less or solvent-based coating applications and is used on polyethylene, paperboard, aluminium foils, woven and non-woven materials.

In Extrusion Lamination process, the molten web is used as an adhesive to bond two webs.

In both, the hot poly melt is extruded through a slot die at temperatures up to 320°C onto the moving web.

This is then passed through a nip of a pressure roller and a chill roll.

The chill roll cools the poly melt back into solid state and also grants the desired finish to the surface of end product.

The final product is rewound as a permanently bonded multi-ply laminated structure.

Most plastic films and foils require a primer coating before they are used in extrusion. Depending on the specific application, extrusion lamination can be used to produce a laminate structure consisting of three or more layers of materials. It has a variety of end-use applications such as:

- flexible packaging, paper converting, liquid packaging, industrial wrappings, sack linings, healthcare, pharmaceutical, insulating membranes, etc.

GOOD2KNOW

Extrusion Coating provides protection against humidity, barrier properties for vapour and aroma and heat-resistance.

In Extrusion Lamination, proper surface treatment is required for the substrates to guarantee a satisfactory bond between the substrates that have to be laminated. Proper surface treatment warrants a long lasting bond and eliminates the possibility of delamination.

TIPS4TREATMENT

Surface treatment using Corona Treatment ensures proper bonding between the laminates, improving the overall efficiency of the extrusion lamination/ coating process.

Even with pre-treated films, the surface energy of the substrate decays with time and hence, Corona Treatment should be done online during extrusion lamination.

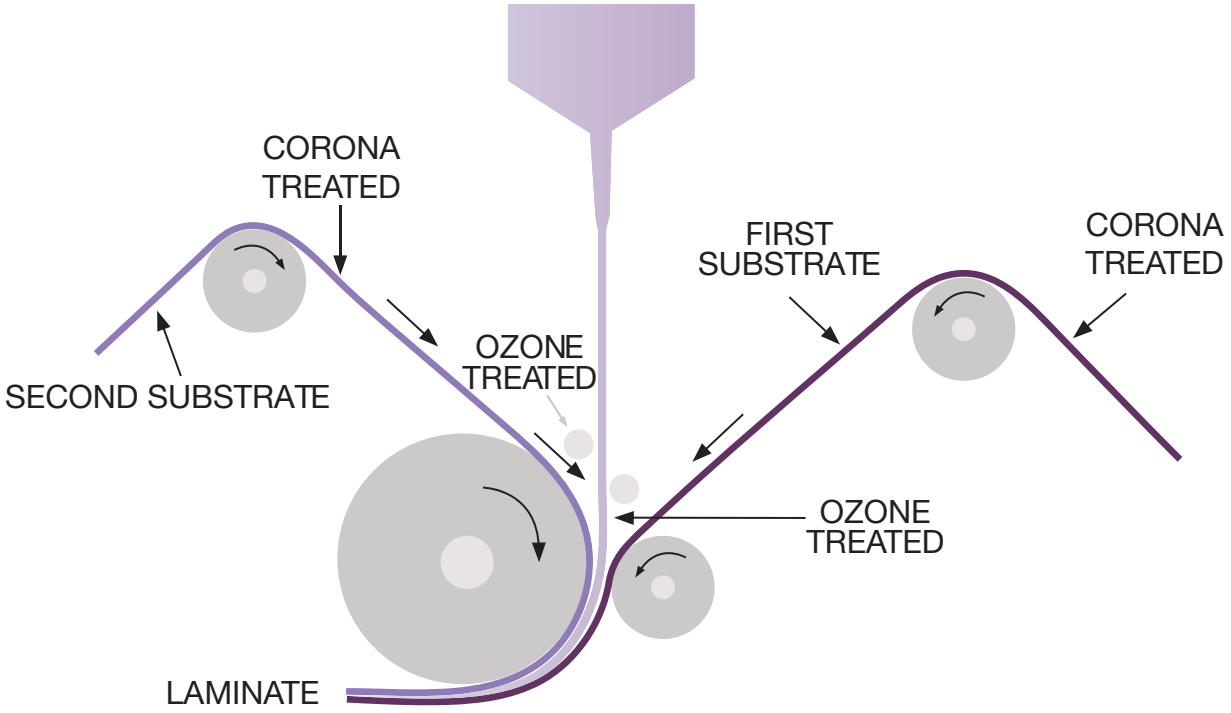


Fig 20: How Extrusion Lamination Works

An ideal setup consists of two corona treaters;
- one installed on the primary unwinding unit
- second on the sandwich unwinding unit

For the treatment of the hot poly melt, ozone treatment system is also used for applications where off-taste and pungent smell is not desired from the end product.

Ozone treatment also enables efficient lamination at lower melt temperatures allowing higher line speeds.

IEEC Corona Treatment systems are specially designed for extrusion lamination and coating to guarantee an excellent level of treatment, even at high line speeds of up to 600 m/min.

Fig 21: Corona Treater on primary unwinder Corona Treater on sandwich unwinder

CORONA TREATMENT FOR METALLIZED FILMS AND FOILS

In flexible packaging, the use of metallized films and aluminium foils is ubiquitous.

IDEAL FOR FOOD PACKAGING: Metallized films are polymeric films coated with thin layer of aluminium. These films offer glossy metallic appearance, excellent barrier properties as well as insulation. Hence, they are widely used for food packaging.

THEY PRESENT SERIOUS ADHESION ISSUES TO BOTH FILM SUPPLIERS AND CONVERTERS: Factors such as time, humidity, additives and contamination hugely affect the dyne levels of these films. Timely inventory and storage facilities with controlled environment may help, but due to unmanageable factors, metallized films and foils still face adhesion issues during converting.

SOME CONSIDERATIONS ARE ESSENTIAL: During metallisation, a layer of metal is deposited on polymeric films using either vapour deposition or electroplating. Adhesion of metallized film depends upon the type of substrate used - polypropylene and polyester are the most commonly metallized substrates. The method used for processing the film must be considered when boost treating the film for improving adhesion results.

BOOST TREATING USING CORONA TREATMENT IS THE BEST PRACTICE: This helps achieve perfect adhesion during converting as it enhances the dynes levels of pre-treated metallized films and foils. Apart from surface treatment, the other important function of Corona Treatment is to get rid of contaminants like oil, dirt on the substrate that gets deposited during transportation or storage. It also etches the film, which in turn creates a fresh clean surface ready for bonding.

THE BENEFITS: Typically, these films show better results when subject to high power corona discharge. This puts the converter in control of the substrate surface energy and value added process. IEEC offers Corona Treatment systems that are specially designed for aluminium foils and metallized substrates. These systems are equipped with ceramic electrodes which itself is an excellent dielectric and can be used for efficient treatment of conductive materials.

To know more about surface treatment of metallized films, write to us at info@ieecpe.com.

CORONA TREATMENT FOR NARROW WEB AND LABELS

The need to use Corona Treatment transcends to the narrow web and label manufacturing industry. Here the printers work with a wide variety of films including metallized films and foils. These materials are treated during extrusion but they lose dyne levels with time and fail to produce desired print quality. Additionally, the use of water based and UV printing inks makes it further difficult to achieve target print quality with insufficient dyne levels.

Corona Treatment is vital for this industry: Just as the converting industry, substrates are boost treated with Corona Treatment systems installed on the narrow web flexographic or digital printing machines and coating machines. Corona treaters used for these applications exhibit a compact footprint as the mounting space is very less. They are equipped with ceramic electrodes to treat conductive and non-conductive materials.

Fig 22: Corona Treatment for Narrow Web & Labels

Adaptable to needs of the industry: Adhesion performance of the label inks and functional coatings on the surface of materials is becoming increasingly complex day by day due to a huge variety of options being used to obtain an attractive end-product. Labels are designed to convey product information as well as attract the consumer into buying the product. Hence, more emphasis needs to be given to dyne levels of the substrate to obtain sufficient ink adhesion required in high quality printing. Many narrow web applications use environmental friendly inks, mostly solvent less or water based, which require high dyne levels.

Ideal for narrow labels: The labels are narrow in width - hence the printing lines are called narrow web lines. The typical working widths for narrow web lines range from 330mm to 500mm. IEEC offers narrow web corona treaters equipped with 4, 6 or even 8 ceramic electrodes depending upon the specific application. Our treaters are easy to maintain as they are equipped with pull-out cartridge design. Other features include proportional watt density which monitors and controls the corona power with reference to the line speeds.

PLASMA TREATMENT

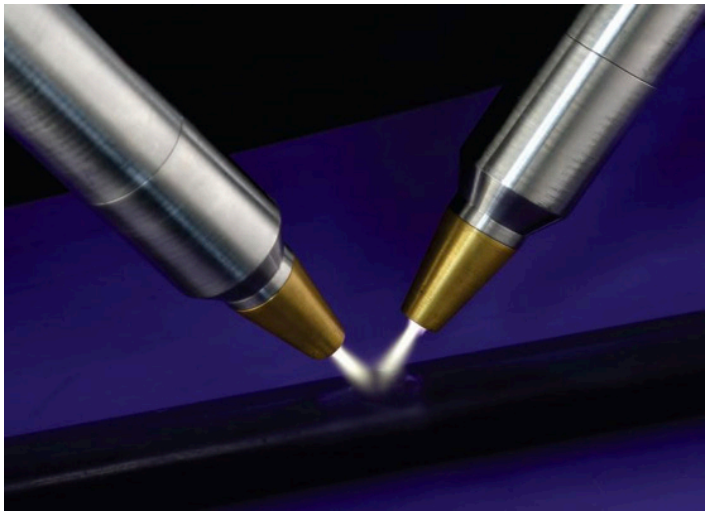


Fig. 23: How Plasma treatment works

Fig. 24 Plasma Treatment on Automotive Parts

Plasma, referred to as the fourth state of matter, is described as an ionized gas or as an electrically neutral medium of positive and negative particles. It results from further energy being given to a gas, causing negatively charged electrons to break free from the nucleus.

In a plasma treatment system, compressed air or gas is passed through a cylinder and nozzle assembly and subjected to a strong electrical field that ionizes most atoms. The resulting super ionized air or Atmospheric Plasma is ejected through the nozzle tip and used for surface modification or surface cleaning. The effects of plasma treatment on any surface can be tuned by selecting a gas mixture, pressure and power etc.

Plasma treatment performed at low temperature can easily treat materials that are heat sensitive. That is why this type of plasma is also referred to as "cold plasma". It is mainly used for surface cleaning, surface activation, etching and deposition.

A. WHY PLASMA TREATMENT

Plasma surface treatment offers innovative solutions to adhesion and wettability issues in many industries and is an important step prior to any coating, printing, bonding, or etching process.

- It removes foreign contaminants from the material surface which pose as an obstacle during adhesion. Thus, it makes the treated material ideal for further processing.

GOOD2KNOW

Any material prone to lose printing or coating done on its surface due to its low surface energy and glossy texture can hugely benefit from plasma treatment

Most of the injection moulded, blow moulded or extruded plastic products are homo polar meaning they face issues during bonding.

- Using plasma surface treatment on such surfaces can result in an efficient pre-treatment or surface activation before any further processing like gluing, printing, varnishing, coating, etc.

- Similarly, a variety of materials like glass, ceramics, rubber, fluoropolymers, silicon, metals can benefit from plasma treatment. Usually, atmospheric gas is used in plasma treatment. Hence, it is also referred to as "atmospheric plasma". Oxygen as well as inert gases can be used as a process gas depending upon application and desired result. Different materials show different results in plasma treatment and the effect can remain influential for minutes or even months. Improved surface tension values of some common industrial materials are as below:

Material	Initial Dyne Level (Dynes/cm)	Post-treatment Dyne Levels (Dynes/cm)
PET	**35**	**44-60**
Polycarbonate	37	57-72
Polyethylene	32-34	42-60
Polypropylene	30-34	45-60
Polystyrene	36	52-70
PTFE	30>	50
ETFE	30>	50
Rigid PVC	33-36	40-60+
Flexible PVC	33-36	50-56
TPU	34	50
ABS	31-35	44-72
PEEK	30	>72

Table 5

B. APPLICATIONS

Changing regulations and competitive pressure among manufacturers has led to the rapid adoption of plasma treatment in all industries. Plasma treatment promotes safety, durability and acoustic comfort. The resulting weight reduction in some applications gives better performance and fuel efficiency, and promotes environmental sustainability.

Some industries which employ plasma treatment are:

- **Automobile industry:** Head lights, door sealing profiles, decorative trim, switch components, control unit housings, body bumpers
- **Printing industry:** For inkjet printing on bottles, caps, wires and cables, pipes, glass, plastic cards and other materials. For pad printing on pens, mobile covers, switches, switch boards etc.
- **Medical devices:** Dialysis machines, disposable syringes, catheter, ampoules, contact lenses, test tubes, petri dishes.
- **Glass industry:** Window seals, window frames, printing on drinking glasses and bottles, perfume flacons.

- **Coating:** Foil coating, flocking, laminating.
- **Adhesive technology:** Plastic sheets, furniture coatings.
- **Laminating:** Instrument panels, interior door coverings, car boot linings.
- **Extrusion:** Signage, pipe extrusion, EPDM profile extrusion.

For Printing on Pipes: Plasma treatment on pipes improves ink adhesion and makes it permanent. It increases surface energy of the pipe surface and allows the manufacturer to do inkjet marking on the pipe to identify the product and comply with warranty conditions required by the standards. Just after extrusion and before inkjet marking, the surface tension of polyethylene is increased to optimize ink adhesion. Based on pipe diameter and font size, one or more spot guns can be used to cover the treatment area. Each spot gun covers about 10 – 12 mm of surface.

For Wires & Cables: Plasma treatment is used as an in-line surface treatment solution to improve the adhesion of marking ink on wire and cable. Plasma treatment activates the surface and increases the surface tension to improve anchorage of aqueous inks, and coatings to provide resistance against abrasion and smudge.

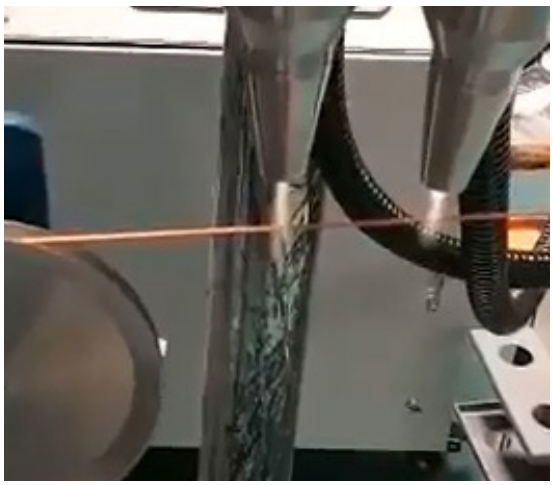


Fig. 25 Plasma Treatment on Cables

It can be done on a variety of surfaces and enables environment-friendly manufacturing along with reduced production cost compared to other surface treatment methods. Plasma treatment also eliminates the need to use chemical primers and surface roughing processes before printing.

For Automotive Parts: Automotive materials with low surface tensions such as PE, PP, TPO, POM, PUR, PTFE and metals require surface treatment when aesthetic or functional enhancement is required. Metallic surfaces require cleaning to remove low molecular weight organic materials prior to further processing. Only after cleaning and activation of these interior and exterior types of substrates, can further applications like printing, gluing and painting be done. Plasma treatment helps in increasing the product quality, while achieving environment goals of the automotive industry.

For Mono Cartons: Mono cartons are usually made from materials like paper, PET, PP, and PE-Paper. These materials face issues like ink and glue adhesion during converting. In folder gluer lines, the glue is applied along the folding edge of the box in strips. Here, plasma treatment finds the perfect application as it occupies less space compared to Corona Treatment. The plasma gun is mounted on folder gluer lines in-line before the gluing application. Implementation of plasma treatment on folder-gluer lines is simple and requires little maintenance.

Plasma treatment increases the surface tension of the substrate and eliminates any impurities thereby, increasing glue adhesion.

OZONE TREATMENT

Modern packaging needs nothing less than the highest quality of laminates. The manufacturers of these advanced packages using extrusion coating must get excellent bond strengths between their laminates.

With consistent Research & Development and valuable customer feedback, IEEC has introduced "OZOGEN-500" which is proving as an efficient Technology in Extrusion Coating.

Extrusion coating is a very complex process and has many limitations when it comes to modern packaging. Line speeds have to be compromised in order to achieve good bond strength, avoid odor and off taste.

Ozone can play an important role to eliminate these problems, and give efficient bond strengths at high line speeds.

The challenge: The diagram on the other page depicts how during Extrusion Coating, Corona Treatment is done on the first and second substrate but not on Hot Melt Poly. As the treatment is only on one surface, the bond strength will not be as good as when the treatment happens on both surfaces.

The solution: To achieve optimum bond Strength, Hot Melt Poly also has to be treated.

Fig. 26 Ozone Treatment

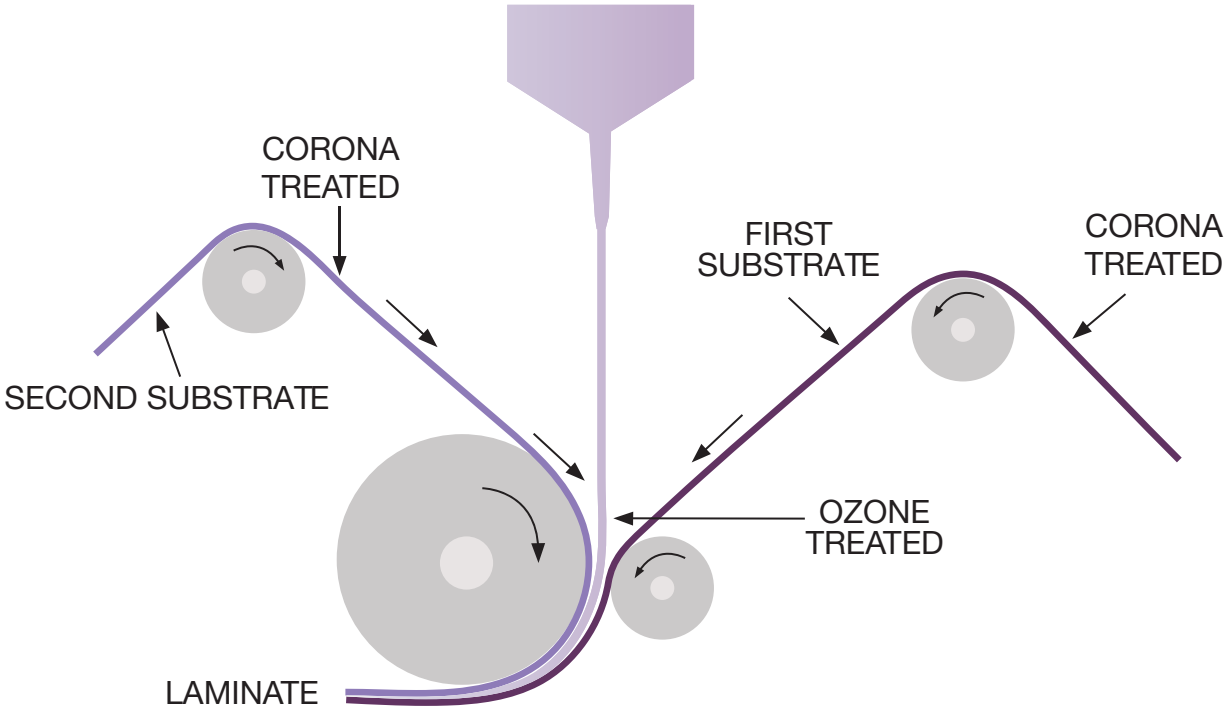


Fig. 27 Extrusion Coating process challenge

IEEC's "OZOGEN-500" Ozone Treatment System is designed to treat the Hot Melt Poly by applying Ozone at a particular point, coming out of the T-Die from extruder.

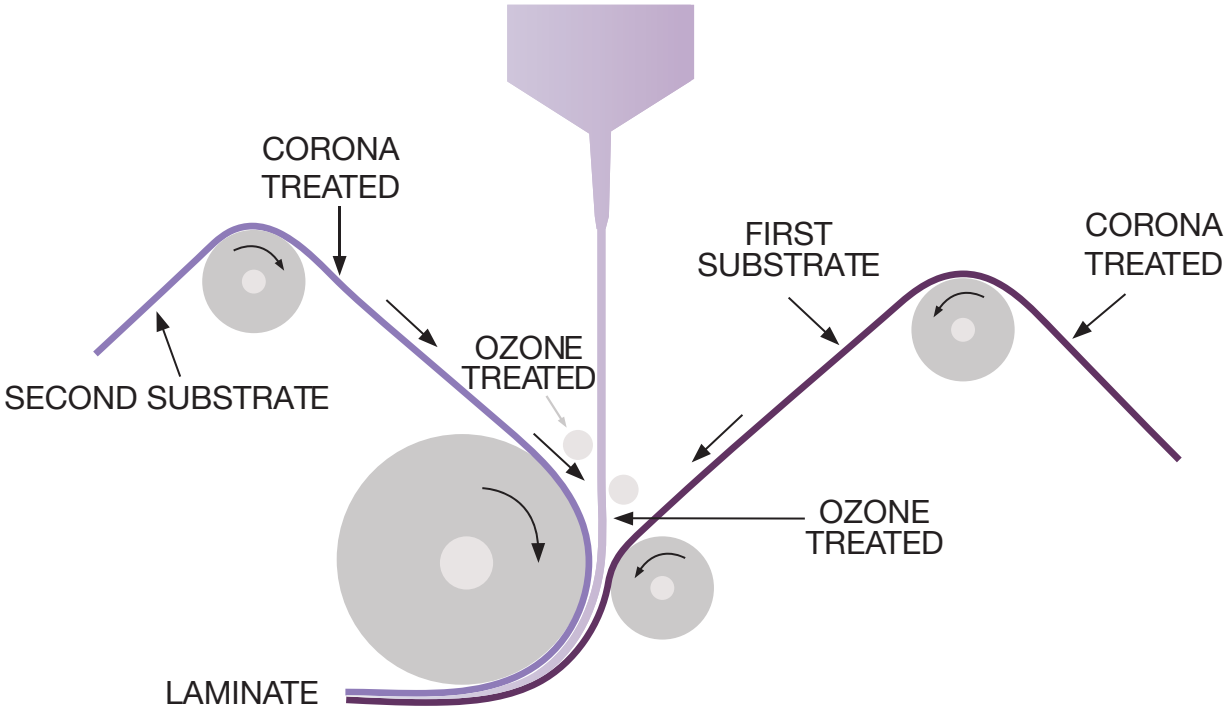


Fig. 28 Extrusion Coating process solution

A. WHY OZONE TREATMENT

Ozone Treatment not only increases Surface Tension (Dyne/cm) of the Hot Melt Poly coming out of extruder but also helps:

- Reduce Melt Temperatures
- Reduce Odor and Off Taste
- Increase Line Speeds
- Eliminate Use of Primers
- Improve Heat Seal-ability

WHY OZONE

The use of Ozone helps to achieve good bond strength without any high temperature oxidation concerns. Ozone is produced under strictly controlled conditions and is exposed to the hot melt poly deep in the nip area at the contacting surface. As ozone decomposes to Oxygen molecule and nascent oxygen, it acts as a strong oxidizing agent. Nascent oxygen will accelerate melt oxidation as it has a shorter reaction initiation time.

$$O3 \rightarrow [O] + O2$$

Ozone — Oxygen — Nascent Oxygen

Understanding melt temperatures and its effects on lamination process and speed

Melt temperature is a property which determines initiation time, reaction rate and reaction time. Research and analysis show that at constant line speeds adhesion is not linearly proportional to temperature but dramatically drops below a critical temperature. The temperature depends on the dwell time of melt in the laminator air gap. Research and experiments show that if the ozone is applied near the nip at a distance of 4 cm from the hot melt poly, the adhesion achieved is maximum. Following are kept as constant:

1. Speed: 160m/min
2. Melt Temperature: 300°C
3. Coating weight 20g/sq.m

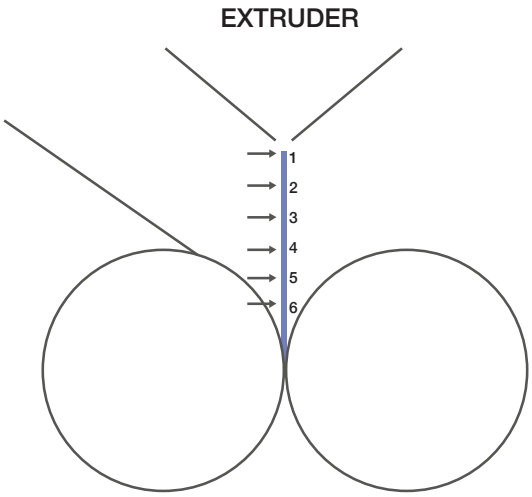
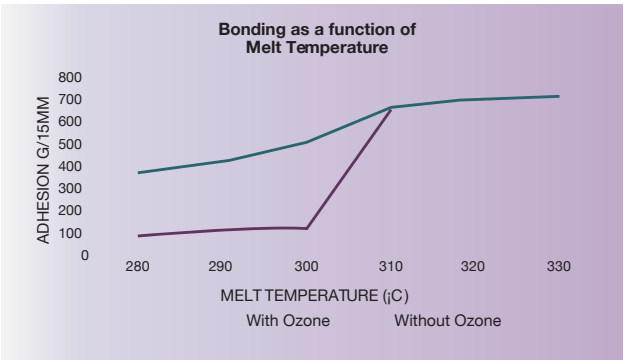


Fig. 29 Set-up



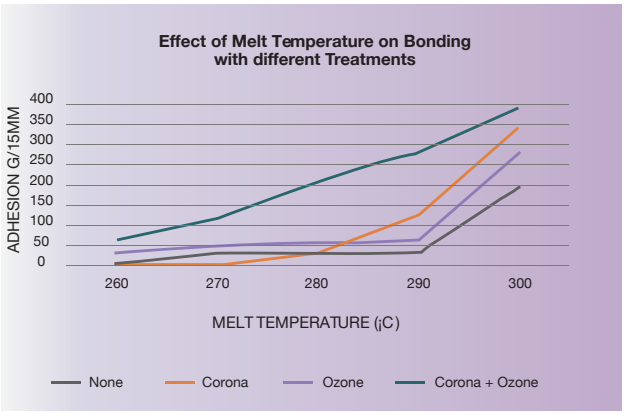


Fig. 30 & 31 Mapping the Effect

Position	C.O.F.
1	60%
2	63%
3	61%
4	80%
5	99%
6	96%

Table 6: Results Obtained

OZONE REDUCES OFF-TASTE

The experiments have proven that the ozone helps in reducing the levels of off-Taste. Excessive melt-oxidation degrades the polymer, which eventually results in the odor or off-taste. This is a serious issue when the end product is to be used for food packaging.

With emerging trends of packaging and improved demand of high quality product, these technologies are vital to achieve better quality at high line speeds.

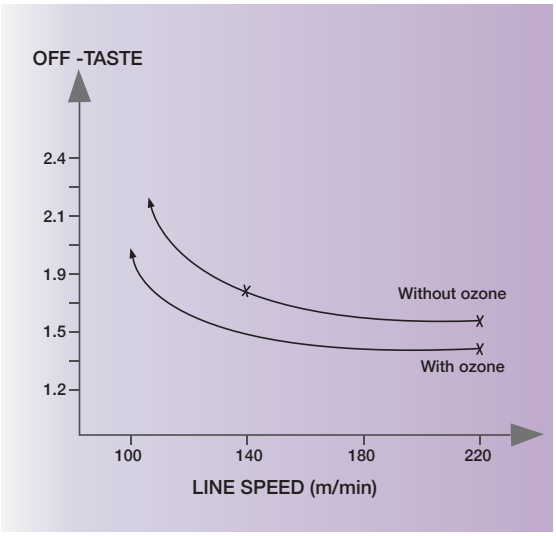


Fig. 32 - Shows that equal bonding levels can be achieved irrespective of line speed, with the application of Ozone to achieve oxidation, off-taste/odor will be significantly reduced.

B. APPLICATIONS

Ozone treatment is used to treat the poly melt in extrusion lamination process to achieve bonding results. Because of its advantages like off-taste and odor reduction, and the fact that it enables running extrusion lines at lower temperatures, higher line speed, and improved Heat Seal-ability, converters have realized its importance and have started installing ozone treatment systems in their plants.

IEEC has developed Ozonator 500, an ozone treatment system that enables treating inside of products.

These include insulated coolers, ice boxes, boats, surfboards, refrigerator room walls, etc. Products that consist of fiberglass on the outside and foam on the inside require ozone treatment as other surface treatment methods cannot reach the insides of such products.

Ozonator 500 works on the principles of corona treater.

- It produces ozone, which is then blown into the inside of the product and sucked out after a while.
- The ozone gas treats the inner cavity of the product.
- After this, foam is injected into the cavity.
- It is then left to cure and after hardening, the foam adheres to the walls of the cavity.

Benefits of Ozonator 500

- Higher dyne levels compared to stock resins
- Flexible settings for treating products with various sizes and dimensions
- Small carbon footprint
- No exotic treating gases required
- Ability to treat interior of moulded parts

Speciality: Treatment of rotational moulded parts

Rotational moulded products are typical hollow thermosat plastic parts. The heated and melted resin is rotated, which then fills the cavity of the mould creating the part with a hollow inside. Most of these products are then insulated with foam in order to improve their rigidity and thermal properties.

TIPS4TREATMENT

Ozonator plays an important role in activating the inside surface of the product to improve adhesion with the foam. It helps in achieving a uniform thickness of the walls. It can be installed as an in-line process or as a standalone solution.

OTHER SURFACE TREATMENT TECHNOLOGIES

Flame treatment

Flame treatment is the oldest dry pre-treatment method for plastic surfaces and has been used industrially since 1930s. It works as follows:

- The plastic is subjected briefly to a gas flame
- This results in creation of polar groups containing oxygen on the surface, oftentimes providing better wettability

- The flame plasma is responsible for the process and, like Corona pre-treatment, it causes an oxidative modification of the surface through highly reactive gas particles

Pure heating up of the surface, for example by using an infrared radiator, does not increase surface tension; as such, flame treatment can also be regarded as a plasma process.

Composition of combustion gases: Methane, propane, or butane that are mixed in a specific ratio with air and are usually used as combustion gases. The combustion products are H_20 and CO_2 as per:

$$CnH2n+2 + 3/2\ n\ O2 \rightarrow$$
$$\text{Flame plasma} \rightarrow n\ CO_2 + n+1\ H_2O$$

Required oxygen can be taken partially from outside air, but is mainly dosed in through the gas-air mixture. The composition of the mixture influences the flame characteristics. Usually a slightly lean mixture is used in which the oxygen content lies above the required stoichiometric amount. The optimal mixture setting should always be checked individually and can deviate upward or downward from the manufacturers' standard specifications.

Burner output and maximum speeds: The burner output is specified in kW and is directly proportional to the flow rate of the gases. As in Corona Treatment, the burner output also has to be adapted to the respective operating speeds for flame treatment. Incipient melting of the surface that is indicated by a shiny or matte surface must always be avoided. A change in the burner output also produces a change in the flame length, so that the distance from the material must also be adjusted together with the burner output.

Advantages: Flame treatment allows high operating speeds. In the case of moulded forms, speeds of up to 100 m/min can be achieved, for films of up to 1000 m/min. In view of operating costs and handling of flame, treatment is used in the field of moulded parts, particularly in treating large-scale moulded parts. The systems can be designed for any operating widths and, like Corona systems, can be integrated easily into existing lines.

Limitations: To achieve optimal treatment results, all parameters have to be matched with care (burner type, flow rate, distance, speed, material). In moulded parts with complex geometries, uneven treatment results (shadowing effects) can occur. The thermal stress on the material is greater than in other procedures.

CHAPTER 3

DECODE IT

As you move towards a summit, one step at a time; it seems closer, and more achievable. Similarly, as you decode a process one step at a time, it becomes simpler. In this chapter, we will cover four crucial such steps that will simplify your understanding of Corona Treatment and help manage it in your own premises.

MEASURE DYNE LEVEL

The measurement of surface tension of a substrate is called Dyne Level (dyne/m). The amount of dyne level required can be determined based on tape test results, or by beginning with target dyne levels.

Fig. 34 No droplets were formed using number 38 dyne pen. Small amount of droplets can be seen with number 42 dyne pen. Complete droplets were formed within 2 seconds using number 46 dyne pen. Thus, dyne level of the substrate is 38-41.

Fig. 33 Dyne Inks & Pens are very effective in measuring surface tension of many substrates

HOW IT WORKS

- Press the dyne pen and draw a line across the surface of the substrate.
- Wait for 2 seconds and watch if any droplets of ink are formed.
- If no droplets are formed at the centre of the line within 2 seconds, the next highest dyne level pen should be used and same testing procedure should be followed.
- Highest dyne number that did not form any droplets of ink is the dyne level of the substrate.

Suggested Surface Treatment Levels (Dynes/cm)

	FLEXO PRINTING			SCREEN PRINTING			COATING/ LAMINATING	
Material	**Solvent**	**Water**	**UV**	**Solvent**	**Water**	**UV**	**Solvent**	**Water**
LDPE	36-40	39-44	40-50	39-44	42-48	46-60	38-45	42-50
HDPE	35-40	38-44	38-50	38-44	42-48	46-56	38-44	42-50
PET	40-46	44-52	42-52	42-48	48-60	44-62	42-48	42-60
PP	36-40	38-44	40-50	38-44	42-48	44-60	38-44	42-50
PVC	36-40	38-44	36-50	38-44	42-48	42-60	38-45	40-48

Table 7: Approximate Values

CONFIGURE YOUR CORONA

Selecting a perfect corona treating system is easy.

I. Determine the type of basic material to be used onto which the Corona Treatment is to be done to start with.
II. Specify whether the film is to be laminated/ coated/printed and the type of ink/covering.
III. Specify the initial dyne level of the film.
IV. Also specify whether the film is to be treated single side or double side.
V. Specify the maximum web speed (meters per minute) and maximum web width (mm).
VI. Specify the maximum and minimum thickness of the web.
VII. Specify the basic electric supply and the variation.

TREATING ELEMENT WITH SUGGESTIONS

SUBSTRATE/MATERIAL

Suggestions: If the material is to be used for coating, printing, lamination etc. It is advisable to use a pre-treated film because it is very difficult to raise the treatment level of an untreated film in order to make it conducive to good adhesion.

WIDTH

Suggestions: Generally, the stations are designed with wider roller face length and electrode length taking into consideration minor web shifting.

THICKNESS/GAUGE

Suggestions: The films with lesser thickness generally require a driven treater roller arrangement. For treating the films with higher thickness, the roller should be sturdy enough to bear the heavy tensions and deflections.

LINE SPEED

Suggestions: Line speed is a very important parameter in designing the output power for the Corona Treatment. Generally for high line speeds, the roller diameter should also be increased after taking the good wrap angle into consideration in order to prevent the backside treatment (bump) treatment.

ADDITIVES

Suggestions: Depending upon the amount of additives the Output power of corona treater are decided. If the quantity of additives is more than 900ppm then higher power is required to attain the desired treatment level.

APPLICATION

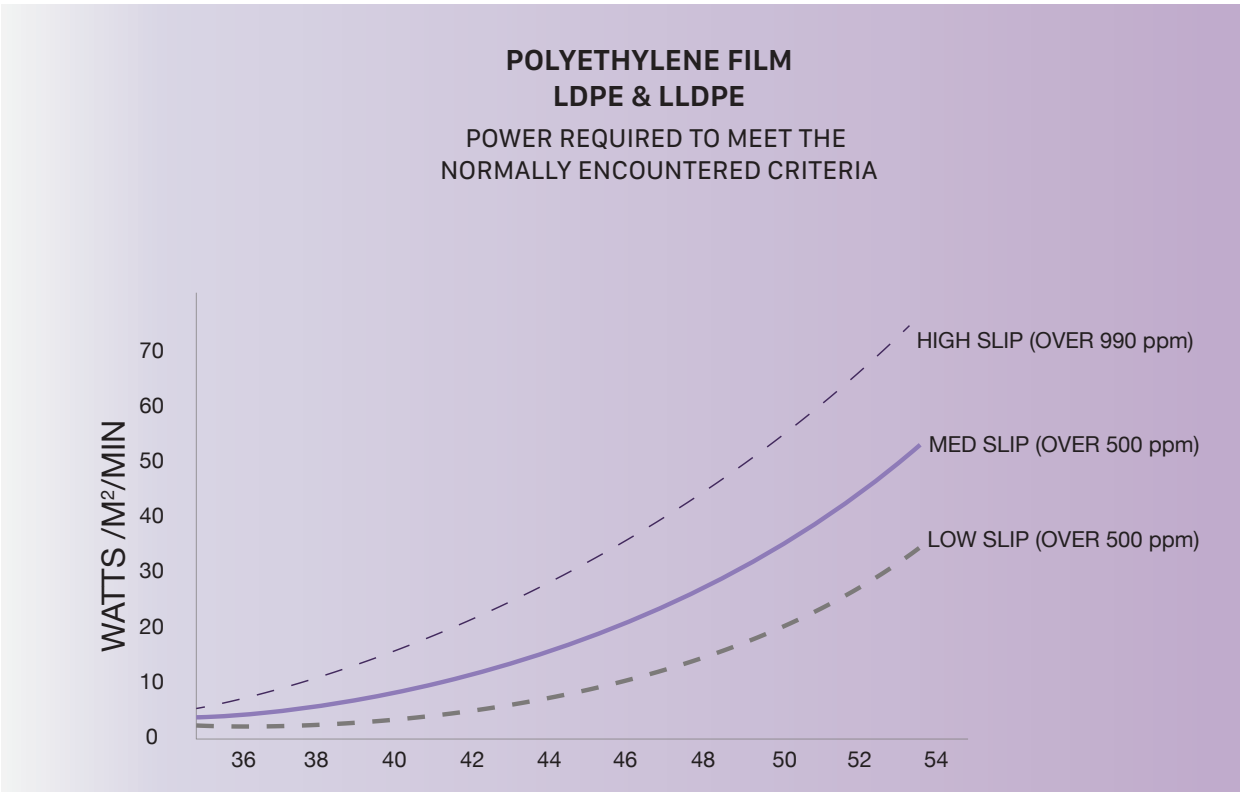
Suggestions: Depending upon the type of application, the Corona Treatment system is optimized as per the necessity of dyne levels.

SIZING OF CORONA

Corona treaters increase the surface tension of substrates by applying a given level of power to it over a period of time. The increase in surface tension is directly related to the amount of power applied. Thus, the size of Corona Treater can be chosen based on the increase in surface tension required for substrates.

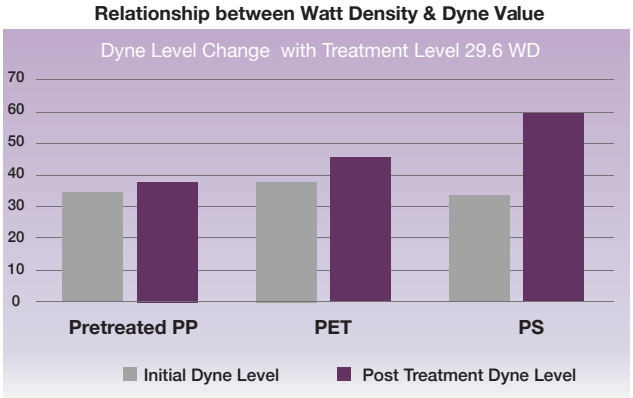
WATT DENSITY

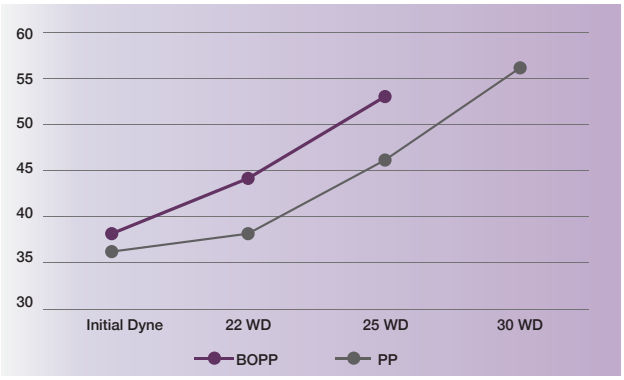
Watt density is the amount of power required to achieve an expected surface tension (dyne level) on the substrate. It is measured in Watts/m2/minute.



BLOWN LDPE/LLDPE	- see above
BLOWN HDPE	- Use PE figures x 0.76
POLYESTER	- Use PE figures x 0.76
NYLON	- Use low slip PE
PAPERBOARD	- Use PE figures x 0.76
BLOWN POLYPROP	- Same as med slip PE
BIAXIAL POLYPROP	
(copolymer)	26 w/m²/min
(homopolymer)	34 w/m²/min
(pearlized)	42 w/m²/min
CAST	- Use PE figures x 1.6
EVA	- Use low slip PE x 1.6

Fig. 35 Relationship between Watt Density & Dyne Value





Watt Density =

Power Supply(W)

Line Speed (m/min) *
Electrode width (m) *
No of sides treated

Example: A line running at 300 m/min, with a power supply of 6000 W and electrode width of 1.3m is treating a substrate on a single side to achieve 42 dyne. Watt density for this line can be achieved as follows:

6000 W/ [300 (m/min) x 1.3 (m) x 1 (side)] = 15.38 (watts/m²/min)

The same formula can be used to calculate Power required at Maximum Line Speed.

Example: To increase line speed in above equation to 400 m/min and still get 42 dyne on same material, the formula can be used as follows:

400 (m/min) X 1.3 (m) X 1 (side) X 15.38 (watts/m²/min) = 7997.6 (watts)

7997.6 watts is required to get 42 dyne at 400 m/min.

RULE OF THUMB

Higher Watt Densities produce High Dyne Levels

Dyne Level cannot be predicted using Watt Densities

The relationship is NOT LINEAR

C. OZONE

Ozone (O3) is a highly toxic and corrosive oxidising agent that poses a major danger to health. The recommended human exposure limit is 3ppm (5.890mg/m³), but exposure to 50ppm for 30 minutes can be dangerous. This colorless gas with its distinctively pungent smell is, as we are constantly reminded, a highly protective necessity in the stratosphere. However, ozone in the work place is, by contrast, an unwelcome pollutant.

KNOWING OZONE

Ozone occurs naturally in the atmosphere and is produced whenever ultraviolet radiation or electrical discharge occurs, for example at high altitude or when lightning strikes. Background concentrations vary with seasons, weather conditions, altitude and humidity but normally these concentrations are low enough not to

cause concern. However, it is the high concentrations of ozone generated by certain industrial processes either deliberately, as a vital constituent of the process application, or as a by-product that cause concern.

Corona Generated Ozone in House Destruction is becoming increasingly less acceptable as it adds to the overall atmospheric pollution load. In certain countries and States, it's illegal.

Concentration ppm	Description of Effects
0.003 - 0.01	Threshold of odor perception by average person in clean air
0.02 - 0.04	Representative average total oxidant concentrations in major US cities in 1964: approximately 95% oxidants have ozone
0.1	Recommended exposure limit: Eye, nose and throat irritation often experienced
0.2 - 0.5	Reduced dark adaptation and alteration of extra-ocular muscle balance occurs after several hours' exposure
0.5	Nausea and headache can occur. Extended exposure can cause pulmonary oedema and enhance susceptibility to respiratory infections (both bacterial and viral)
1	10 minutes exposure typically reduces desaturation rate of ox haemoglobin to 50%
1 - 2	Chronic exposure (one year for 6 hours per day) at this level has resulted in bronchiolitis and bronchitis in animals. 2 hour exposure can cause headache, chest pain and dryness of respiratory tract and a reported 30% reduction in timed vital capacity of the lung
1.5 - 2	Exposure for 2 hours typically results in cough, sub sternal pain and excessive sputum
5 - 25	Experimentation showed that 3 hour exposure at 12ppm was lethal for rats and 25ppm was lethal for guinea pigs. Humans (welders) exposed to 9ppm developed pulmonary oedema. Their chest X-rays were normal in 2-3 weeks, but 9 months later they still exhibited fatigue and exertional dyspnoea (Laboured respiration)
50	30 minutes exposure may be fatal

Table 8 Effects of Ozone

Corona Discharge Treatment for better adhesion is one such industrial process that generates pollution levels of ozone. To ensure tight control management of contaminated ozone, exhaust gas is required to prevent leakage into the workplace environment.

GOOD2KNOW

Analysis of the problem has led to a technological solution in the form of Ozone Destruct Units that are becoming an increasingly standard supply with Corona Treatment machinery.

HOW IS OZONE GENERATED

- In a corona treater, corona is generated by applying a high frequency, high voltage signal to an electrode separated from earth by an air gap and a layer of dielectric material.
- When high voltage is applied to the electrode, breakdown potential is reached. Free electrons are accelerated towards the positive electrode with such energy that they are capable of displacing electrons from molecules in the air gap.
- The consequence is an avalanche effect, with electrons and the corresponding ions being produced, resulting in current flow across the air gap and thus, the corona effect.
- It is during this process of electrical discharge that ozone is produced similar to a lightning strike.

OZONE EXTRACTION

A primary concern in corona treater design

For many years, electrodes have been enclosed in either fabricated housings or integrated into individual ozone extraction ducts, which act to keep electrodes at an optimum operational temperature. If extraction fans are sized correctly, both types will effectively and efficiently exhaust the ozone contaminated air away from the station.

Considerations to select fan size:

- Output power rating of the corona generator
- Treatment width of the electrodes
- Substrate line speed
- Extraction duct configuration
- Pressure and flow characteristics of the fan

With this data, a simple computation will determine correct selection.

Design efforts have also been targeted at achieving leak-proof ozone extraction to keep the ozone concentration levels around the treater station below the required 0.1 ppm. Given that the ozone concentrations in the electrode exhaust are typically in the region 25- 30 ppm, which is seriously harmful to man, the demands on the accuracy of the designs are critical to keep the work station environmental levels below 0.1 ppm. These levels can be monitored locally using a variety of permanent fixtures employing technologies, such as chemiluminescence, ultra-violet photometry and electrochemical cells. However, Draeger vials or sealed gas vials have proved to be operationally reliable and convenient and are also popular.

TIPS4TREATMENT

IEEC recommends that you contact a qualified HVAC professional to properly size and install the exhaust system to avoid future operational problems.

Guidelines include using an aluminium-construction blower with ozone-resistant seals. The blower should be located at the exit side of the duct run, so as to not pressurize the ductwork with the ozone. Ducting should be made from PVC, aluminium or stainless steel only; never use galvanized steel. Any flexible duct sections should be constructed from ozone-tolerant materials and have a smooth interior.

Corona Generated Ozone In-House Destruction

Corona Discharge Treaters need to be designed using components in and around the treater that are corrosion-resistant and more specifically ozone-resistant. Any exposure of unprotected materials will result in rapid attack and eventual deterioration of the component. This is the case with not only the ducting and extraction fans, but also less obvious components like safety interlocks, electrodes assembly bearings and jointing compounds. If insufficient attention is given to this, problems may arise.

- The traditional extraction system uses ozone resistant ducting coupled to an extract fan, sited within a few meters of the treater station.
- The ozone laden air gas stream is drawn from the treater station to the fan.
- After this, the gas stream is pushed along ducting to the outside of the building and the ozone is dispersed into the atmosphere.

Any leaks caused, for example, by accidental damage or corrosion, will severely affect the efficiency of the fan because a negative pressure upstream will be created inside the pipe drawing factory air inwards.

However, converse is the case from the fan downstream where there is a positive pressure inside the duct allowing ozone laden air to be leaked from these points into the factory atmosphere and in to the operator area.

- Because of this an ozone destruction system is designed to only have a short length of ducting from the treater station
- Since this is under a negative pressure, any leaks will only allow air to be drawn in with no chance of ozone leakage into the operator area
- The system draws ozone using a fan, at a temperature higher than ambient air to an ozone destruct unit, so it can gravitate through a layer of catalytic granules that enable ozone conversion to oxygen

OZONE DESTRUCTION

Catalytic versus Thermal Incineration

The conventional method of destroying waste gases has been thermal incineration. Oxygen at a very high temperature combines with hydrocarbons to form carbon dioxide and water, and also with carbon monoxide to form carbon dioxide. The use of high temperatures for relatively long periods is the basis of thermal incineration as a method of oxidation.

Catalytic incineration similarly combines with hydrocarbons and carbon monoxide to form harmless end products, but the oxidizing reaction occurs at much lower temperatures and consequently with lower energy costs.

Catalytic Ozone Elimination

Over the years of catalyst development, two particular types of catalysts have emerged as being most suitable for the conversion of ozone to oxygen:

(1) Activated Carbon, (2) Manganese Dioxide

1.Activated Carbon

It is easy to source and relatively inexpensive. But the chemical reaction between ozone and carbon results in the carbon being consumed and thus exhausting the filter bed during a period of operation. Carbon is also an absorbent for oil, mist, vapours and hydrocarbons. In the presence of a strong oxidising agent, such as ozone, hot spots will

occur in the centre of the carbon granules. Under these circumstances, there is a strong possibility that the localized exotherm will initiate combustion.

GOOD2KNOW

There have been reports of carbon absorbent beds setting on fire due to similar reactions and, in hydrocarbon processing technology, carbon is never used as an absorbent. Thus, activated carbon filters must, under no circumstances be exposed to ozone concentrations higher than 20 g/Nm^3.

2. Manganese Dioxide

With an inert absorbent such as Manganese Dioxide, hot spots do not represent a hazard as any temperature rise is dissipated. The inert absorbent is a mix of manganese dioxide and copper oxide (MnO2/CuO) with proprietary promoters to assist the transformation of ozone to oxygen. The material functions through a continuous oxidation-reduction cycle.

Manganese is reported to supply a source of active oxygen for the reaction, accelerates the decomposition of ozone into oxygen without itself undergoing any change in composition. Thus, in theory, the expected life of the catalyst is indefinite as it is not consumed in the reaction and is independent of the ozone concentration passing through.

In practice, the catalytic activity deteriorates over time due to contamination of active sites with materials present in the gas stream other than ozone. Some forms of deactivation are readily controlled, for example particulates will mask the catalytically active surface and cause a reduction in ozone destruction activity. This form of deactivation is controlled by using pre-filters which remove the particulates from the gas stream prior to contact with the main catalyst.

GOOD2KNOW

Catalysts work by lowering the active energy requirements for a given chemical transformation, which results in a low capital investment with low operating expenses and maintenance costs. Because of this, the catalytic decomposition of ozone is usually preferable to non-catalytic alternatives.

OZONE DESTRUCT UNIT LOCAL TO THE CORONA TREATER STATION

A general purpose fibre glass filter is fitted in a removable drawer, one filter before the catalyst and one filter after the catalyst.

Filter Composition: The filter is made up of evenly distributed bonded, and coated glass fiber mats of constant density faced with scrim and enclosed in rigid frames.

Filter Performance: Constantly monitored by differential pressure gauges which indicate when filters require replacement. The gauges are checked every four weeks and, depending on the contamination in the gas stream, filters are changed as needed.

Corona Generated Ozone In-House Destruction: As Manganese Dioxide is a microporous chemical, it is deactivated by moisture, acidic gases and and oils, or organic non-volatile compounds, which simply sit on the active surface and block the sites of catalytic activity.

These poisoning agents are fairly typical of those found in the gas stream from a corona treating station. To avoid their contact with the main catalyst, it is necessary to use a secondary pre-catalyst prior to the main Manganese Dioxide catalyst. If however the Manganese Dioxide is poisoned, it can be regenerated, returning the catalyst to its previous activity level.

The regeneration takes the form of a simple washing procedure. It takes advantage of the homogeneous nature of the catalyst and abrades only the topmost marked layers, exposing a fresh catalytically active surface.

USING A PRE-CATALYST

In order to prolong the lifetime of the main Manganese Dioxide catalyst, contaminants from the gas stream must be removed before they come in contact with the catalyst.

- Larger particles are removed by the fibre glass filter prior to the catalyst
- But this filter will not remove the moisture content, acidic gases or oil mist

GOOD2KNOW

A pre-catalyst is vital to a high surface area absorbent in order to refine the incoming gas stream.

Alumina pre-catalyst is found across industrial applications as a catalyst support, removing hydrocarbons, odorous organic compounds, metal carbonyls and oil mists from gas streams, making it ideal for removing contaminants prior to ozone destruct catalyst beds.

Alumina is a high pore volume inert absorbent. Its efficiency is a function of the gas flow, residence time and gas species to be removed.

-Generally the alumina will remove 0.5 liters of contaminant per Kg of alumina.
-However, depending upon the application from which the corona treater generated / ozone originates, it is possible to impregnate alumina to make it more effective as a pre-filter catalyst.

(Experience has shown that as per the amount of alumina, the catalyst required will vary)

Without the alumina pre-catalyst on an ozone elimination unit used with a Corona Treatment station, the Manganese Dioxide catalyst will become contaminated with a thin surface layer of polyethylene fines, resulting in deactivation of ozone.

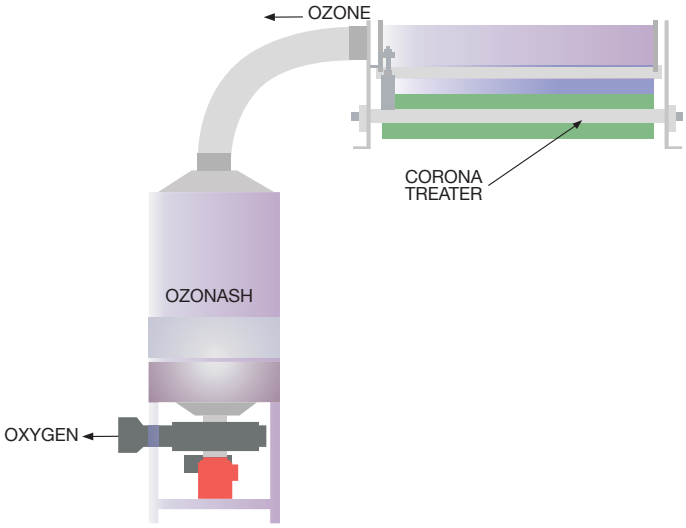


Fig. 36 How it works

- Polyethylene fines pass through fibre glass filters and coat the top of the catalyst bed.
- They subsequently react with ozone in the gas stream leading to oxidative decomposition of polyethylene.
- They liberate gaseous hydrocarbons which are absorbed downstream of the catalyst bed.

The absorbed hydrocarbons block the catalyst surface to the reaction with ozone.
Similar, but not identical, contaminants are present in gas streams from corona treaters in their wide range of industrial applications, including coating and printing lines. But to maximize the effectiveness of the pre-catalytic filter, the process application from which the ozone stream originates must be known. Only then can the correct additives be mixed in with the alumina.

D. EQUIPMENT MAINTENANCE

As in any other well-oiled machine, running a corona treater efficiently for years means that periodic cleaning of the treater is a must to ensure uninterrupted corona operation.

A typical corona treater comprises:

1. Power supply/Generator
2. High voltage transformer
3. Treater assembly having an electrode and a grounded roller
4. Exhaust blower

Any successful maintenance program means:

- Full awareness of when to clean the system
- critical components
- Knowing the appropriate method to clean

A corona treater is ideal for non-porous substrates where surface energy has to be enhanced.

Higher surface energy ensures better adhesion of inks, coatings and adhesion to the material.

IF A CORONA TREATER STATION IS LEFT UNATTENDED

Most corona-related issues happen due to poor maintenance of the corona treater.
These include:

I. Variations in treatment levels

Heavy contamination around ground rolls or inappropriate wrap angle between the web and the roller can lead the air beneath the web to ionize, allowing backside treatment. Such reverse treatment phenomena lowers the energy of the process, deteriorating the treatment level on the front surface. At times, local heating happens primarily due to accumulation of layers of dirt over the ground roll, which carbonizes over a period and causes the heating.

II. Electrode assembly

Contaminated electrode assemblies will cause electrodes to fail prematurely due to overheating, and they can also reduce the evacuation of ozone from the treater station. If metal segments of the electrode become sticky, they are harder to adjust for treating different widths and types of webs.

III. High voltage wiring and insulators

Any dirt or debris will provide a shorter path to the ground for high-voltage electricity, affecting treatment and clearly present a serious safety issue.

TIME-BASED PREVENTATIVE MAINTENANCE CAN GO A LONG WAY

Bi-weekly cleaning and inspection of components helps enhance the life of the corona treater. However, depending on what materials are being corona-treated, plant-environment temperature and humidity, this may have to be done weekly or even daily.

1. Secure power supply from loose electrical connections and heat.

Loose connections cause multiple problems in the treater, heat being the most common one. Electrical connections need to be mechanically tight to ensure that the resistance across that connection is minimum, ideally 0ohms. Poorly made connections can lead to overheating and premature terminal-block failures. Also, exhaust fans should be periodically checked and clogging

of dust in fan filters should be avoided by cleaning it. This task should be done weekly.

Electrical-grounding inspections are critical to protect the equipment from the danger of high voltage. Deterioration in treatment levels and treater roller bearing failure is observed due to improper contact with the ground connection. For the ground-roll brush, good contact must be made with the roll. For the treater-station, high voltage transformer and power supply, improper grounding can result in a shock hazard or equipment damage—just as with any electrical product.

2. Inspect the exhaust blower to confirm that its rotating in the proper direction.
Remove the cover on the exhaust side of the plenum to check for and remove any dust, dirt and debris. Possibilities are that the phasing of the input supply might have changed over the years due to the relocation or replacement of the blower itself. Change in the phasing of incoming supply will reverse the blower's direction.

Fig. 37 Ductwork should be foolproof in terms of cracks, leaks or corrosion.

TIPS TO DETERMINE THE EXHAUST BLOWER EFFICIENCY

- Exhaust blower efficiency is affected due to its usage over a period of time. Hence, for smooth functioning, it is imperative to be assured that your blower efficiency is at the optimum level. Devices are available for this task.
- Exhaust static pressure is measured in inch/ water column or kilo-Pascal. An anemometer measures exhaust flow in CFM/CMM after inputting the cross-sectional area of the exhaust tube. The average value of several readings noted at different points of the exhaust will determine the final CFM value of the blower.
- Every IEEC corona treater has a specification for these two measurements.

3. Clean electrodes as per their types.
Exhaust systems are responsible for the removal of heat as well as ozone, dirt and debris from the electrode assembly area. Poor maintenance will result in below occurrences, which eventually hamper the Corona Treatment:

1. Overheating of electrodes
2. Accumulation of dirt and debris on the electrode surface
3. Ozone contamination in electrode-assembly area

Fig. 38 Cleaning methods for electrodes differ with type

IEEC Corona Treatment has an easy maintenance and cleaning system in place:

- It allows the operator to completely detach the ceramic electrode assembly from the treating station
- It allows access to every corner of the electrode body which is otherwise tricky, if it remains mounted on the treating station
- For light dust and dirt, use a clean cloth or sponge and mild soap
- Finish with a wipe-down of isopropyl alcohol
- Don't just clean what you can easily see; be sure to clean the backside of the assembly and insulators
- For grease and oil contamination, use a clean cloth or sponge along with a grease-cutting agent (simple Green all-purpose cleaner), before finishing with isopropyl alcohol
- For tough stains, clean using an abrasive cleanser, abrasive pad, and then alcohol

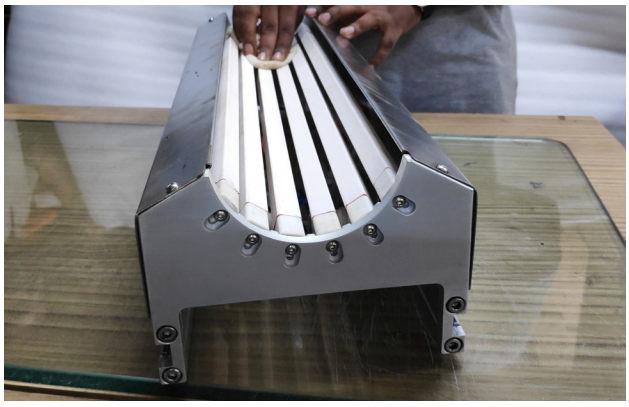


Fig. 38 Cleaning methods for electrodes differ with type

Metal Electrode Assembly: Two rounds of cleaning are often required. First, scrape the backside of the assembly with a metal brush, then vacuum the dirt and debris. Second, for tough build-up of melted poly or other debris from the web, employ the abrasive cleanser/pad method and alcohol rinse.

Roll Cleaning Methods

Ground Roll Type	Cleaning Utilities	Important Instructions
Ceramic Covered	Mild soap and water Mild household abrasive cleaner Soft, lint free cloth Isopropyl alcohol	Never use metallic tools Use only non-metallic tools Wear protective gloves Some discoloration may remain Wipe down the isopropyl acohol
Non-ceramic (Hypalon, silicon or epoxy coverings)	Mild soap and water Soft, lint free cloth Isopropyl alcohol	Wear protective gloves Rinse with isopropyl alcohol
Non-ceramic (Silicone covered)	Mild soap and water Soft, lint free cloth Isoporpyl alcohol	Wear protective gloves Use alcohol sparingly because silicone absorbs alcohol
Aluminium	Mild soap and water Household abrasive pad Isoporpyl alcohol	Oxidation is more pronounced on parts of the roll outside the web path. If oxidation is severe, roll can be skin-cut, removing no more than 0.03 - 0.05 mm

Is your Time-based Preventative Maintenance Schedule on track? Happy Cleaning to You

Action	Daily	Weekly	Bi-Weekly	Monthly	3 Months	Yearly
Air Gap		☑				
Viewing Window		☑				
Ceramic Electrode		☑				
Segment Electrode			☑			
Silicon Roller Sleeves		☑				
Electrode Cartridge		☑				
Exhaust Blower				☑		
Blower CFM						☑
Bearing Lubrication				☑		
HT Cable				☑		
Assembly Cables					☑	
Zero Speed Sensors					☑	
Clean With Air Gun			☑			
Treater Rollers					☑	
Terminal Blocks				☑		

Your corona-treating system is now completely clean and shining like new. But before it goes back into production, it's important to confirm that the electrodes are lined up properly.

REMEMBER TO CHECK IF:

1. The air gap between each electrode and the ground roll is equal.
2. The recommended air gap is 1.5mm or whatever consistent distance is needed for the material to be treated.
3. The material is receiving equal discharge from each electrode.

A misaligned electrode assembly causes uneven treatment, provides for inadequate treatment and may even lead to electrode failure.

CHAPTER 4
EXPLORATIONS

CORONA TREATMENT BOOSTS PRODUCTIVITY

The problem with printing on plastic substrates is evident. One may want to print on a plastic film but unfortunately the ink doesn't adhere to the film. This is because the untreated film's chemically inert structure makes it difficult for ink to adhere on the surface. Corona Treatment is the answer to this well-known problem.

Typically, converters want to run their press at maximum possible line speeds to achieve higher throughput. However, due to the low wettability of the film, they are restricted to lower line speeds, thus hampering their productivity.
Is it solely the structure of the material that causes this issue or is it also the ink being used? Whether ink wets a material good or poorly depends essentially on the chemical structure of both the ink and the substrate. Given that corona treated substrates are used, how does this increase productivity? This is why it is fundamental to understand the basics of Corona Treatment.

What does Corona Treatment do?
Corona Treatment increases the surface tension (dyne level) of the substrate to improve its wettability allowing the adhesion of inks. This is achieved by passing the film over an electrically grounded roller through an air gap between fixed electrodes and dielectric where the film is exposed to a very high voltage potential at a very high frequency. The voltage build-up causes ionization of air, creating a corona discharge, which increases the surface tension of the film.
What do you gain? A Win-Win!
Corona Treatment strengthens the bond between the substrate and the ink consequently decreasing the curing time for the ink. The process also eliminates the need for closer monitoring for print quality by the operator.

Converters get increased productivity by printing at higher line speeds and minimizing discarded products. Converters can choose to save money by using uncoated films and corona treating it just before printing. The technique has proved to be both highly efficient and cost-effective, especially as it can take place inline.

How to determine treatment level?
The amount of Corona Treatment required depends on the specific material being used. Different materials show different characteristics and the amount of slip additives hugely impact the amount of Corona Treatment required. There are no restrictions with respect to the materials that can be corona treated. Having said that, the magnitude of treatment (watt/m2/min) may vary notably. The treatment level can be calculated using the following formula:

Power (watt) = S x W x N x WD
S = Line Speed (m/min)
W = Film Width (m)
N = Number of sides to treat (single/double)
WD = Watt Density (watt/m2/min)

What are the factors affecting the process?
1. It should be noted that the dyne level of the material that is corona treated at the time of production would decay over time. Since it is difficult to make sure that the film you receive will be printed on within the required time limit, it is necessary to bump treat it inline. To ensure consistent quality, it is recommended to use films that have been corona treated at the time of production and then bump treat it inline.
2. Improper web tension can lead to wrinkles in the substrate, which in turn, would lead to undesired backside treatment. Also, if proper web tension is not maintained, the wrap angle of the substrate with the roller gets hampered.

With slim profit margins and print quality 'a given' in today's market, converters must understand the importance of this crucial ancillary process. Installing a Corona Treatment system can increase productivity and ensure that products are processed to a consistently high quality while being cost-effective.

Tape Test Failure? Corona Treatment Can Help

Many standard test methods are used to measure ink or coating anchorage on pressure-sensitive labels. Tape test method is the most common test performed during label inspection by QC. When experiencing ink flaking, the tape test can determine if the ink to substrate adhesion is acceptable. Poor ink or coating adhesion on the film can affect the readability, functionality, and even cause contamination on the surface. With protocols getting stringent day by day, the last thing a label manufacturer wants is ink failure.

It is important to understand and standardize all possible variables that cause this issue in the first place.

- The film's chemically inert structure makes it difficult for the ink to anchor on the substrate. Corona Treatment can help.
- Whether ink wets a material good or poorly depends essentially on the surface energy (dyne level) of the material. Corona Treatment increases the surface energy of the substrate to improve its wettability.
- Corona Treatment also rids the material of organic and inorganic contaminants that can interfere with adhesion.

Only Corona Treatment can ensure ink adhesion on film surfaces and equip labels to withstand the harshest conditions.

This is achieved by passing the film over an electrically grounded roller through an air gap between fixed electrodes and dielectric where the film is exposed to a very high voltage potential at a very high frequency. The voltage build-up causes ionization of air, creating a corona discharge, which increases the surface energy of the film.

Avoid expensive materials as they do not promise ink adhesion and durability

Yes, top coating primes the material surface for printing. But converters can cut costs by using non-top-coated films and corona treating it just before printing. Corona Treatment strengthens the bond between the substrate and the ink, consequently increasing the scuff resistance. The technique is both highly efficient and cost-effective, especially as it takes place inline. The process also eliminates the need for closer monitoring by the operator for print quality. Converters get increased productivity by printing at higher line speeds and minimizing discarded products.

Choose wisely as many variables govern the adhesion of ink on the substrate: right choice of ink, curing time, surface energy of the material. Using a non-top-coated material and refreshing it with Corona Treatment inline with printing will save expenses and offer a consistently superior ink adhesion with a scuff-resistant print quality. Corona Treatment is the solution to tape test failure.

Corona Treatment strengthens the bond between substrate and ink, decreasing the curing time for the ink. It eliminates the need for closer monitoring of print quality. You enjoy increased productivity by printing at higher line speeds and minimizing discarded products. Save money by using uncoated films and corona treating it just before printing. It's time you embraced the highly efficient and cost- effective technique.

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APPENDICES

INHERENT SURFACE TENSIONS OF SUBSTRATES

Material	Surface Tension (Dynes/cm)
Hydercarbons	
PP, OPP BOPP	29-31
Polyehylene	30-31
Polystyrene PS	38
Low IONOMER	33
Polystyrene	
ABS	35-42
Polyamide	<36
Polyamide Methyl Methacrylate	
PMMA	<36
Polyvinyl Acetate/ Polyethylene Copolymer	
PVA/PE Copolymer	33-44
Epoxy	<36
Polyester	41-44
Rigid Polyvinyl Chloride	
PVC	39
Plasticized	
Polyvinylchloride	
PVC	33-38

Material	Surface Tension (Dynes/cm)
Rubber	48
Engineering Thermoplastics	
PET	41-44
Polycarbonate	46
Polyamide	40
Polyaryl Ether Ketone	<36
Polyacetal	<36
Polyphenylene Oxide	
PPO	47
PBT	32
Polyesulphone	41
Polyethersulphone	50
Polyarylsulphone	41
Polyphenylene Sulphide	38
Nylon	33-46
Elastomers	
Silicon	24
Natural Rubber	24
Styrene Butadiene	33-38

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Corona • Plasma • Ozone

IEEC POWER ELECTRONICS PVT. LTD. is one of the leading suppliers of Corona Treatment System and Plasma.

Founded in 1969, the company's progressive, innovative spirit continues to boost its ability to navigate the sea of change 50 years on. It has introduced new technologies to its business, offering the single most comprehensive range of Corona Treaters, Plasma Treaters, Moving Band Pinning System for BoPET, Ozone Generator for Extrusion Lamination, Ozone Destructor, etc. to name a few.

IEEC offers a full range of corona equipment for applications ranging from the narrow web market to cast/blown film, coating and converting on to the ultra wide web BOPET, BOPP, CPP. In recent years, the demand for its full product range has been particularly strong in the extrusion coating/lamination market sector. IEEC also caters to Narrow Web Corona Treatment System for Label Industries. Our Plasma Treatment Systems are widely used in industries such as Automobile, Wire & Cable, Pipes, Injection & Blow Moulding, etc.

IEEC has been actively involved with the Plastic, Rubber, Paper and Conversion Industries for 5 decades supporting these industries from its manufacturing plant in Mumbai and various service centres throughout India and the world over. To this day, Research and Development, Design Engineering and Manufacturing remains at the heart of the company.

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