



WORLD LEADER IN COIL PROCESSING EQUIPMENT



ABSTRACT

Electrostatic Coatings

Galvanizers

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ABSTRACT

THE PRINCIPLES OF ELECTROSTATICS

Electrostatics Explained

The electrostatic principle is based on the law of physics which simply states; 'like charges repel, unlike charges attract'. Thus, when a suitable liquid (oil) is formed into a thin film exposed to an intense electrostatic energy field, it will separate almost immediately into a collection of very uniform and equally charged particles.

The reason for this is that the electrostatic charge in a sprayed particle tends to be forced to the outer surface, as all of the like-charged ions repel each other. Because of factors like surface tension, resistivity, etc. only so much charge (energy) can exist in a droplet before it spontaneously breaks up into smaller droplets in order to increase its surface area, as the so-called "Rayleigh Limit" of the liquid is exceeded.

Each smaller droplet generated will thus carry a charge of the same value and polarity (normally negative) and will therefore repel its neighbor. In consequence, this controlled dispersion within the electrostatic field ensures excellent uniformity over the surface being coated; more drops for less coating material.

Electrostatics ensure that each charged particle of liquid is attracted strongly to the target, which is earthen and hence seen by the particle as being opposite polarity. It then loses its charge and returns to its stable state. (Voltages as high as 120,000 volts are used, but at only some 200 micro amps).

Such intense electrostatic energy fields overcome gravity, enabling the system to work equally well "upside down" to ensure uniform application on both sides of the target when presented horizontally. (For vertical presentation of strip, the sprayers are positioned to discharge horizontally).

The electrostatic effect is seen in its purest form in the Linear Accelerator (L.A.) Blade. However, for special applications, electrostatic systems from can also use air-assisted nozzles or high speed rotating cup (bowl) atomizers, thus extending the range of liquids can be sprayed electro statically.



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THE PRINCIPLES OF ELECTROSTATICS

Features And Benefits Of Electrostatics

Uniform Coating

Electrostatic ensures that a uniform coating of oil is applied to a substrate at a precisely controlled coating weight, thus, reducing reject rates and hence cost as well as being better able to satisfy customers demands.

Significant Oil (Capital) Saving

Due to the high transfer efficiencies occurring, electrostatics reduce significantly the amount of oil/coating fluid needed for complete protection in comparison with non-electrostatic methods, therefore reducing coating costs. The saving is considerable and can result in the machine paying for itself in under a year.

Coating Weight Flexibility

Electrostatic applicator systems are capable of applying coating weights form as low as 3 mg/m², if required. Hence a wide variety of different coating programs and oil (coating) types can be handled by a single machine.

If coating requirements change, the machine can normally accommodate them.

No Mechanical Contact

There is no mechanical contact with the target surface. Thus, the risk of surface damage is negligible and wear on the machine is minimal. Also, intermittent or patchy covering of the strip. as can occur with other systems using contract rollers, is eliminated. Further, roller bounce from uneven strip surface is avoided, as is costly maintenance of rollers and their bearings.

Coating Material Transfer Efficiency Near 100%

Any unused coating / oil is confined within the machine and is recycled, giving an overall transfer efficiency approaching 100%. Thus, coating costs are further reduced.



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Features And Benefits Of Electrostatics

Improved Environment - Improved Coil Shape

Because excessive coating is eliminated, seepage from coils does not occur. Thus, there is no opportunity for coils to lose shape and hence the tension in the coils remains stable. Further, capillary evacuation from high pressure points (which can cause circular dry patches) cannot occur.

Oil spillage to floors and nearby machinery and oil mist emissions are effectively eliminated, thereby improving the working environment and often allowing for reduced insurance costs.

Few Moving Parts - Low Maintenance Costs

The Electrostatic Coating System achieves its objective using very few moving parts. Hence, maintenance is minimized so downtime of the line is reduced to the lowest possible level, giving further cost savings.



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OILS FOR ELECTROSTATIC DEPOSITION

As specialist suppliers of electrostatic oiling machines it has been necessary for us to test many different types of coating oils for their suitability to the process. Although we have yet to find an oil which is totally unsuitable, it is clear from our tests that some oils perform better than others.

The test method is to duplicate, as closely as possible in the laboratory, the conditions in which the medium is to be run in production. Oil flow and high voltage control settings are adjusted to give the optimum atomization and spread patterns, and the oils classified between excellent and poor according to the recognized pattern achieved. Assessments are made by experience observed in controlled conditions, ensuring good correlation between tests.

There are three main factors which contribute to the compatibility of an oil with electrostatics application. These are:

1. Conductivity.
2. Viscosity.
3. Surface tension.

All three factors are inter-related and all are affected by environmental conditions.



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OILS FOR ELECTROSTATIC DEPOSITION

Conductivity

The conductivity of an oil will determine the degree of charge which it will accept and therefore, the strength of electrostatic field generated. For convenience the property measured is in fact the reciprocal of a material's conductivity, i.e. its resistivity and this is accomplished by rating with a test meter and probe.

In relation to suitability for electrostatic application the following tabulation broadly applies:-

Resistance

Characteristics

0 - 90K Ohm

Almost totally conductive. Erratic uncontrollable atomization. Special needs for insulation.

90 - 750K Ohm

Excellent atomization, particularly suitable for low film weights. Some insulation precautions may be necessary.

750 K Ohm - 15M Ohm

Good atomization. Ideal for finishing mill application.

15M Ohm - 50m Ohm

Medium atomization. General purpose and pickle line applications.

50M Ohm +

Coarse atomization. Complete coverage of coated surface may rely on after flow. Heating is normally required.

Resistance of an oil may be changed in two ways (i) by adjusting the extender present in the oil, e.g. by altering its polar properties, and (ii) by altering its temperature; although not linear in value the resistance is inversely proportional to temperature increase.



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OILS FOR ELECTROSTATIC DEPOSITION

Viscosity

Viscosity is a liquid's resistance to flow at a given temperature so the manner in which an oil can flow from a blade, and its mobility upon reaching the target surface, may be given a numerical value.

Oil viscosity's may conveniently be typified as follows:-

Viscosity

(Centipoises at ambient temperature)

100 +

70 - 100

20 - 70

Less than 20

Characteristics

Heavy and immobile. Heating required to allow to flow.

Medium/heavy coarse atomization.

Good atomization - preferred range.

Very thin consistency. Very narrow slot gap required, for uniform output from blade.

The viscosity of an oil is also inversely proportional to temperature change. Normally, higher viscosity oils will be heated to a reduced viscosity suitable for atomization.

Surface Tension

The surface tension of an oil is the measure of internal force holding the mass together and resisting its atomization into small particles. High surface tension equates with difficulty in atomizing.

Commonly encountered oils are from the following range:

Surface Tension (Dynes/cm)

34 +

26 - 34

Less than 26

Characteristics

Requires heating for good atomization and should be in preferred resistively range.

Good atomization properties. Preferred range.

Erratic uncontrollable atomization. Unsuitable for blade coaters.

Surface tension is also inversely proportional to temperature change.

The foregoing are generalities aimed at indicating the more desirable features of oils intended for electrostatics application. All are inter-related and GFG Peabody's experience can maximize an oil's performance through experience related engineering.



GFG

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OILS FOR ELECTROSTATIC DEPOSITION

Figure A

Excellent atomization and coverage at all coating weights.



0.015-2M. Ohm

Figure B

Good atomization with slight deterioration of coverage at some levels.



2M.Ohm-15M. Ohm

Figure C

Coarse atomization. To achieve full coverage some after flo may be required



15M. Ohm-50M. Ohm +

These spray patterns can be expected using oils having resistance readings as shown. The figures given are approximate guidelines. Also, spray patterns can vary with oil output. For example; oil emission of 2cc/cm of blade length may result in spray pattern (Fig A) whereas, an output of 10cc.cm ma Dy result in (Fig B) using the same oil. The Peabody Dynamic Voltage Control, originally patented and first sold by GFG, which delivers the optimum charging strength for any given oil output, has been developed to minimize these differences and maintain stable spray patterns over a wide range.

Typical spray pattern as seen from side of blade.

Figure A

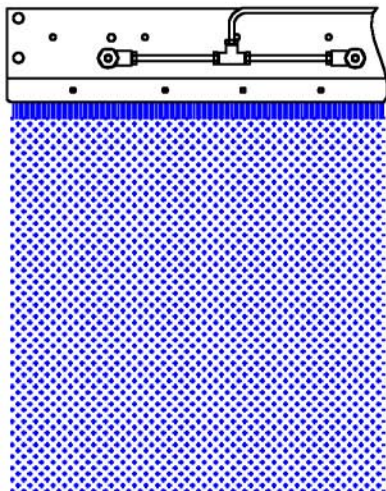


Figure B

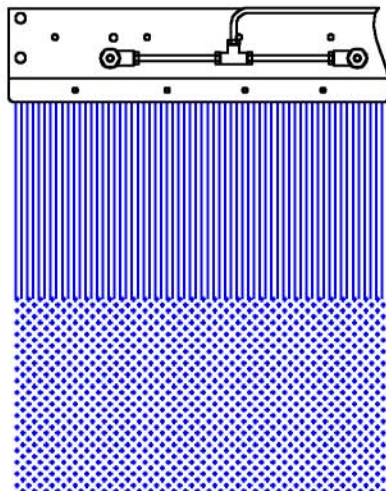
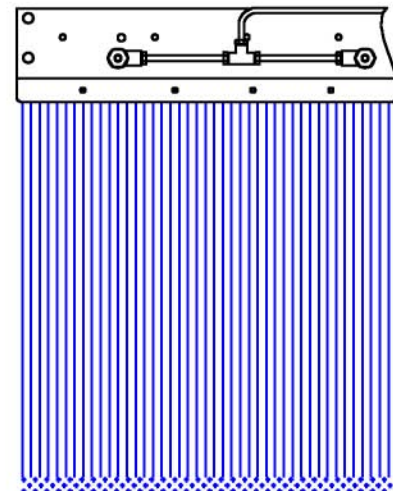


Figure C





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OILS FOR ELECTROSTATIC DEPOSITION

Types of Electrostatic Applicators

We can offer several methods of spraying the various types of coating oils, waxes or other materials, to give a fineness and uniformity of particle size suitable for electrostatics. These are described below:-

The Blade Coater

We originally developed the concept of the Electrostatic Blade Coaters some 30 years ago. The latest form is the so-called L.A. (Linear Accelerator) Blade and it offers a wide range of coating weights and product speeds.

Blade coaters utilize a narrow slot to distribute the coating fluid. A natural interaction between the electrostatically-charged particles after atomization ensures complete uniformity of coating fluid over the entire target surface. The blade converts the fluid into a dense, well-defined pattern of electrostatically charged particles, which are strongly attracted to the target surfaces with a transfer efficiency approaching 100%.

The latest L.A. Blade embodies design features which increase the density of the atomized particles within the charged pattern almost six-fold over earlier blade types. Therefore linear accelerator blade uses less coating fluid and is able to operate over a much wider range of coating weights than earlier blade design, generally from 15 mg/m² upwards.

The Rotary Atomizer

Rotary Atomizers have been used for many years in industrial applications. In electrostatics, the coating fluid applied to the bell of an atomizer is spun out to its edge and subjected to an intense electrostatic energy field.

The cup-shaped atomizer is rotated at high speeds (up to 40,000 rpm) using a friction-free air turbine and utilizes a combination of centrifugal and electrostatic energy to atomize and distribute uniformly coating fluids down to low mg/m² levels.

The resultant dense, uniformly-distributed pattern of charged fluid particles is strongly attracted to the earthen target, providing almost 100% transfer efficiency.

The particular advantage of the rotary atomizer is its ability to maintain uniform distribution down to extremely low coating weights (as low as 3mg/m²) and generally up to 200mg/m² with excellent control characteristics.

Further, many types of coating can be used, including waxes and water-based fluids. Another advantage is that the rotary atomizer has excellent response time to accelerations/decelerations are required.



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TYPES OF ELECTROSTATIC APPLICATORS

The Electro-Air Atomizer

The electrostatic spray nozzle uses air-assisted atomization and is especially designed to handle a wide range of coating weights from low mg/m^2 levels. It is thus ideally suited to sheet coating processes particularly where mineral or water-soluble coating fluids are used. Each spray nozzle is supplied with its own fluid control valve, offering unique air flow adjustment for both atomizing and pattern shape control.

A needle electrode at the nose of the gun creates a high energy electrostatic fluid which induces an electrostatic charge on each atomized fluid particle. The resulting electrostatic attraction ensures efficient transfer of the coating material to the target.

Air-assisted spray nozzles are normally incorporated in completely integrated systems designed to cut and handle varying widths or lengths of, say, cut steel sheet. Of special note is the facility to spray on to selected areas of, for example, blanks for press feeding in the Automotive Industry using PLC (Programmable Logic Controller) Control. Coating weights handled are typically in the range of $100\text{-}4,500\text{mg}/\text{m}^2$.



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NEW DEVELOPMENTS

The Following New Developments Can All Be Retro-Fitted To Existing Electrostatic Oilers

Adjustable Spray Width (ASW)

ASW blade so that a spray width control system can be included in their range of coating equipment and offered where appropriate.

The spray band width is adjusted in 50mm steps from either side of center line up to maximum strip width. Each step is fed from a specially designed segmented high precision pump ensuring that an accurate metered amount of oil is fed to each blade step or zone.

ADVANTAGES of the ASW Steel Blades

1. Gives complete oiling across strip width.
2. Greater accuracy across the strip uniformity in oil coating. Typically +/- 6%.
3. Sharp linear accelerator edge giving the best atomization quality.
4. Ability to emit oil spray through a narrow gap (100mm) allowing plastic wing protectors to be shaped and positioned so as to give adequate protection plus facilitating front edge strip feeding through the oiling enclosure which therefore need only be 700mm in width if there are on line space restrictions
5. No delay in oiling at start of line running. With the blade coater using the catchment trough facility the strip is completely oiled from the moment the strip begins to move.
6. Capable of withstanding temperatures in excess of 150oC.

In order to achieve the best oiling results from the system we have improved blade manufacture where the slot gap is now controlled to within extremely tight tolerances (ie. better than 5% deviation over 2 meter length). Greater emphasis has also been put on improved filtration which has virtually eliminated blade clogging.



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The Hard Steel Blade With Sharp-Edge Technology

To improve upon the condition of insufficient integration of spray patterns leading to stripes and poor uniformity in the final oil coating which occurs where banks of individual atomizers are used, the sharp edged steel blade with the linear accelerator edge is retained. This ensures a complete spray band with no gaps between each width zone with the highest degree of atomization that only comes from the sharpened steel edge. The width control gives a clean cut off at each side of the spray band. The target width can be either set from a line computer or operator control.

Solid State High Voltage Power Supplies

Solid state high voltage power supplies. These rack-mounted light weight units eliminate the use of oil filled transformer assemblies.

This unit gives a variable output up to 125Kv. The solid state design allows instantaneous power to the blades, eliminating the existing high voltage controller which was a soft start up wind up system.

The electrostatic oiler is capable of operating using only one (negative) power supply, but with reduced flexibility and a reduction in maximum performance. This is useful only in the unlikely event that one of the two supplies fail.

The most important reason for considering two units is the ability to operate at both positive and negative potential at the same time and be able to vary the applied potential between top and underside blades.

The main benefits of dual polarity relate to a controlled coating at the edges of the strip and reduction of unwanted particle emission from the machine particularly when processing narrow strip. The power supply incorporates the Peabody Dynamic Voltage Control, originally patented and first sold by GFG, which is a standard feature to all GFG Peabody electrostatic oilers and is essential if the full potential coating range of the system is to be realized.

The DVC is fully adjustable and automatically varies the high voltage according the oil flow present at the blades.

It is the DVC control that ensures uniformity of coating weight through the very wide coating range of the LA and sharp edged narrow-slot steel blades.



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Servo Controlled Metering Pump System

With this refinement greater accuracy is obtained in metered oil supply to the blades as well as improved faster response to line speed variations especially during line acceleration and deceleration times.

The system comprises one (1) servo controller with a servo motor driving a high speed precision made double cell metering pump which supplies both blades plus the necessary auxiliary electrical equipment.

Dedicated Blade Heating Retro-Fit

It is not good practice to heat bulk supply oil tanks above 50oC but heating the small amount of oil which passes through the blade is permissible and is very important if the highest degree of atomization is required.

Dedicated blade heating retro - fit kit

Blade heater panel

Comprising one (1) 220 volt circulation pump, one (1) long-path electrical heater with temperature gauge, header tank, all piped and mounted to a substantial back plate.

Two (2) blade heater pipes

These are square steel tubes approximately twice the length of each blade, but arranged as parallel pairs with quick release couplings at one end. One set is attached to each blade.

Note: If the new steel blades are installed these blade heater pipes would not be required. The steel blades have an internal heating manifold which is machined in during manufacture.

One (1) kit of flexible oil pipe and fittings.

One (1) kit of rigid pipe, manifold and fittings.

One (1) control box.

Power connections: 1 x 220 Volt supply.

Maximum demand: 3 Kw.

This system is strongly recommended as the beneficial effect of the blade heating on the oil to be electrostatically applied can be as much as a 40% atomization improvement.



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Oil Flow Meters

These units which are mounted as near as possible to each blade oil inlet, determine very accurately the actual amount of oil being applied to the strip. They give a digital display of oil in ccs/min and an analogue signal, for use to display actual coating weight in Grams/m².

Air Purge System

From time to time lanolin or a similar content of the coating oil tends to gel at the blade slot. To overcome the need to stop the line for blade cleaning we have developed, for our newest oilers, an air purge system. Each blade can be purged individually. This has the benefit of cutting production down time to minimum.

Pressurized Oil Feed and Filtration System

Connected from the outlet of the oil tank to the inlet side of the metering pumps system is a pressurized oil feed and filtration system. This consists of a pump/motor assembly and two 25 micron filters complete with a dirty filter pressure switch. The switch notifies the operator when the oil filter is blocked. The oil can be quickly diverted manually to the second filter/strainer to allow continuous operation. The first filter is designed to collect water, and the second one is for fine debris. The system continually circulates filtered oil to the tank. The system ensures only the cleaned oil is applied via the blade applicators to the steel strip.