COMPARISON OF PM₁₀ CONCENTRATIONS IN HIGH- AND MEDIUM-VOLUME SAMPLERS IN A DESERT ENVIRONMENT

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Abstract. The USEPA replaced TSP with PM₁₀ as the National Ambient Air Quality Standard for particulate matter. The commercially available PM₁₀ sampler is a high-volume model using quartz fiber filters. In certain investigations, such as source apportionment studies, chemical analysis of the filter is necessary, however, many analyses cannot be run on quartz filters. An alternate filter such as Teflon is amenable to XRF and ion chemical analyses but is not amenable to analysis for carbon. To overcome these problems DRI constructed a medium-volume PM₁₀ sampler that is capable of collecting particulates on both Teflon and quartz fiber filters simultaneously. This paper describes the design of the DRI medium-volume PM₁₀ sampler, discusses a method for determining equivalence of two samplers, the results of applying the method to test the equivalence of the medium-volume sampler and a commercial high-volume sampler, and examines differences between PM₁₀ and TSP measurements in a southwestern desert.

1. Introduction

The U.S. Environmental Protection Agency (EPA), to better assess the health effects of ambient particulate matter, promulgated revisions to the National Ambient Air Quality Standards (NAAQS) for particulate matter (USEPA, 1987a). Total suspended particulate matter (TSP) was replaced by particles with aerodynamic diameter less than 10 μm (PM₁₀) as the measure of ambient aerosol loading. Additionally, the primary and secondary standards were set at 150 μg m⁻³ for a 24 h period as compared with the TSP primary and secondary standards of 260 and 150 μg m⁻³ for the same time interval.

The reference method (USEPA, 1987b) did not prescribe a sampler flow rate. The primary criterion was that explicit test procedures be met, including one for precision. Owing to their large sample volume, greater collected mass and similarity with most TSP measurements, high-volume samplers were preferred for the analysis of PM₁₀.

One problem associated with high-volume PM₁₀ samplers is the disparity between reported particulate loadings (Rodes et al., 1985; Wedding et al., 1986; Wedding et al., 1988; Mathai et al., 1988). Differences as great as 34% have been reported for collocated samples of different design (Wedding et al., 1986) and
agreement to within 10% is considered to be good (Rodes et al., 1985). Medium-volume samplers have also been examined and have performed well, but tests have been limited.

A second difficulty with high-volume measurements is that samples generally are collected on quartz fiber filters, a medium not readily amenable to chemical analysis. In order to obtain data for use in source apportionment studies, both Teflon and quartz filters are necessary for measurement of mass, elements, ions, and carbon.

To collect PM$_{10}$ samples on appropriate media for chemical analysis, the Desert Research Institute (DRI) has constructed a medium-volume sampler using a Sierra-Andersen (SA) 254 PM$_{10}$ inlet, and EPA reference method (USEPA, 1989), and deployed it at an impacted site located in the desert of northwestern Arizona. Prior to employing results of chemical analyses of collected samples to determine source apportionment, equivalence of the sampler must be demonstrated.

The objectives of this paper are:

- to describe the design of the DRI medium-volume PM$_{10}$ sampler;
- to compare the equivalence of medium- and high-volume PM$_{10}$ sampling methods;
- to examine differences between PM$_{10}$ and TSP measurements at a desert location.

The sample design and comparison results are presented in the sections which follow.

2. Study Design

2.1. SITE DESCRIPTION

Samples were collected during the eleven month period of February through December, 1988 in Bullhead City, AZ, as part of the Desert and Intermountain Air Transport Program (DMAT), Mohave Valley Atmospheric Survey. This study involves collection of air quality and meteorological measurements at six stations in the Mohave Valley (Figure 1). Monitoring is performed at site locations determined from computer models of the area. Previous results have found the highest particulate loadings to occur in the Bullhead City area (Gertler, 1988).

In order to determine the source of elevated particulate levels previously observed in the Mohave Valley (Gertler, 1988), a DRI constructed medium-volume sampler was installed at the site in January, 1988 to complement already existing off-the-shelf high-volume PM$_{10}$ and collocated TSP samplers, and to obtain samples appropriate for chemical analysis for use in source/receptor models.

Samplers were located on a 7.3 m long, 1.8 m high platform. The units were evenly spaced with the two PM$_{10}$ samplers located at opposite ends of the platform.