

## Corona-Quenching by submicrometer particles in turbulent tube-wire electrostatic precipitators

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The suppression of current uptake in electrostatic precipitators by space charge attached to low mobility particles is known as corona-quenching. A physical model is developed which allows the description of this effect by equations which can be solved analytically. In contrast to space charge simulations done by many other authors (Talaie (2005), Elmoursi & Castle (1984), Lindau & Matts (1984)) our model directly shows the dependence of corona-quenching on particle size and concentration, on geometry and electric parameters.

The model departs from a superposition of externally imposed electric field the space charge electric field in the quenched state, whereby the contribution of gas ions is neglected. This allows establishing a balance equation for space charge, whereby the deposition of charged particles to the walls is directly connected to the increase of charge on individual particles during the quench process.

$$c \cdot \left( \frac{dn}{dt}(\bar{n}) \right) = \bar{n} \cdot \left( \frac{dc}{dt} \right)$$

c: Particle number concentration  
 n: Number of elementary charges per particle  
 t: time

Macroscopic charging kinetics and current uptake in the quenched regime are derived from a Lambert-Beer-style extinction function for the gas ions passing through the aerosol, whereby the extinction coefficient considers the mechanisms of single particle charging kinetics and electric field strength.

$$I(r_{tube}) = I(r_{wire}) \cdot \exp \left\{ - \frac{c}{Z_i} \cdot \int_{r_{wire}}^{r_{tube}} \frac{\Lambda(r)}{E(r)} \cdot dr \right\}$$

I: Current  
 n:  $Z_i$  Ion mobility  
 E: Electric field strength  
 r: radius coordinate  
 $\Lambda$ : ion-particle combination coefficient

A well mixed tube-wire electrostatic precipitator operated in a batch-wise mode was used to verify the basic assumptions as well as the complete time dependent current uptake by highly resolving measurements.

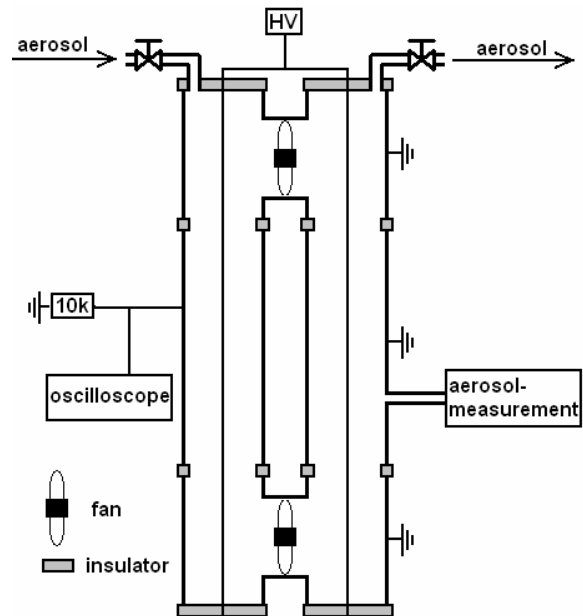


Fig.1: Experimental setup for corona-quenching measurement

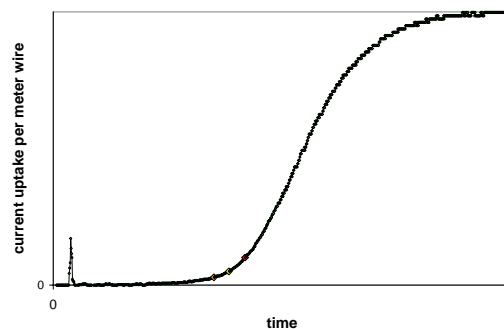


Fig.2: Typical time time dependent current uptake measured the setup in Fig.1

Talaie, M. R. (2005). *J. Hazardous Materials*, (B124), 44-52.

Elmoursi, A. A. & Castle, G. S. P. (1984). Second international conference on electrostatic precipitation, Kyoto, Nov. 1984, 911-919.

Lindau, L. & Matts, S. (1984). Second international conference on electrostatic precipitation, Kyoto, Nov. 1984, 911-919.