Environmental friendly technologies

KEE/ENT

ESF II project of the University of West Bohemia in Pilsen

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Lecture 7

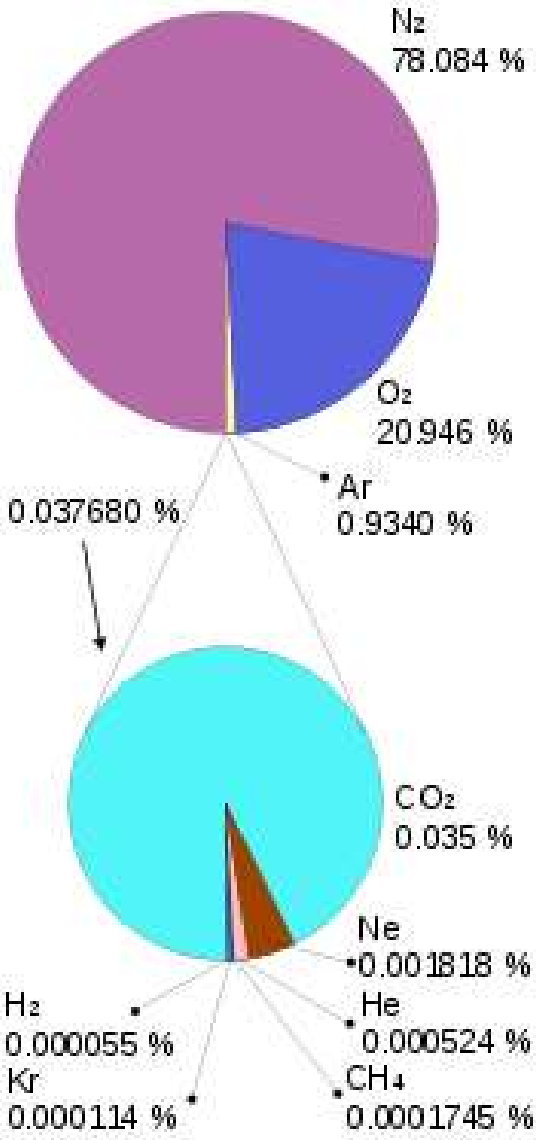
Separation of harmful instances – basic principles

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Air environment



Troposfere – intensive mixing („tropos“ = to mix) → air has here stabil composition – necessary for life

In troposphere there occurs the most important climate phenomenons.

Troposphere contains 80 % of atmosphere mass.

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Emissions and imissions

Emissions
– harmful instances released to the atmosphere
(unit: mass / time)
Imissions
– emissions affecting local environment
- Ground imissions
(unit: mass / volume)

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Emissions and imissions

weather

– partial conditions in locality and time

climate

– longtime weather in location

Electrical features of particles

- Charge of the particle
  - Natural charge

    During genesis

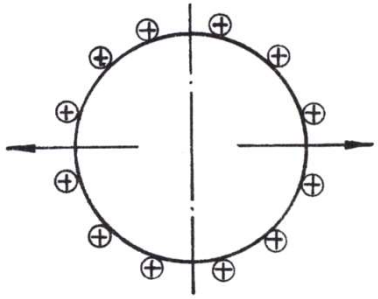
    triboelectrical effect
  - Artifitial charge

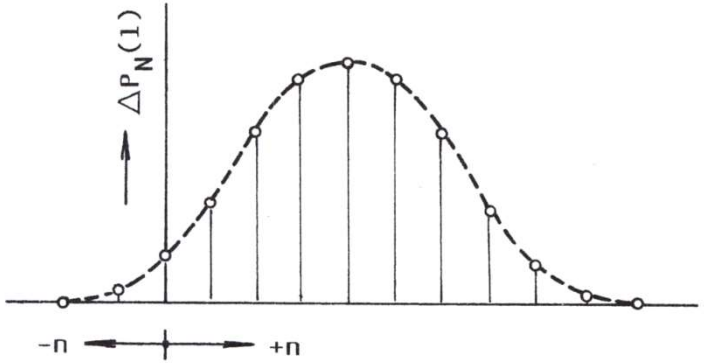
    field charging

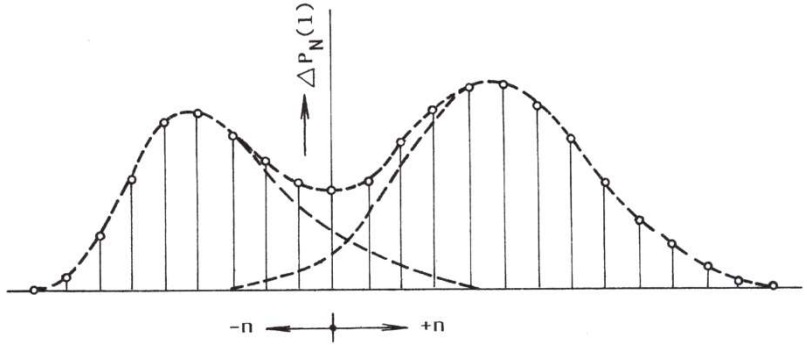
    diffusion charging
- Resistance of a layer

$$e = 1{,}602 \cdot 10^{-19}\ C$$

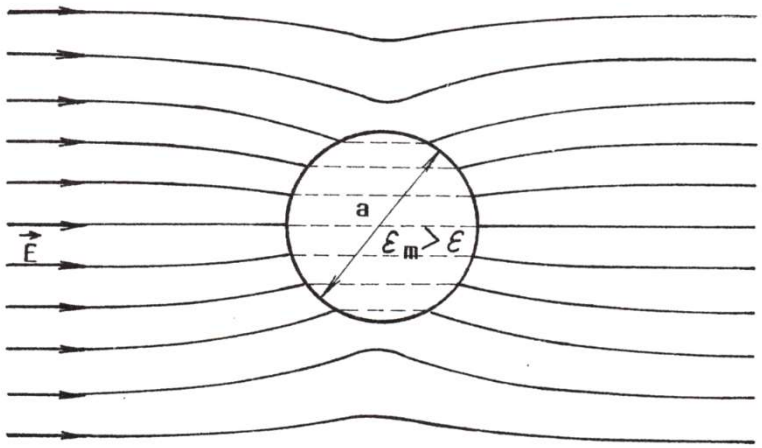
Electrical features







Field charging



$\varepsilon_o = 8{,}854 \cdot 10^{-12}$ F/m

$\varepsilon = 1$

$\varepsilon_m > 1$

$\vec{F} = Q\ \vec{E}$

Field charging

$$Q = \varepsilon_0 \varepsilon \pi a^2 E \kappa \frac{t}{t + t_p}$$

$$t_p = 10^{-3}\ \mathrm{s}$$

$$t/(t + t_p) \approx 1 \qquad \varepsilon \doteq 1$$

$$Q = \varepsilon_0 \pi a^2 \kappa E$$

$$\kappa = 1 + 2\frac{\varepsilon_m - \varepsilon}{\varepsilon_m + 2\varepsilon} = 1 + 2\frac{\varepsilon_r - 1}{\varepsilon_r + 2}$$

$$\varepsilon_r = \frac{\varepsilon_m}{\varepsilon}$$

$$\varepsilon \doteq 1 \qquad \varepsilon_r \doteq \varepsilon_m$$

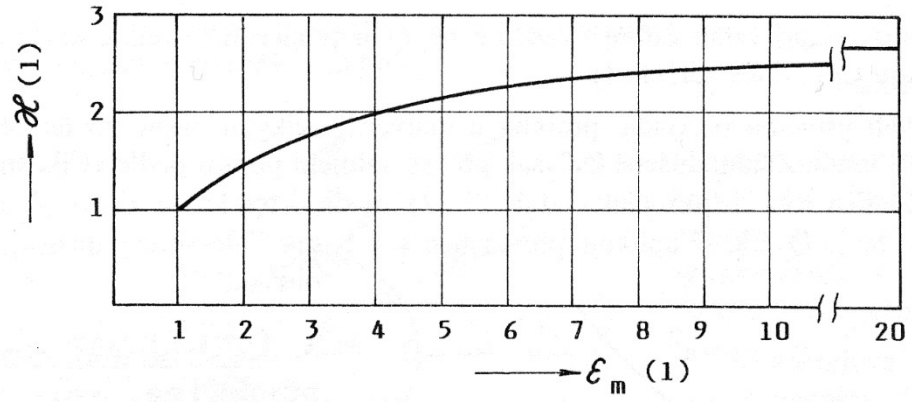
$$\kappa \doteq 1 + 2\frac{\varepsilon_m - 1}{\varepsilon_m + 2} = \frac{3\varepsilon_m}{\varepsilon_m + 2}$$

εm: 1 (non conductive material)

æ (non conductive material)

κ: 1 – 3 (teoretical)

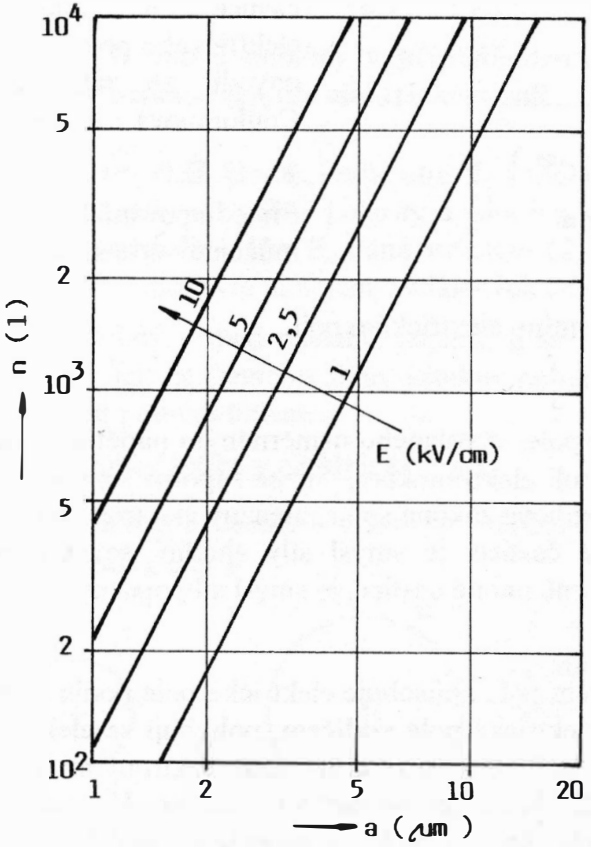
2 – 2,5 (real dusts)



$a > 1\ \mu m$

$Q \sim a^2$.

$Q = ne$



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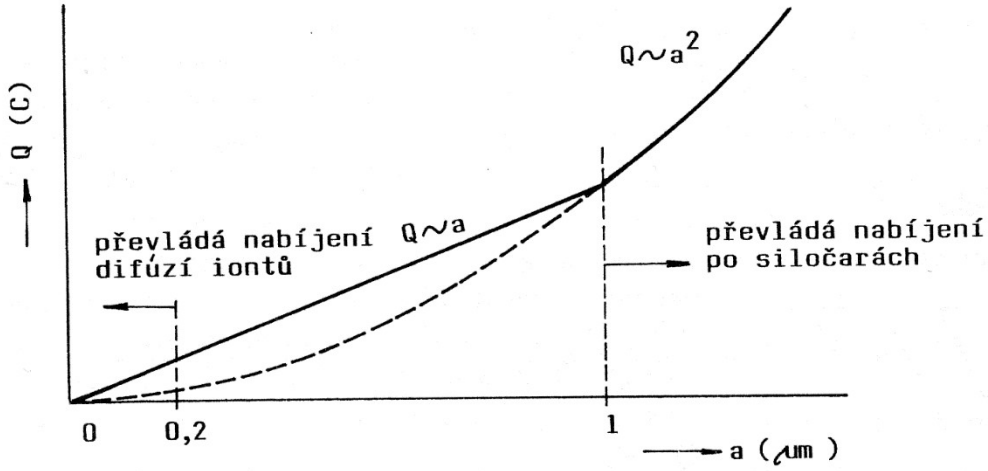
Diffusion charging

a < 0,2 μm

$$Q = \frac{2\pi\varepsilon_0 a k T}{e} \ln\left(1 + \frac{a\bar{c} C_{Ni} e^2}{8\varepsilon_0 k T} t\right)$$

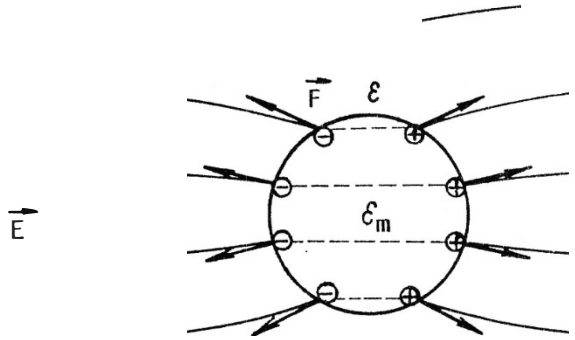
k = 1,3805 . 10^{-23} J/K,

$$Q \doteq 10^8 a e$$



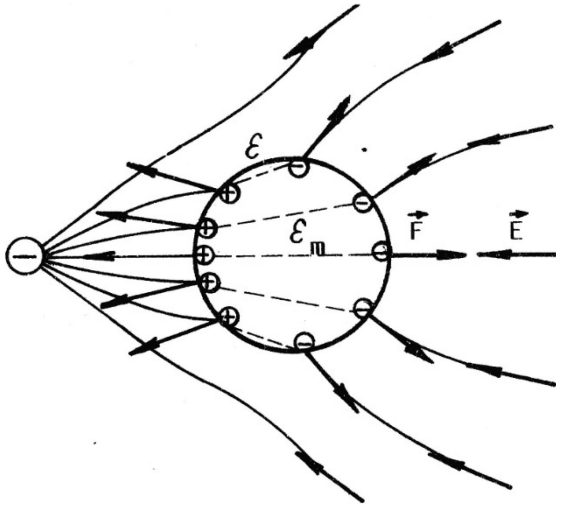
Non charged particle in field

- induction
- polarisation



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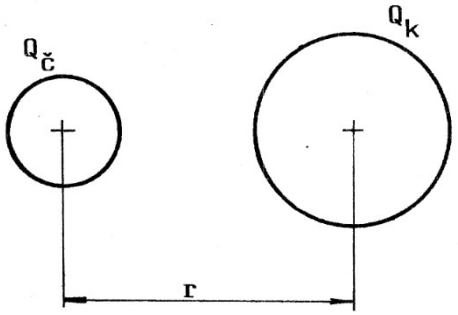
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Charged particle in field



$$\vec{F} = Q\ \vec{E}$$

$$F = \frac{Q_{\check{c}}\, Q_K}{4\,\pi\varepsilon_0\, r^2}$$

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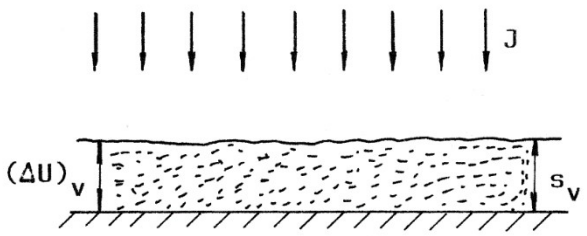
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Charged particle near the wall

- Non charged conductive wall
  - induction – charge with opposite orientation
  - Attractive force (mirroring: 2h)
- Non charged non conductive wall
  - polarisation – charge with opposite orientation
  - Attractive force

Resistance of layer

- **Relative resistance of layer (apparent)**



$$E_v = \frac{(\Delta U)_v}{s_v} \qquad E_v = \rho_v J$$

$$\rho_v = \frac{(\Delta U)_v}{J\, s_v}$$

- **Back corone**

$$\mathbf{J} \approx 1\ \mathrm{mA/m^2} \qquad \mathbf{E_{krit}} \approx 10^6\ \mathrm{V/m}$$

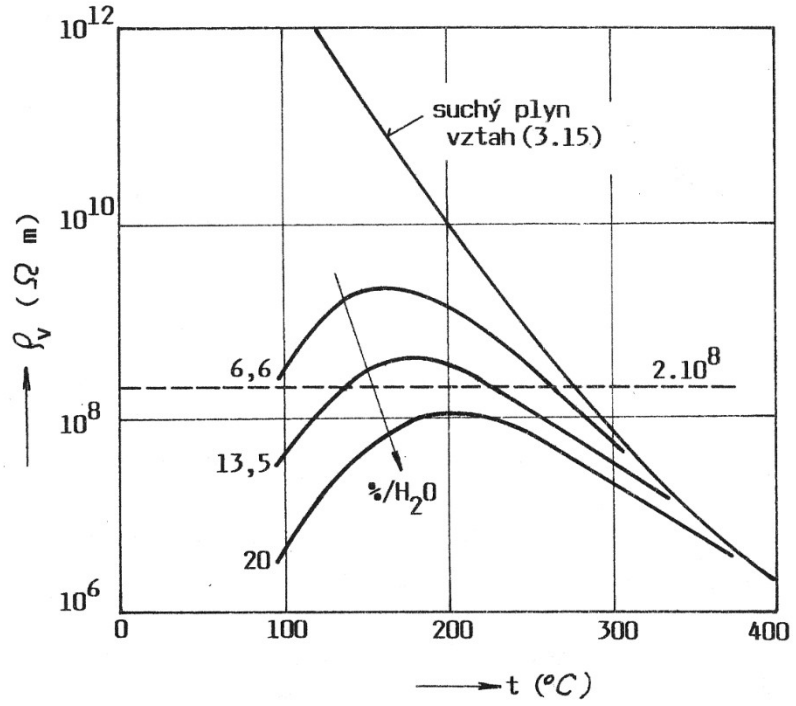
$$\rho_v > \frac{E_{krit}}{J} \approx \frac{10^6}{10^{-3}} = 10^9\ \Omega m$$

$$\rho_v < 2 \cdot 10^8\ \Omega\mathrm{m}.$$

- **Very small resistance of particles**

$$\rho_v < 10^2 \ \ 10^3\ \Omega\mathrm{m}$$

Resistance of layer



Thank you for your attention...

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