A Pre-filter for Thermal Desorption Tubes

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Thermal desorption tubes are commonly used to quantify trace amount of volatile organic compounds in the atmospheric air. However, previous studies have demonstrated that the aerosol loading on the sorbent could significantly influence the adsorption and desorption characteristics. Normally, a piece of glass wool was placed in front of the sorbent, but filtration efficiency data were limited. Therefore, this study aimed to evaluate the filtration characteristic of the glass wool, and to design a pre-filter for the better performance of the thermal desorption tubes.

A constant output aerosol generator and an ultrasonic atomizing nozzle were used to generate sub-micrometer-sized and micrometer-sized aerosol particles, respectively. A scanning mobility particle sizer and an aerodynamic particle sizer were employed to measure the aerosol concentration and size distribution upstream and downstream of the test filter. The pressure drop across the filter was simultaneously monitored. Glass wool, stainless steel mesh (#400, #1500), polyurethane foam (110 ppi) and filter disc cut from N95 filtering facepieces were tested in this work.

The experimental results showed that the most penetrating particle size (MPPS) of the glass wool was 0.3-0.5 μm and the aerosol penetration of MPPS was about 60-75%, under the sampling flow of 0.2 L/min. To reach the same level of performance of glass wool, it took 60 layers of #400 stainless steel mesh. Higher aerosol collection efficiency (90%) could be achieved by increasing the mesh number and disc size (to reduce face velocity). Generally speaking, the use of stainless steel mesh was too clumsy because of the size. For 110-ppi foam, the total height of the foam disc was estimated to be 30 cm to attain the required collection efficiency (90%). The aerosol collection efficiency could be enhanced by increasing the foam packing density. However, there was no guarantee of the packing quality to gain stable performance. The use of N95 filter disc appeared quite promising. The aerosol penetration was 5% and pressure drop was only 9.8 mmH2O, the lowest among all tested materials.

The glass wool pieces did not provide stable and sufficient filtration efficiency to protect the sorbents from aerosol contamination. Among the filter materials tested, the N95 filter worked best, for low cost, low pressure drop and stable quality. The oil-resistant P95 filter could be used when oil aerosol particles were present in the workplace.

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