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A Potential Problem with the TSI Electrostatic Aerosol Classifier

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TECHNICAL NOTE

A POTENTIAL PROBLEM WITH THE TSI ELECTROSTATIC AEROSOL CLASSIFIER

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An apparatus for electrostatically fractionating aerosols into a narrow, prescribed size range has recently become commercially available from TSI* as their 3071 electrostatic classifier. This device can be used to generate monodisperse aerosols in the approximate size range 0.01 to 0.3 μm diameter (Liu and Pui, 1974). Also, when coupled with a suitable device to measure aerosol concentration, it affords a method of measuring aerosol size distributions (Hoppel, 1978; Haaf, 1980). The purpose of this note is to point out a constructional deficiency of the commercial model, and to describe a simple correction for it.

The classifier (also, called a differential mobility analyzer, DMA) consists of an outer cylinder at zero electrical potential, and a concentric inner rod at negative electrical potential. Two streams of air are introduced into the annular region at the top of the DMA. The smaller air flow is that of the electrically charged aerosol, and is introduced near the outer cylinder. The other air flow is filtered air, which is introduced near the inner rod. Ideally these two air streams merge smoothly, with no turbulent vortices, so that they flow side by side without mixing as they travel down through the full length of the DMA.

The constructional details of the commercial unit are quite similar to those shown in Fig. 1 of the paper by Knutson and Whitby (1975), and a reader interested in the full details may want to refer to that figure. The filtered air enters the DMA and flows radially outward from the axis through 8 holes. Next it passes through two fine mesh Dacron screens which span across an annular region. Then it merges with the aerosol flow.

The purpose of the Dacron screens is to dampen out the non uniformities of flow produced by the 8 clean air inlet holes. Our experience has been that air leaked past the inside diameter of the Dacron screens. The results of this leak were seen when taking apart the DMA for cleaning. The aerosol deposits were observed to be axially nonsymmetric on both the inner rod and the outer cylinder. The reason for the leak was found to be the dimensional instability of the plastic bushing immediately above the Dacron screens. This bushing, made of Teflon, had shrunk in length and increased in diameter. Since Teflon has poor dimensional stability, it is advised that other users of the commercial instrument be aware of this possibility in their own instrument. A simple correction was to install o-rings at the inside and outside diameter of the Dacron screens. After installing these o-rings, the deposition pattern in the DMA was found to be very uniform, with complete axial symmetry.

The reader should be alert to one other potential problem regarding the Dacron screens. Slight ripples can develop in the screens due to non-symmetric compression of the o-rings installed to fix the leakage. Rippling of the screens is almost as detrimental as leakage past them. Fortunately the DMA can be partially disassembled to observe the deposition patterns without disturbing the Dacron screens. It is, therefore, recommended that the deposition pattern always be checked after any re-installation of the Dacron screens. If rippling of the Dacron screens occurs, we recommend applying lubricant on the o-rings or decreasing the amount of o-ring compression.

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