Controlling Static on an Unwinding Roll

Kelly Robinson, PE, PhD

Agenda

1. Motivation:
   a. Static on unwinding rolls cause problems.
   b. Static performance of prototype products is often evaluated by unwinding rolls.
2. Sources of Charging:
   a. Tribocharging between the "outside" surface and the "inside" surface
   b. Charge wound into the roll from previous operations
   c. These two sources "look" the same!
3. Analysis: 2–Ionizer Strategy
   a. Two ionizers are required.
   b. Conveyance roller locations are critical.
4. Summary

Unwinding Roll

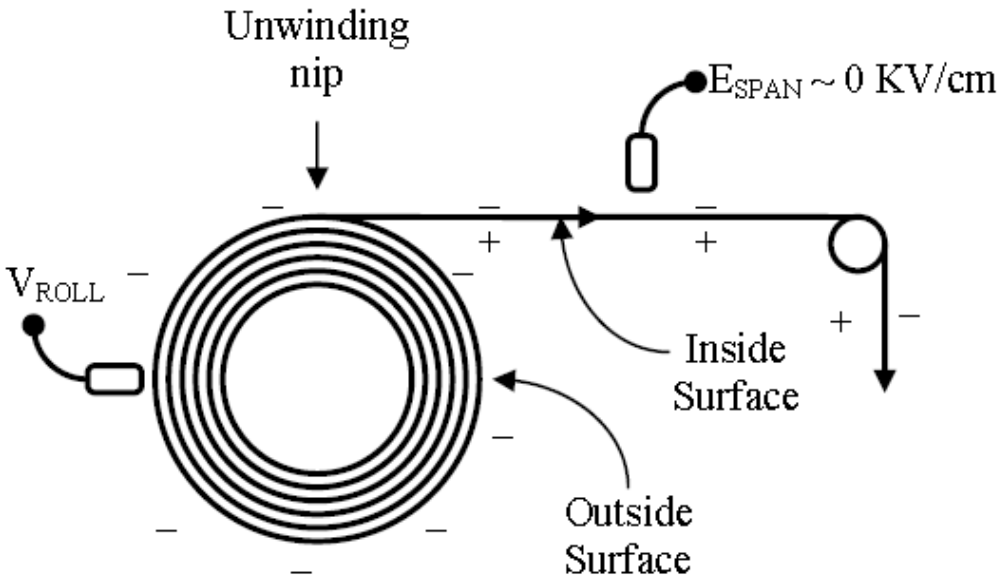


Figure 2: When tribocharging is the source of static, the electric field measured on the first web span is approximately zero. However, the voltage on the unwinding roll is very high and can exceed 50 KV. The voltage can cause sparks from the roll surface to the core or to other nearby grounded objects.

Triboelectric Series

Less human processing ▲

Positive	inorganics & biological materials	human skin
		asbestos
		glass
		human hair
		mica
	exception	nylon
	inorganics & biological materials	wool
		cat fur
		silk
		alumina
	natural fibers	paper
		cotton
		wood
Nearly Neutral	exceptions	steel
		poly(methyl methacrylate) (Elvacite®)
	natural resins	wax
		amber
		latex
	metals	copper
		brass
		gold

Triboelectric Series

Nearly	metals	copper
		brass
		gold
		platinum
Negative	exceptions	synthetic rubber (neoprene)
		sulfur
	biopolymers	acetate (Rayon®)
		acrylic (Orlon®)
		cellophane
	synthetic polymers	polyurethane
		polycarbonate
		polyvinylidene chloride (Saran®)
		polystyrene
		polyethylene
		polypropylene
		polyimide
		polyethylene terephthalate (PET)
	chloropolymers	polyvinyl chloride (PVC)
	fluoropolymers	polychloro trifluoro ethylene (PCTFE)
		polyvinylidene fluoride (Kynar®)
		polytetrafluoroethylene (PTFE) (Teflon®)
	exception	silicone rubber

More human processing

Process Charge

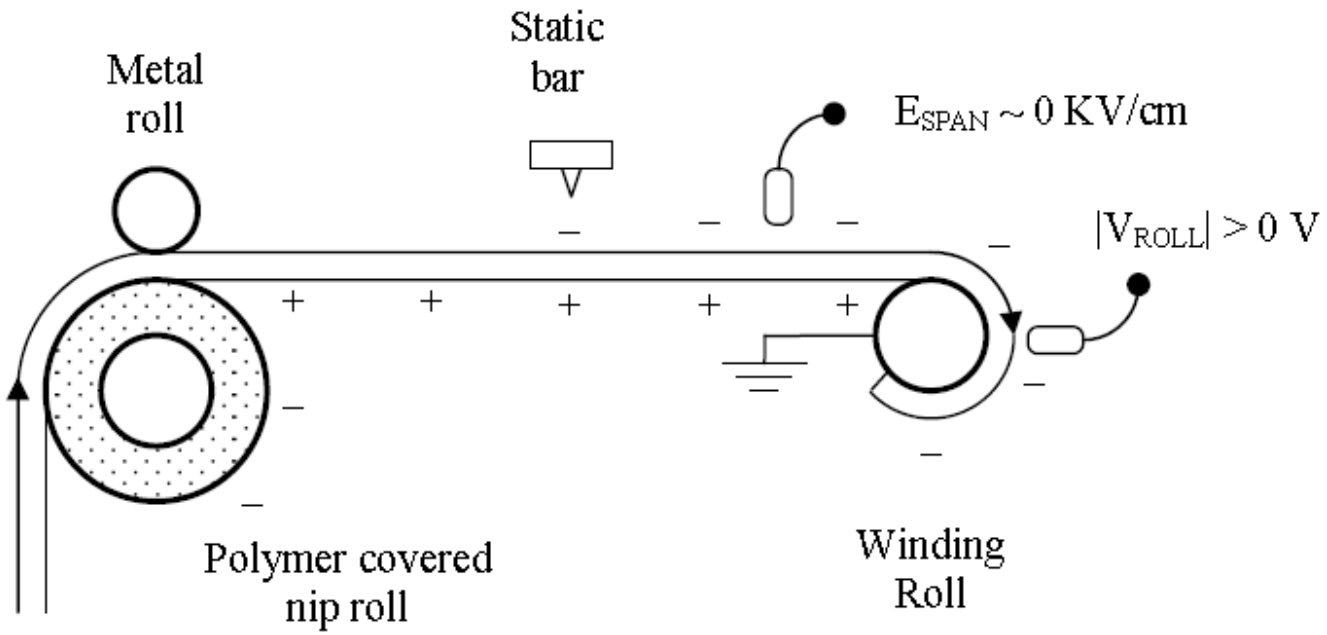


Figure 4: The web is charged by contact with the polymer covered nip roller. The static bar is located on the wrong side of the web, which results in negative charges on the outside surface and an equal number of positive charges on the inside surface of the web.

Measuring Process Charge

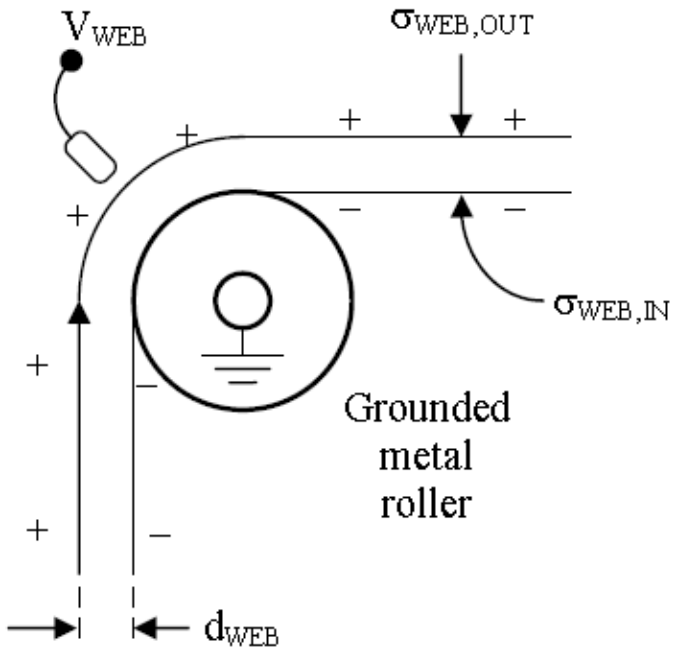
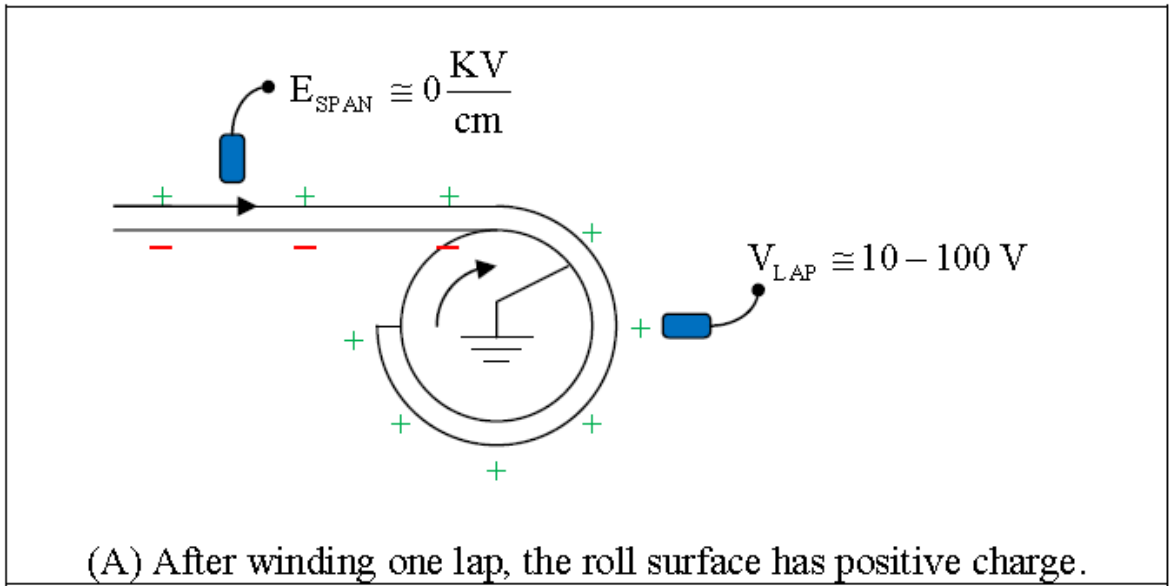
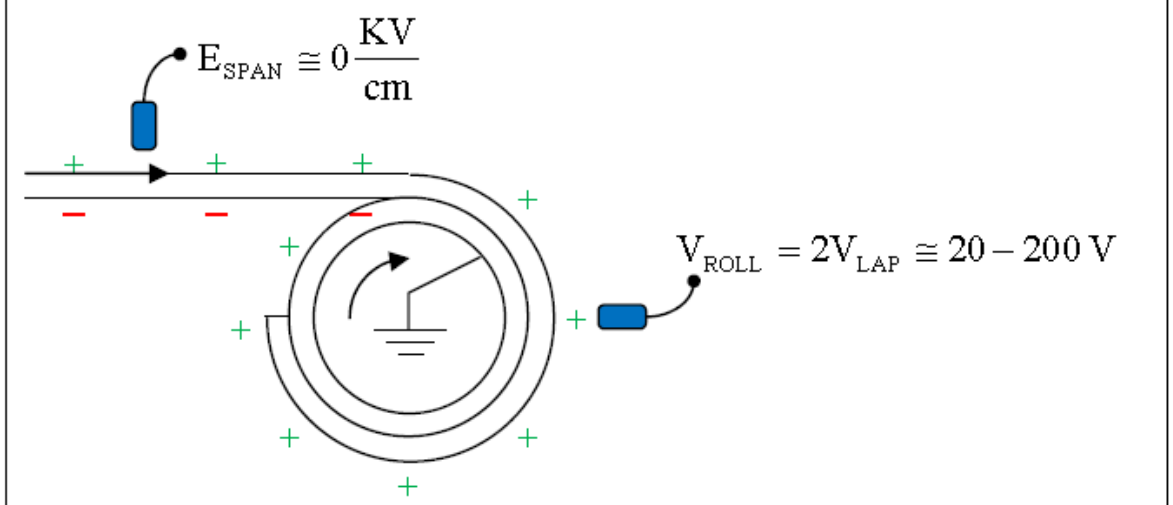


Figure 6: A non-contacting electrostatic voltmeter measures the surface potential V_{WEB} of the web wrapped on a grounded metal conveyance roller. V_{WEB} varies only with the surface charge density $\sigma_{WEB,OUT}$ on the exposed surface of the web.

Process Charge



(A) After winding one lap, the roll surface has positive charge.



(B) After winding the 2nd lap, the roll surface has a positive charge.

Winding Roll Potential

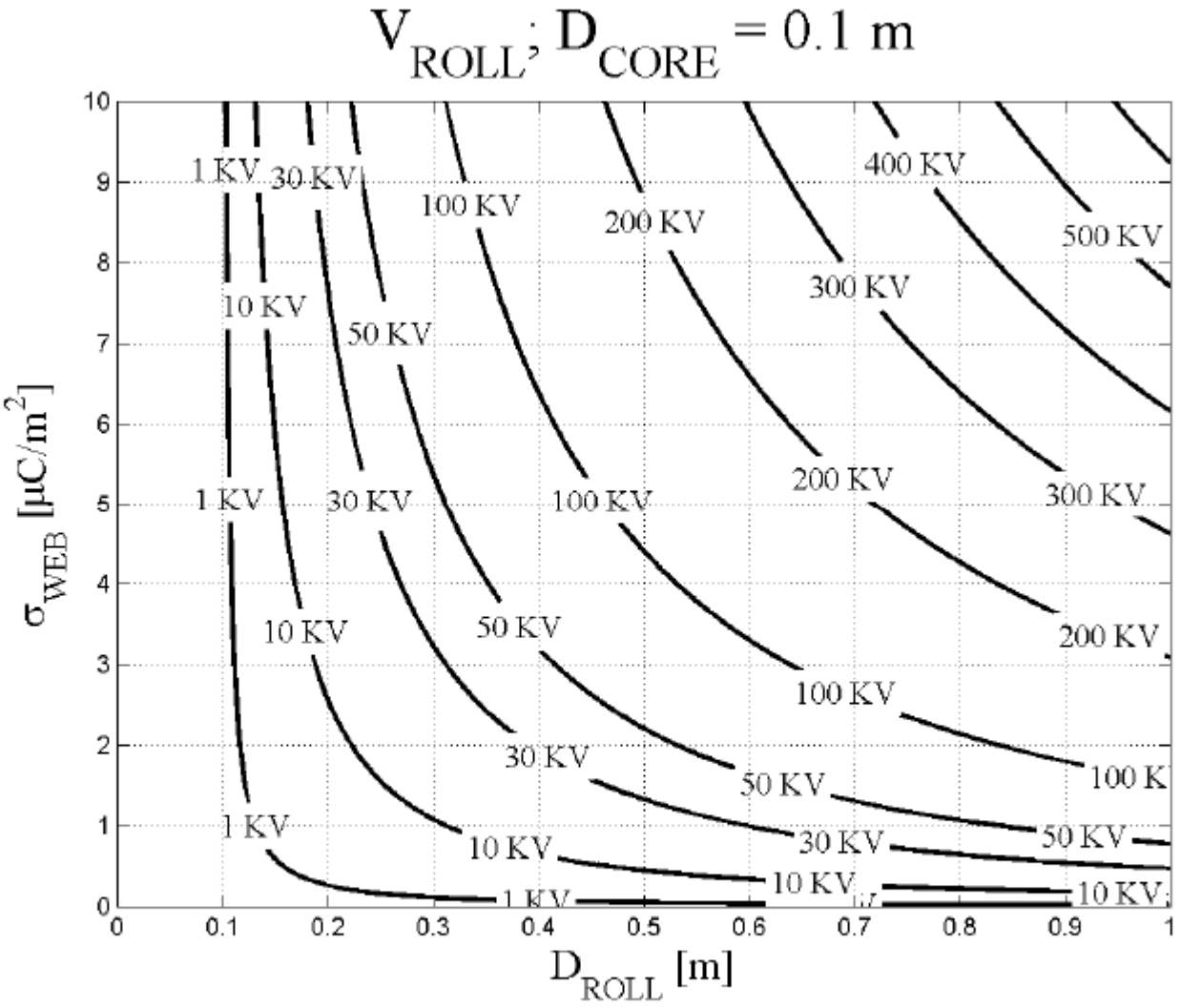
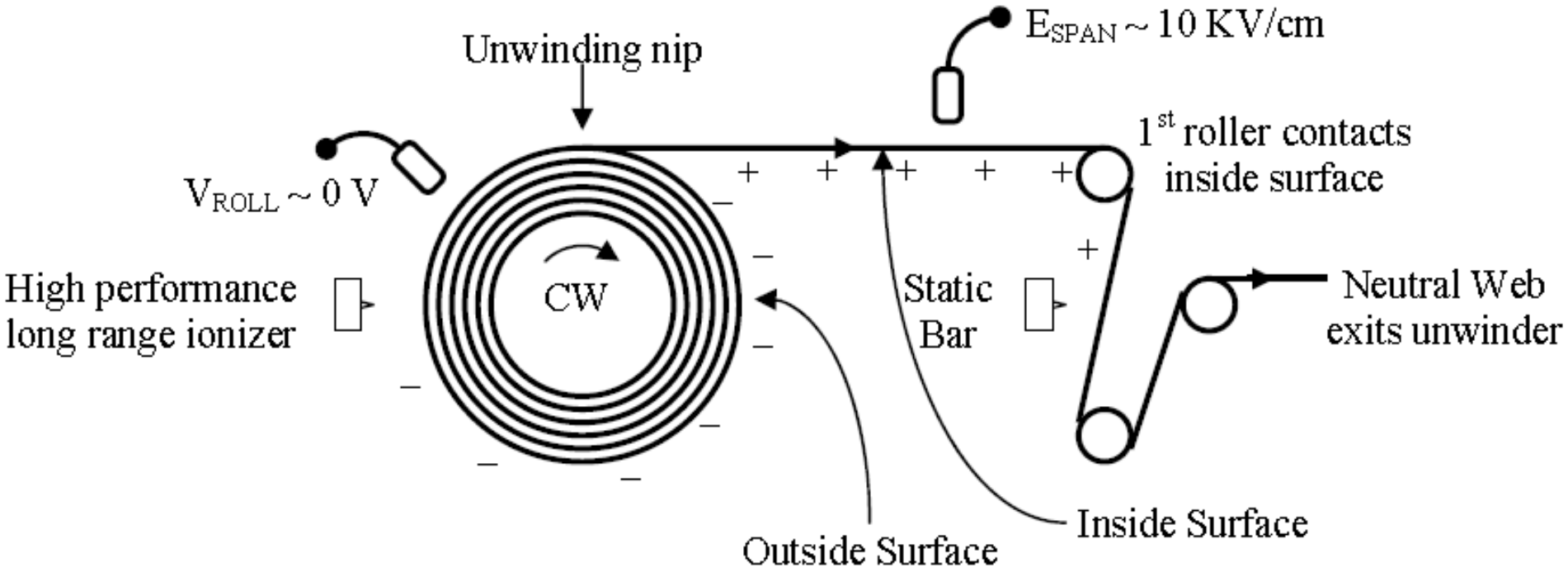


Figure 3: For a web charge density σ_{WEB} of 1 μC/m^2 that is typical of tribocharging, the voltage of a large unwinding roll (D_{ROLL} ~ 1 m) can exceed 50 KV.

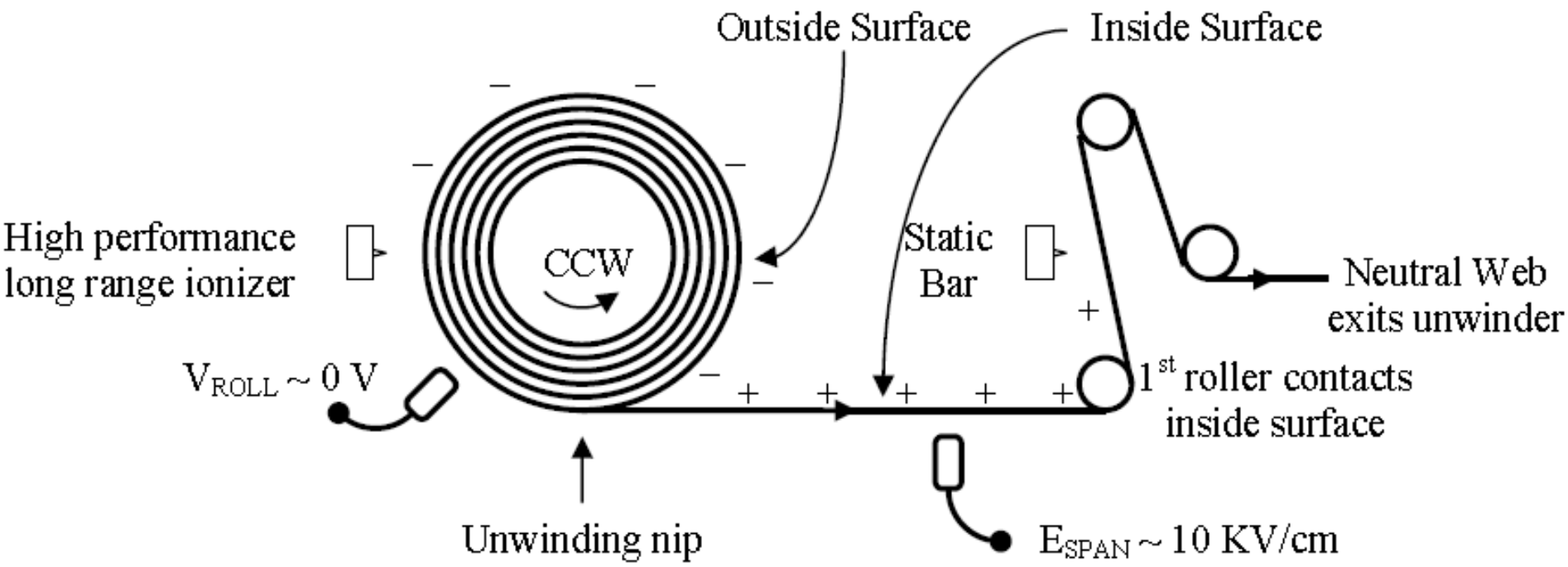
2-Ionizer Method



(a) Shown is the thread-up for a clockwise or over unwind.

Robinson, K. S., "Apparatus and Method for Neutralizing Static Charge on an Unwinding Roll," US Patent Application 61/536996, 09/20/2011.

2-Ionizer Method



(b) Shown is the thread-up for a counter-clockwise or under unwind.

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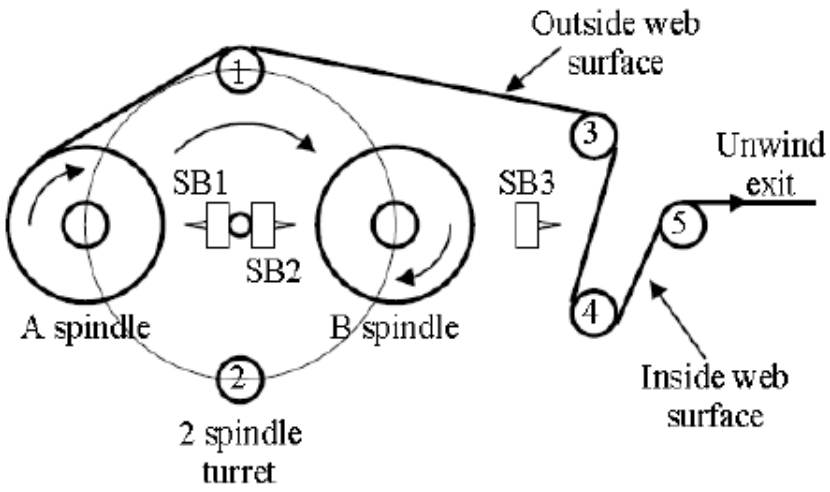
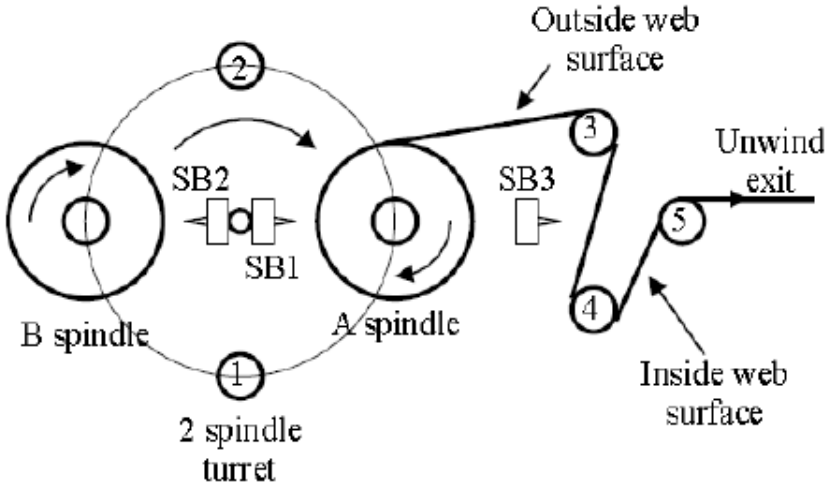
2-Ionizer Method



(A) With a clockwise unwind from spindle A, the inside web surface touches both rollers 1 and 2 prior to being neutralized by static bar SB3.



(B) With a clockwise unwind from spindle A, after the turret rotates the inside web surface touches only roller 3 prior to being neutralized by static bar SB3.

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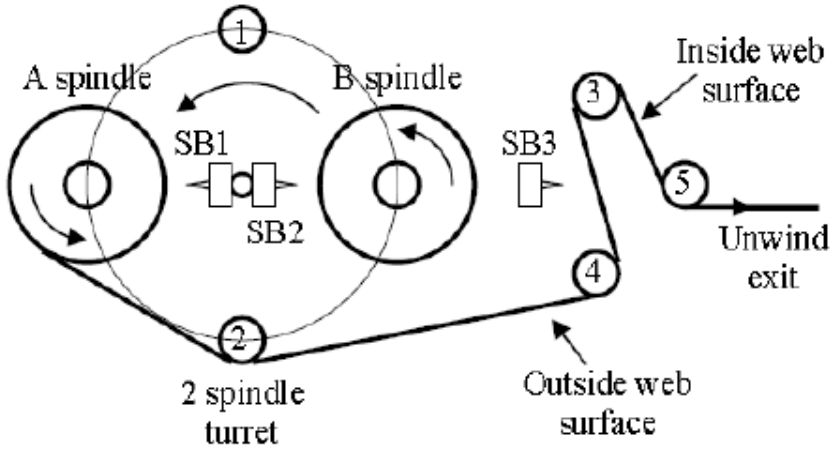
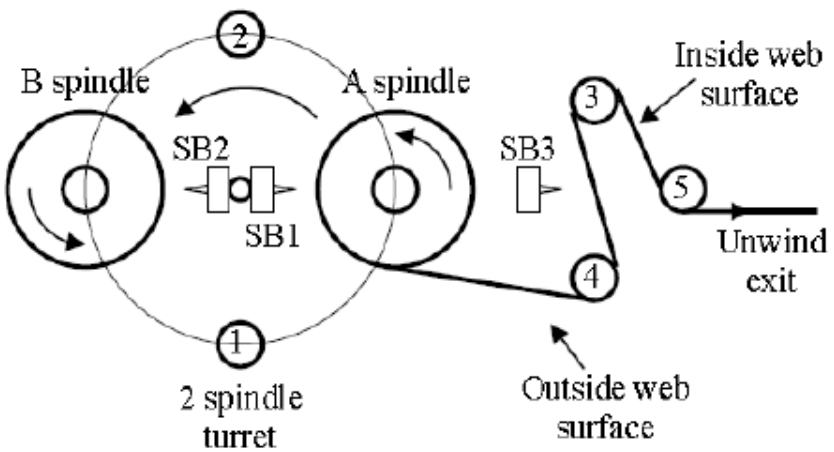
2-Ionizer Method



(C) With a counter clockwise unwind from spindle A, the inside web surface touches both rollers 2 and 4 prior to being neutralized by static bar SB3.



(D) With a counter clockwise unwind from spindle A, after the turret rotates the inside web surface touches only roller 4 prior to being neutralized by static bar SB3.

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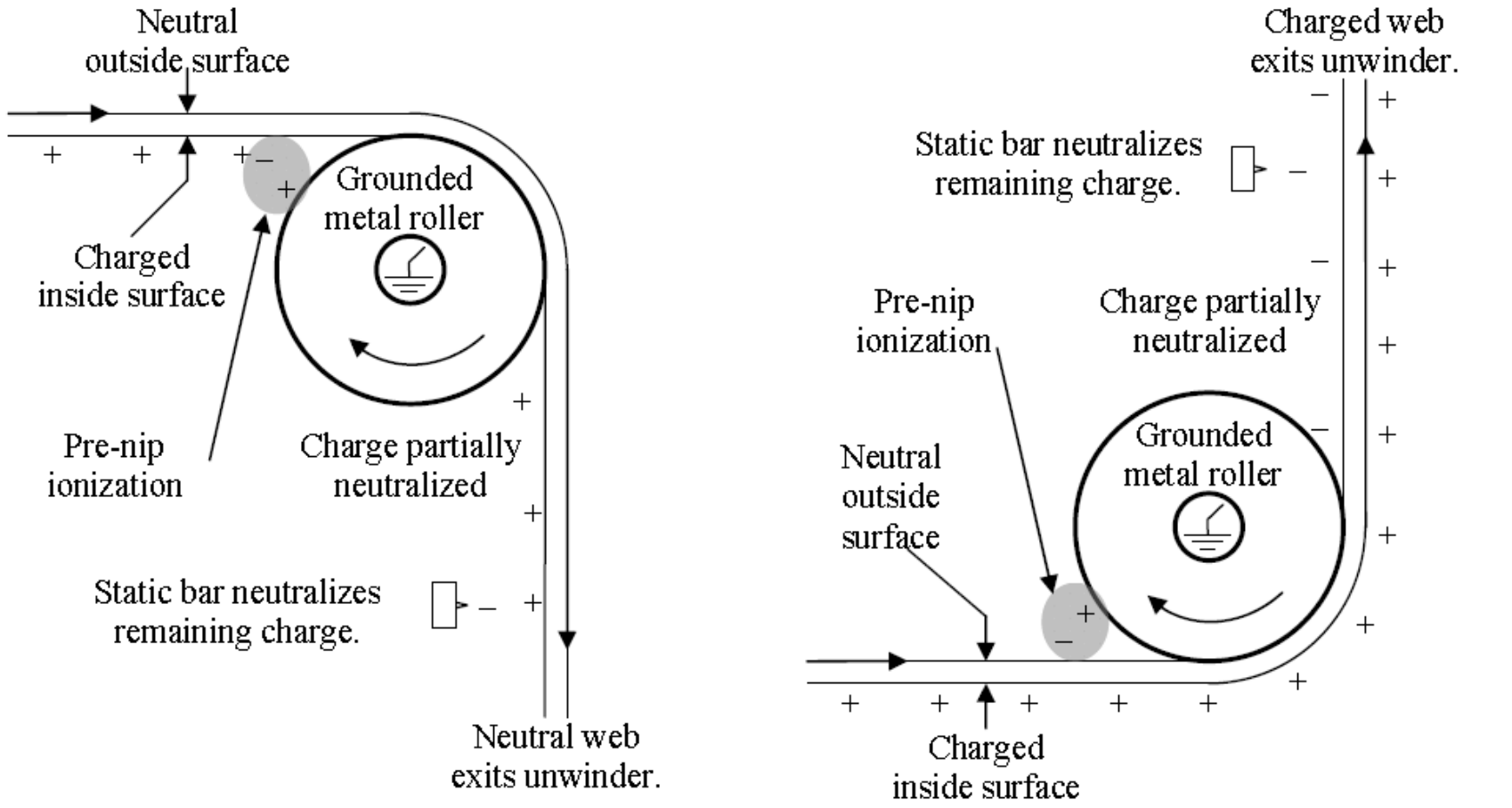
Roller Ionization



(a) An electrically neutral web exits the unwinder when the first roller touches the inside surface.

(b) An electrically charged web exits the unwinder when the first roller touches the outside surface.

Figure 9: Pre-nip ionization occurs in the air gap between the charged web and the roller prior to contact. Here, pre-nip ionization deposits negative charge on the web surface that touches the roller.

Summary

1. Each time a roll is unwound is a unique opportunity to neutralize static.
2. Two common root causes of static on an unwinding roll are:
   i. tribocharging between the inside and outside web surface, and
   ii. charge on the web from previous production operations.
3. Static charge from these two root causes are indistinguishable!
4. The countermeasures for these root causes are quite different.
   i. Tribocharging is minimized by adjusting the product formulation.
   ii. Process charge must be neutralized by dissipaters along the web conveyance path.

Summary

5. The static neutralization method for unwinding rolls has 3 key elements:
   i. A first static bar neutralizes the outside surface of the unwinding roll.
   ii. A second static bar neutralizes the inside surface of the web. This static bar should be located prior to the first conveyance roller that touches the outside web surface.
   iii. One or more conveyance rollers between the unwinding roll and the second static bar must touch only the inside surface of the web.
6. Ionization at the conveyance rollers prior to the second static bar will partially neutralize the charge on the inside web surface.
7. Charge neutralization is compromised if any conveyance roller prior to the second static bar touch the outside web surface.

QUESTIONS?

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