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Factors Effect Efficiency of Electrostatic Assist, Construction and Safety in Roto-Gravure Printing

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ABSTRACT: Roto-gravure printing is considered a pioneer in high quality long-run jobs, especially for printing packaging materials.The process employs heavy nip pressure to draw ink out of image cells by means of contact-adhesion relationship resulting in a form of capillary action. This phenomenon might fail due to surface structure of the printing substrate or doctor blade leaving behind a concave meniscus of ink in the cell. This result in print appears speckled with white dots, which is known as Speckle or Dot skips. Electorstatic Asssist (ESA) substantially improves the transfer of ink on to substrate with minimum pressure. This report aims to determine the factors effecting efficiency of ESA and the corresponding extent of change that occurs on printability, safety in the system. The analysis revealed that increase in substrate thickness decreases the relative permittivity of dielectric medium (substrate), hence more voltage required for decreasing relative permittivity so as to achieve optimal printing.

I. INTRODUCTION

Gravure printing is considered a pioneer in high quality long-run jobs, where dot skips are the major problem which effects the quality, dot skips occurs when ink in the image cells do not make contact to the substrate. [8]The physical cut of the doctor blade used to clear ink from the surface of a gravure image cylinder can leave behind a concave meniscus of ink in the cell, thus ink is in position beneath the surface of the image cylinder.

[5]Electrostatic force is defined as the region around a charged body where another charged body experiences a mechanical force.Electrostatic Assist (ESA) has contributed more to improve the quality of roto-gravure printing than any other innovation, ESA system facilitate ink to elevatefrom the surface to achieve contact with the substrate by means of high voltage DC electrostatic force.

Electrostatic Assist (ESA) uses a specially designed conductive impression cylinder where gravure and impression cylinder both are grounded. The electro static force produces a downward force into the grounded gravure cells which creates additional pressure that helps to disturbs ink cell contents resulting in a wave that elevates the ink to the surface.The substrate which are used are non-conducting in nature have a high resistance to flow of electrostatic flux known as Permittivity. Permittivity is defined as the ratio of electrostatic flux density that allows/passes through a dielectric medium (non-conducting medium) produced in vacuum or free space, by the same electric field strength.[5]Higher the value of relative permittivity, easier is the passage of electric flux lines through the material, generally paper has 2 to 2.5 relative permittivity which is very less, a high voltage is required to produce enough electrostatic force / electrostatic flux to pass the medium.

[2]Very high voltage is necessary to operate on comparatively low viscosity inks, to deform the surface and thereby improve the chance of the ink making contact with the substrate. Water based ink need more voltage compared to solvent based inks.

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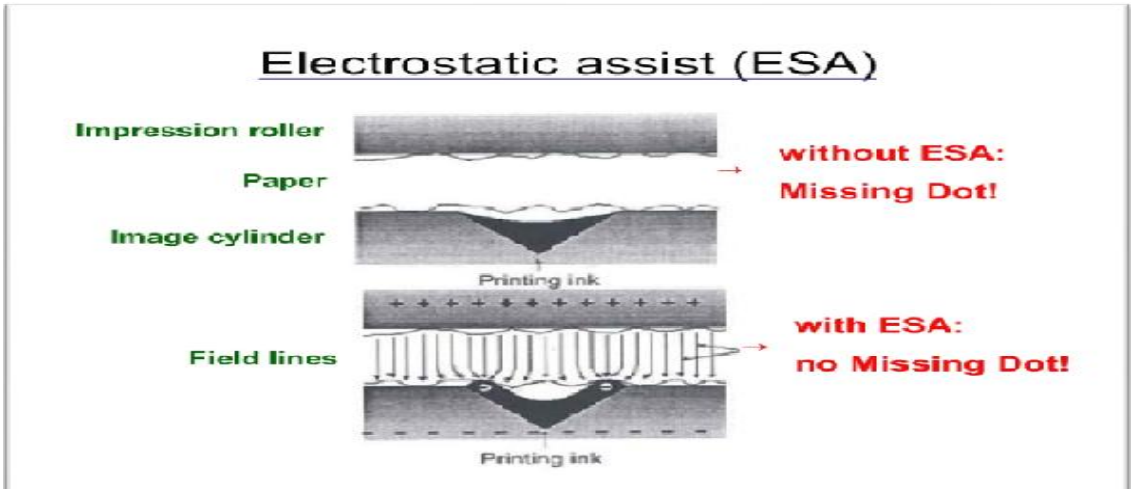
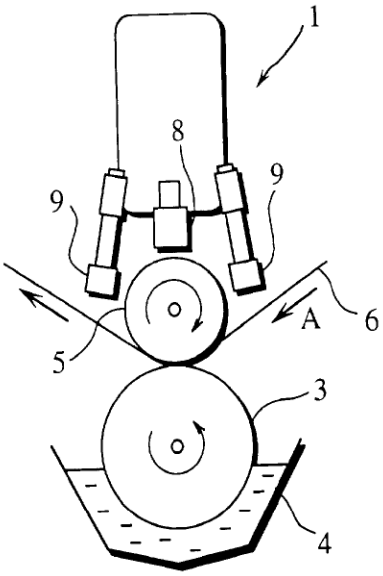
II. PRINCIPLE



The Electrostatic printing Assist is based on the principle ofthe plate-type capacitor. This means thata homogeneous electric field is generatedbetween two plates, in which a dielectric pulled between the two plates. The electrostaticprinting assist applies this principle in thenip at precisely the point where the inkis to be transferred onto the web.This principle of ink transfer with electrostaticsupport works evenly over the entirewidth of the web and operates reliablyfrom the slowest to the highest productionspeed.

[5] The electric lines of force acts like stretched elastic bands and always try to contract in length; this causes a pull force in the gravure image cells.

III. CONSTRUCTION



1. ESA Assembly
3. Grounded Gravure Cylinder
4. Ink Pan
5. Conductive Impression Cylinder
6. Substrate
8. Charging Unit
9. Discharging Unit before entering the printing unit
10. Discharging Unit after coming out from printing unit.

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Discharging Units:[8]Twoionizing or Discharge Bars one of which is positioned parallelat a distance of approximately 20 - 30mm from the web before the printing nipand the other of which is positioned parallel to and at a distance of approximately 20 -30mm from the web after the printing nip. The positions of both bars are asclose to the nip as practicably possible. The purpose of the discharge bar installed infront of the print nip is to ensure the uniform condition (ideally 0 Volts) of the webprior to the printing operation and is there for reasons related to the printing process.The discharge bar positioned after the printing nip is there to eliminate any staticinduced into the web by the electrostatic assist process and any static otherwise inthe web. It should be regarded as a safety device.

Charging Unit: Receives a high voltage supply, the inner elements like electrode forms the electrostatic force necessary to run the printing.

Conductive Impression Cylinder: Depend upon the type of ESA loading the construction differs;generally the outer layer is a semi-conductive layer with a formulation of graphite, having higher insulation resistance.

Grounded Gravure Cylinder: The Bearings of the gravure cylinders is grounded to avoid electrical leakages to the main frame by using insulation material.

CONSTRUCTION BASED ON TYPE OF ESA LOADING

1. Top Loading

   a. Non-Contact Loading
      - Bar loading

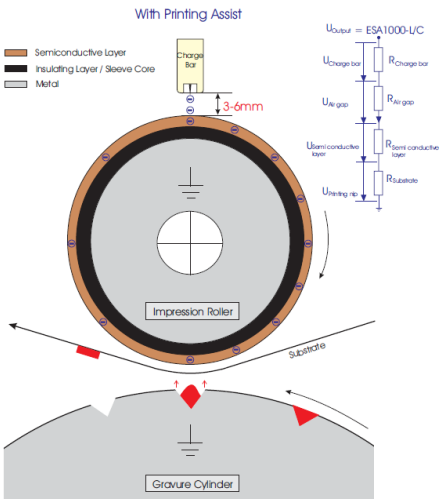
   b. Contact Loading
      - Roller loading

2. Core Loading

3. Side Loading

TOP LOADING

Non-contact type [Bar type]



[8]Charging unit is placed at a distance of 3-6mm away from the impression cylinder,it has protruded pins within their bar and by increasing the number of pins on the charge bars having pin pitch of 5mm providing 2-4 times

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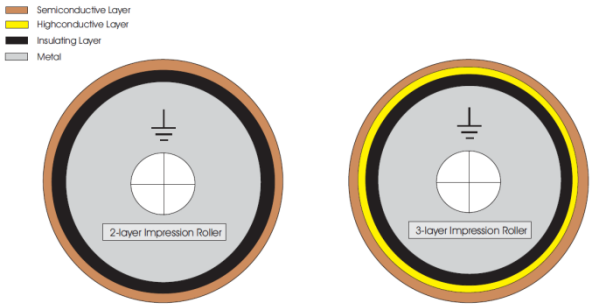
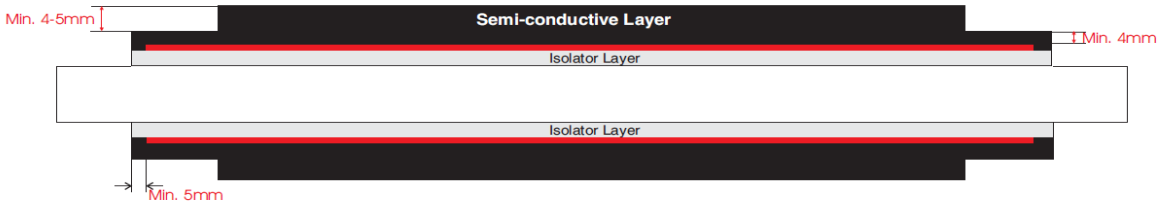
more energy points for the ESA to transfer.It works by creating a controlled voltage in the order of 500-1200V in the printing nip from the output voltage of 15kV coming from the power supply. Voltage in the area of the nip creates a force field which acts on the ink contained in the cells of the gravure printing cylinder and causes the ink to seek to evacuate itself from the cells so assisting the capillary action of the gravure printing process.

Impression cylinder



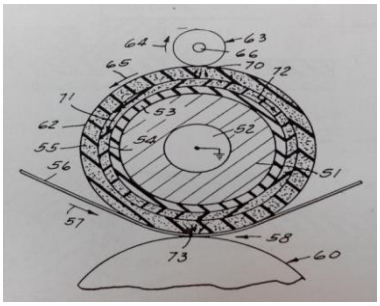
Impression cylinder and gravure cylinder both are grounded. [4]The middle conductive layer should be as thin as practical for roller stability provides a low resistance path and is usually encapsulated within the other two layer as a safety, reduces the risk of sparking.[4]Conductive layer material may be natural or synthetic rubber containing conductive carbon black or other conductive materials. As a protective measure, the cross-sectional areas of the base layer and semi-conductive layer are coated with a very thin layer of a moisture resistant epoxy to prevent ink from penetration into theinsulation layer.

Cross-Sectional View of Impression Cylinder



Contact Loading

- Roller loading



A small roller which run over the conduction impression cylinder,The voltage is supplied by the contact brush on the roller, this system has may problems; the difference in RPM causes the roller to heat and bending.

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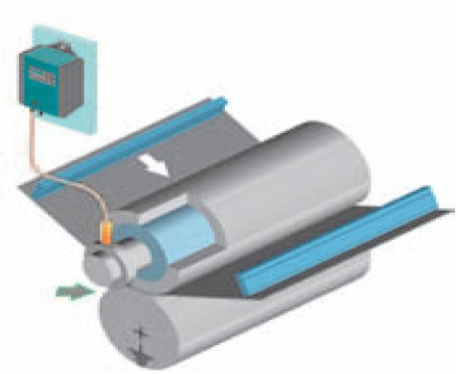
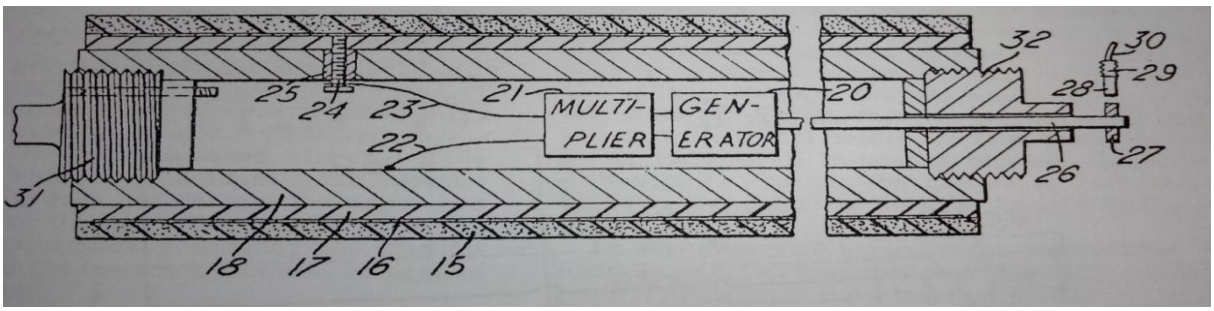
Core Loading



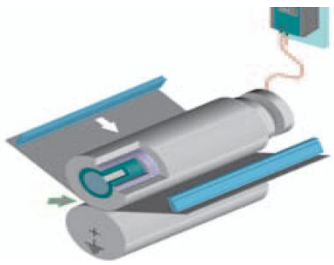
[2]Voltage required for the electrostatic ink-transfer assistance is applied through a brush or sliding contact to a slip ring on the journal of the impression cylinder.The brush and slip rings connection constitute an explosion hazard, as an addition is made to avoid it by providing sealed by screwed journal ends to form an explosion-proof chamber.

Cross-Sectional View of Impression Cylinder



[2]The insulation layer may have a radial thickness of 3/6th inch, the conductive layer may have a thickness of 1/4th inch, and the outer semiconducting layer may have a thickness of 5/6th inch.

Side Loading



[1]The infeed paper or web is discharged by a discharge bar to eliminate any existing residual static charges. The nip voltage required in the printing nip is transferred into the conductive layer of the impression roller coating via the rotary transformer. This nip voltage (300…1000 V DC) causes the ink to transfer from the cells to the substrate with point-to-point accuracy and without high impression roller pressure.

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IV. FACTOR EFFECTING EFFICIENCY OF ESA

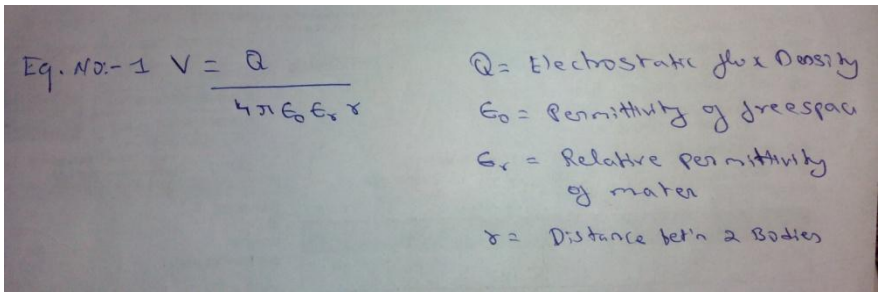
1. Supply type (AC or DC)]
2. Voltage relationship with substrate
3. Variables in system
4. Insulation Resistance of material

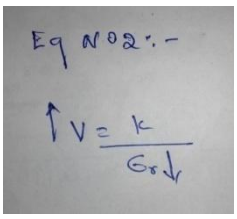
Supply Type (AC or DC)

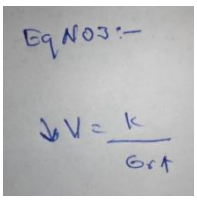
[2]With an AC (Alternating Current) supply the voltage at the back of the web is positive and negative in alternate half-cycle, provided that the voltage amplitude is large enough. The frequency of A.C.Voltage applied should then be related to the maximum speed of the web. As an example, for a web travelling at 2,000 ft/min, a frequency of 4000 cycles/sec would get a complete cycle, including positive and negative halves, during the passage of about 1/10th inch of paper.Since the circumferential width of the nip of the rollers would be more than 1/10th inch, optimum transfer would be obtained without the streaking effect which would take place at low frequencies

Voltage relationship with substrate

Since the substrate is non-conductive material or Dielectric material, as the caliper thickness of the substrate increase,the resistance to the flow of electrostatic flux also increase hence resulting in decrease in permittivity as increase in caliper thickness.[5]The relationship can be better understood by the Electrical potential Difference formula. Eq No :1







Eq no2: As the of material caliper increases (Thicker substrate), voltage should be increased to cross the potential barrier of the material

Eq. no3: As the permittivity of material increases (thinner substrate), voltage should be decreased.

Variables in system

- Voltage supplied
- Distance Between the charge bar and impression cylinder.

As the voltage supplied from ESA is optimized generally by control board, for the better results the distance between the charge bar and the impression cylinder can be varied by 3-6mm, by this electrostatic flux linkage can be controlled and varied.

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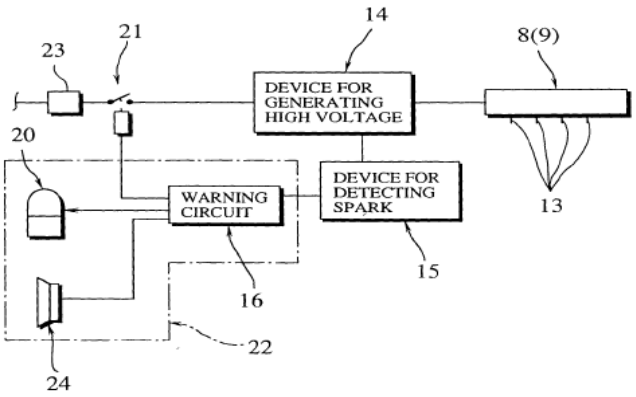
Insulation Resistance of material

[8]Outer semi-conductive layer has the insulation resistance of 20 Mega Ohm, inner layer has the insulation resistance of 50Giga Ohms, most of the time Manufacturer of the ESA system will provide the conductive impression cylinder, which is considerably constant in all the conditions. Two or three layerimpression cylinders are available; the voltage application varies on this factor too.

REASONS FOR HIGH VOLTAGE IN ESA

- [5]The Electrostatic Flux need the cross the high insulation resistance potential barrier.
- [5]Lower Permittivity of the substrate (Non-conductive / Dielectric materials)
- [2]Gravure use Low viscosity inks, to disturb the condition and create the pressure that results in elevation of the ink to the surface.

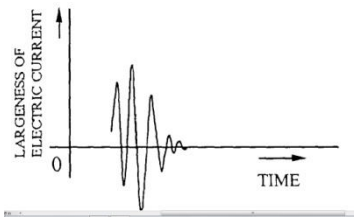
V. SAFETY IN THE ESA SYSTEM



As shown in above figure, this electrostatic assist system is provided with a charge unit(8), a device 15 for detecting spark that detects generation of a spark (abnormal dis-charge) from an electric current flowing at the electrodes (13) of the charge unit, the warning circuit employed to buzzer incase of spark detection.

Spark : When the electric field strength exceeds the dielectric field strength of air, this causes an increase in the number of free electrons and ions in the air, temporarily causing the air to become an electrical conductor, results as spark with sound.

Working Mechanism :



Spark detecting device monitors an electric current flowing at the electrodes by means of generating high voltage. When a spark is generated at an electrode, a current signal sent to device, to check the changes occurred in the signal in a short period as shown in the graph, results in trigger to open circuit
(close the electrical supply).

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VI. SAFETY PRECAUTIONS

Care should be taken to ensure that ESA system is maintained in a clean condition and cables should be inspected regularly to ensure that they are not damaged or frayed. Ensure that the charge and discharge bars are properly plugged into the related power supply sockets and that the related earth connections are solidly made.Always ensure that the gap between the charge bar and the impression roller is maintained at its optimum distance (as close to 3mm as possible) and that the discharge bars are maintained at a distance of20-30mm from the web.Charge and discharge bars should be kept clean by brushing with a firm non-metallic brush having the consistency of a nail brush and using a normal cleaning agent.
Dirty pins reduce the efficiency of the equipment and the amount of utilizablecurrent in the print nip area, the current which can flow through each pin in the charge bar is restricted to a safelimit by a resistor. If dirt is allowed to accumulate between a numbers of pins thepossibility exists that a conductive bridge could be formed between several pinsenabling the current from these pins to be added together resulting in a current level which is no longer "safe".When cleaning charge and discharge bars, ensure that the equipment is switched off andthat the bars are disengaged from the related power supplies.Never touch the charge bar pins (other than when cleaning) and ensure that the powersupplies are only opened by qualified electrical person.

ADVANTAGES OF ESA

- Optimum ink transfer to substrate
- Longer running time for impression rollers
- Reduced impression roll line pressure (NIP width)
- Optimal print results on low quality paper, board and plastic materials
- Faster production speed and best print results
- Consistent control of print quality
- Built in Antistatic safety bars before and after each print station.

VII. CONCLUSION

- ESA adds additional force along with capillary action, helps to achieve the high quality printing on all variety of substrates.

- Voltage supplied to the ESA system depends on the permittivity of the material (substrate).

- To avoid the fire hazards, regular maintenance should be operator regime.

REFERENCES

1. Gary A.Zagorski, Downers Grove, "Electrostatic Assist Rotogravure Printing Safety Contact". Patent Number US 4966555.
2. K.B.Morris, "Electrostatically Assisted Ink Transfer". Patent Number US 3489082.
3. Joel F.Hutchison Danville, "Impression Roller For Current-Assisted Printing". Patent Number US 3625146.
4. Bruce E. Hyllerg, "Impression Roller and Method of Preparation". Patent Number US 5178071.
5. J.S.Katre, "Basic Electrical Engineering". Tech Max Publications, Pune.
6. Trimborn, Christian wolfgang, "Electrostatic Assist System". Patent Number EP 0850760B1
7. Ernst August Hahne, "Electrostatic Printing Aid". Patent Number US 6508174 B1.
8. http://www.enulec.com
9. http://www.eltex.com