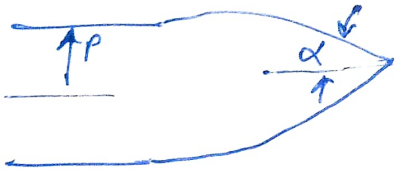
Spray Mode

As decided by the applied voltage and the liquid flowrate through capillary

- Continuous (a continuous jet from the tip of the capillary which disintegrates into droplets)
- Pulsating (Meniscus cone from the orifice oscillates as the droplets are ejected from the tip)

Taylor Cone :



For a perfectly conducting drop with liquid to gas permittivity ratio as ∞, cone angle approaches a limit of 49.3°.

Electrospray
- DC electrospray → Concern Areas
  - (i) Electrolytic reactions to balance the charge, induced by applied voltage
  - (ii) Joule heating
  - (iii) Generation of other chemicals due to faradic reaction at electrode
- Ac electrospray

The above problems could be circumvented.

Electrospinning

The electrospray jet emanating from the tip of conical meniscus solidifies (due to solvent evaporation) before disintegration into droplets

Leaves behind polymer fiber strand that can be aligned and wound by using rotating grounded electrode.

Rayleigh instability in jet
- Axisymmetric → beading in fiber
- Azimuthal → coiling, bending, winding, spiralling, looping

(Random occurrence and can be controlled)

Multiple fibers producing from single jet upon perturbation in operating parameters

Control of instability through deployment of ring electrode (grounded) around the jet, and thus creating a field around the jet.

Various timescales in electrospray process

// Hydrodynamic time scale $\sim \frac{L}{U} \sim \frac{R^2 L}{Q}$

Here, $R \equiv$ radius of liquid meniscus
$Q \equiv$ Volumetric flowrate
$L \equiv$ Length of the needle

Residence time of the liquid in the needle

// Viscous (diffusion) time scale $\sim \frac{R^2}{\nu} \sim \frac{R^2 \rho}{\mu}$

Time required for meniscus to form through slide of one layer against the other.

// Charge diffusion time scale (Also referred as charge relaxation time scale) $\sim \frac{\lambda_D^2}{D_i}$

λ_D is the Debye Length
D_i is Ionic diffusivity

— Time required for the ion to diffuse through distance λ_D (i.e., the distance from bulk to electrode surface).

// Elastic relaxation timescale of polymeric liquid

// For AC electrospray the time scale arising from AC frequency