INCLINED GRID MOBILITY ANALYZER: THE PLAIN MODEL

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INTRODUCTION

Loscertales (1998) proposed the inclined field mobility analyzer and initiated the revision of the theory of the diffusion-limited mobility resolution. The inclined field can be accomplished by using inclined grids as proposed by Tammet (1999). The transfer function and mobility resolution can be easily estimated for the simplest configuration of the Inclined Grid Mobility Analyzer (IGMA) where the plug air flow and plain electric field are implemented.

CONFIGURATION AND DIFFUSION-FREE TRANSFER FUNCTION OF PLAIN IGMA

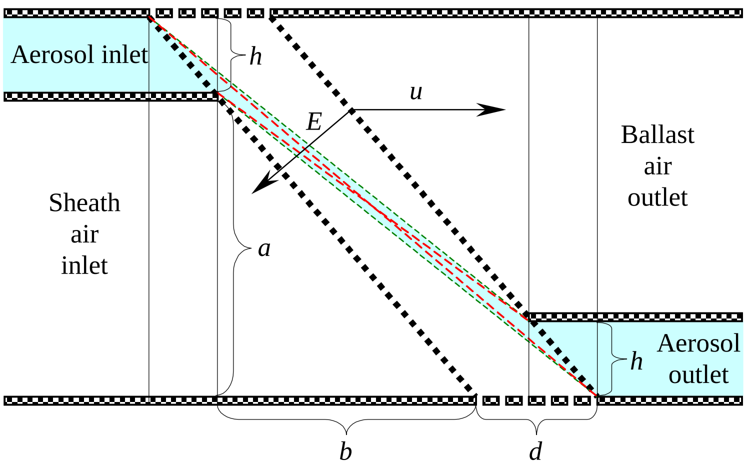

Figure 1. Cross section of a plain IGMA.

The configuration of a plain IGMA is described in Figure 1. The air flow channel between two parallel plates is of height $a + h$ and of arbitrary width. The inlet of the channel is divided into the aerosol inlet and the filtered sheath air inlet. Equal heights of the sheath air inlet and ballast air outlet enable to recirculate the sheath-ballast air. The air flow velocity u is parallel to the plates. Air passes two inclined grids. Driving voltage V is applied between the grids and the regions left and right of the grids are free of electric field. The sidewalls between the grids could be made as voltage dividers that help to keep the electric field E between the grids uniform. The diffusion free limiting trajectories of particles between the grids are shown in Figure 1. The triangular transfer function in Figure 2 expresses the probability of particles to reach the outlet depending on the mobility. The critical mobilities and the passage-through-grids probabilities are calculated by means of the method of fluxes described by Tammet (1970):

$$Z_1 = \frac{ud}{V} \frac{1}{1 + (b/a)(b + d - bh/a)/(a - h)},$$

$$Z_0 = \frac{ud}{V} \frac{1}{1 + (b/a)(b + d)/a},$$

$$Z_2 = \frac{ud}{V} \frac{1}{1 + (b/a)(b + d + bh/a)/(a + h)},$$

$$p_0 = \frac{bd}{a^2 + b^2 + bd}.$$

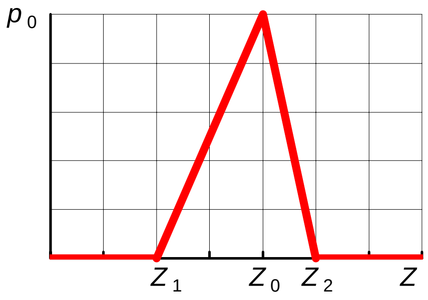

Figure 2. Diffusion-free transfer function of a plain IGMA

EFFECT OF BROWNIAN DIFFUSION

The diffusion limited mobility resolution is described by the ratio δ of the Brownian standard deviation of the measured apparent mobility to the actual mobility. In classic analyzers the lowest possible value of this ratio is achieved in drift tubes where

$$\delta = \delta_{\circ} = \sqrt{2\frac{kT}{qV}} .$$

k is the Boltzmann constant, *T* is absolute temperature, *q* is the particle charge, and *V* is the driving voltage. The Loscertales effect of inclined field enables to improve the mobility resolution. The mobility in IGMA is measured according to the inclination angle of the particle trajectory. The Brownian fluctuations of the trajectory can be estimated according to the methods explained by Tammet (1970) and the diffusion originated relative standard deviation of the measured mobility can be expressed as

$$\delta_d = \kappa\delta_{\circ} ,$$

where

$$\kappa = \frac{\sqrt{1+\frac{d(b+d)}{a^2+b^2+bd}}}{\sqrt{1+\frac{a^2+b^2}{bd}}}$$

is the factor of resolution enhancement. Dependence of this factor on the geometry of IGMA is shown in Figure 3.

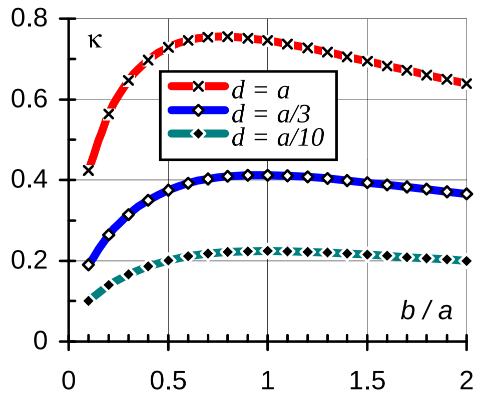

Figure 3. Resolution factor of a plain IGMA

CONCLUSIONS

Inclined Grid Mobility Analyzer (IGMA) is a realistic way to implement the inclined field method proposed by Loscertales. The plain model enables to calculate the performance parameters of a simple IGMA and show that the diffusion-limited mobility resolution can be several times improved as compared with customary transversal field mobility analyzers.

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