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Electrostatic Control on Insulating Webs

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Objectives

Electrostatic charges cause defects in web products and safety issues. To avoid these issues, electrostatic control should be provided during web manufacturing.

- To manufacture high quality products
- To reduce wastes
- To ensure safety

Outline

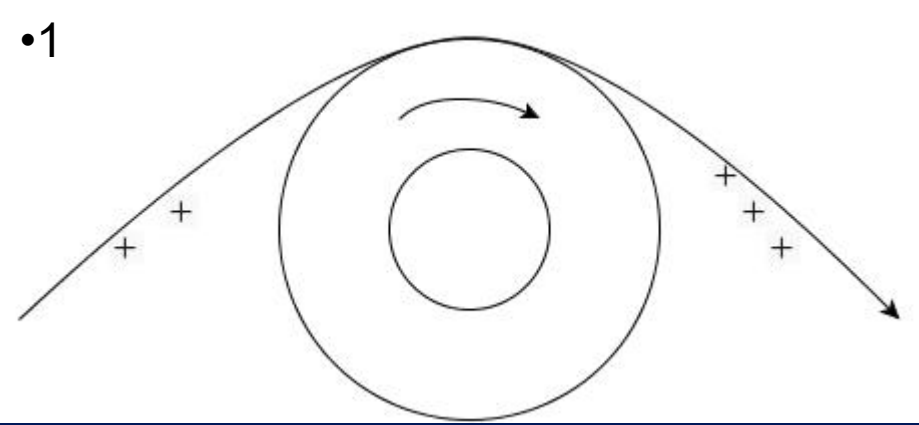
1. Problem Statement
2. 5000 Volts Rule
3. Material Selection (Static Prevention)
4. Passive Static-dissipation (Static Control)
5. Monitoring (Static Inspection)
6. Discussion & Conclusion

1. Problem Statement

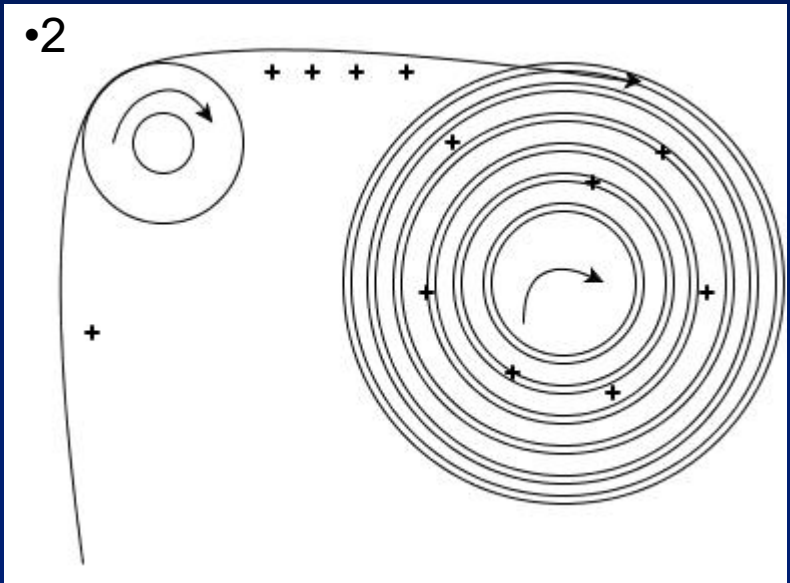
- Electrostatic charge is generated when two chemically dissimilar surfaces touch and separate.
  - web and roller.
  - Face and back of web. (they are chemically different)

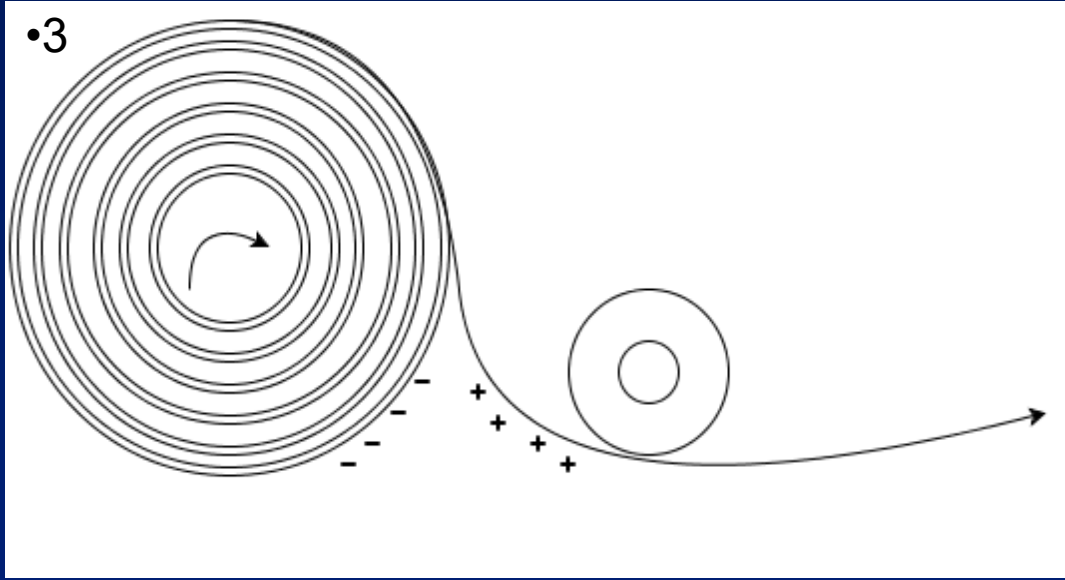
- During manufacturing process, such as coating, printing, laminating and slitting, electrostatic charge causes defects in the products and increases wastes. It may also causes sparks, fires and explosions when flammable materials are around.

1. Problem Statement

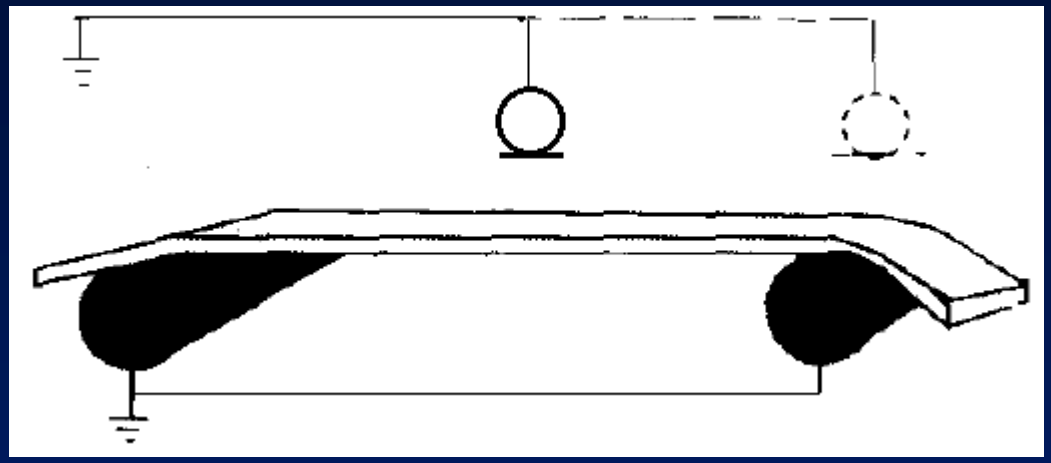


- 1. Rolling
- 2. Winding
- 3. Unwinding
- Static charge will be generated even if roller is conductive and grounded [1].





2. 5000V Rule



- $V = \frac{\sigma d}{\varepsilon_0 \varepsilon_r}$

Free span of a web should meet the 5000 Volts Rule, which is un-written 'rule of safety'. Same as keeping surface charge density below 1.7 uc/m^2 . (d=2.5cm, dielectric constant = 1) [2]

- Potential for web against a grounded roller is much lower than 5000V of the free-span. (d is web thickness, dielectric constant >1) [2]

3. Material Selection

- Material selection
  - Use rollers made of or coated with non-insulating materials.
  - Ground rollers. (drain charges on roller, not web)
  - Select materials for both rollers and webs to minimize charge separation. (cost-effective in the long run) [1]

4. Passive Static-dissipation

- Passive static dissipation (static strings, tinsel, arc-rod):
  - Sufficient to suppress sparks and lower dust attraction, no external power is needed.
  - Ineffective at low levels of charge as the voltage is not high enough to breakdown the air.
  - Degrade as equipment becomes dirty. (cleaning required)
  - Affected by the ambient factors. (relative humidity & temperature)

5. Monitoring

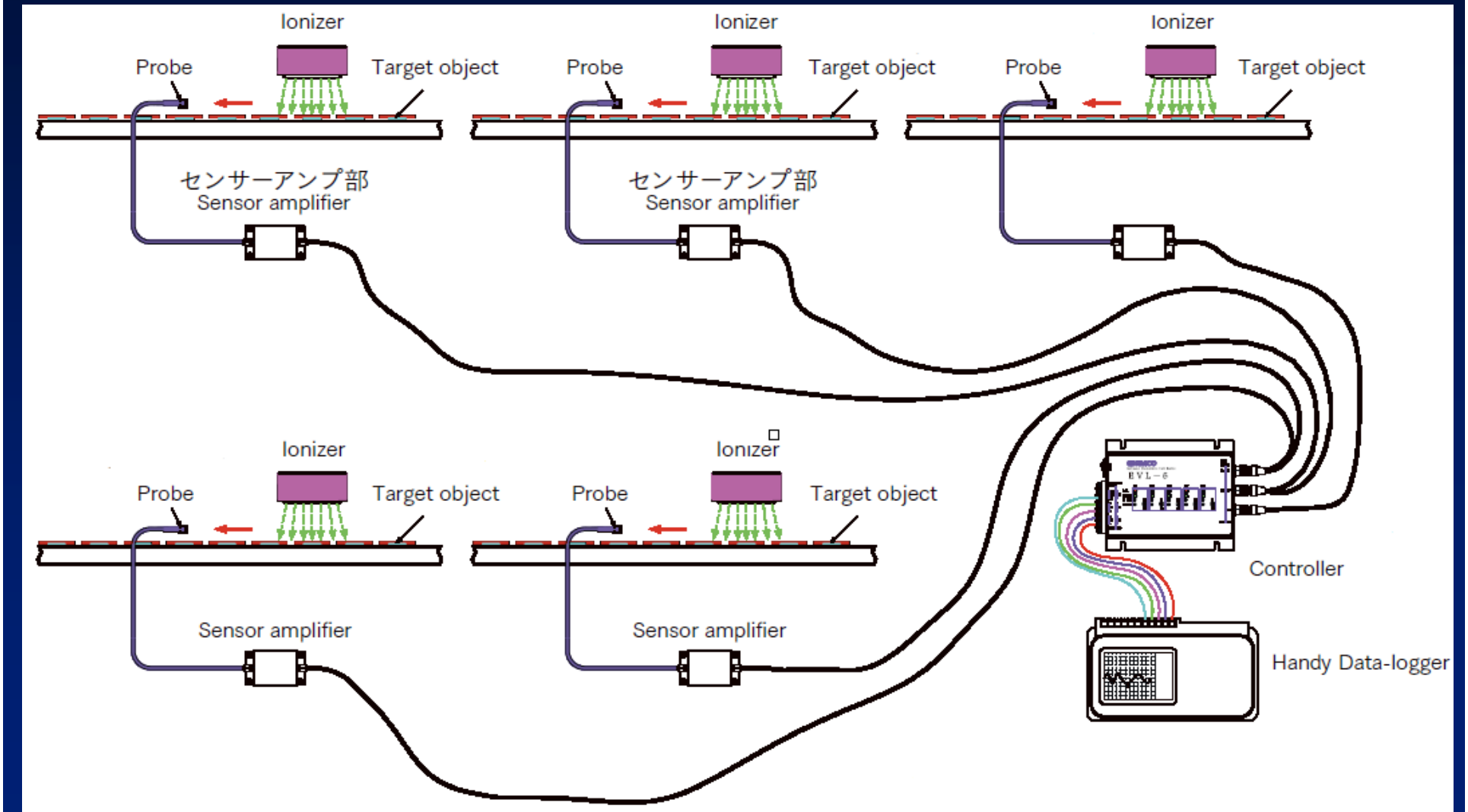
- Electrostatic fieldmeters permanently mounted at strategic locations along the web path to monitor the voltage.
- Data from fieldmeters can be analyzed using control charts.
- Control charts of the output of fieldmeters can detect variations in charge levels caused by assignable causes Assignable cause must be identified and remedied to prevent generation of waste.

5. Monitoring

Cause of variation

- Machine Conditioning
  - Transfer of surfactants or other materials present on the surface of the web onto the machine rollers and belts. This is especially important at changeovers between different products.
- Set-up & Maintenance
  - Adjustments such as pinch roller nip pressure, roller alignment, and belt tension affect the amount of static charge separated during operation.
- Environment
  - The relative humidity and temperature during operations may affect charge levels [1].

5. Monitoring



6. Conclusion & Discussion

- All the four principles are operational and practical.
  1. 5000 Volts Rule
  2. Material Selection (Static Prevention)
  3. Passive Static-dissipation (Static Control)
  4. Monitoring (Static Inspection)
- Static charge can be well controlled through grounding, static dissipation and static monitoring.
- Launching a control program is necessary.

References

[1] K. Robinson, "Electrostatic Issues in Roll-to-Roll Manufacturing Operations," in *Industry Applications Conference, 2007. 42nd IAS Annual Meeting. Conference Record of the 2007 IEEE*, 2007, pp. 781-786.

[2] A. E. Seaver, "Analysis of electrostatic measurements on webs," in *Industry Applications Society Annual Meeting, 1993., Conference Record of the 1993 IEEE*, 1993, pp. 1721-1727 vol.3.

Thank You