ENVR 754 Air Pollution Control
Laboratory on Filtration - 2007

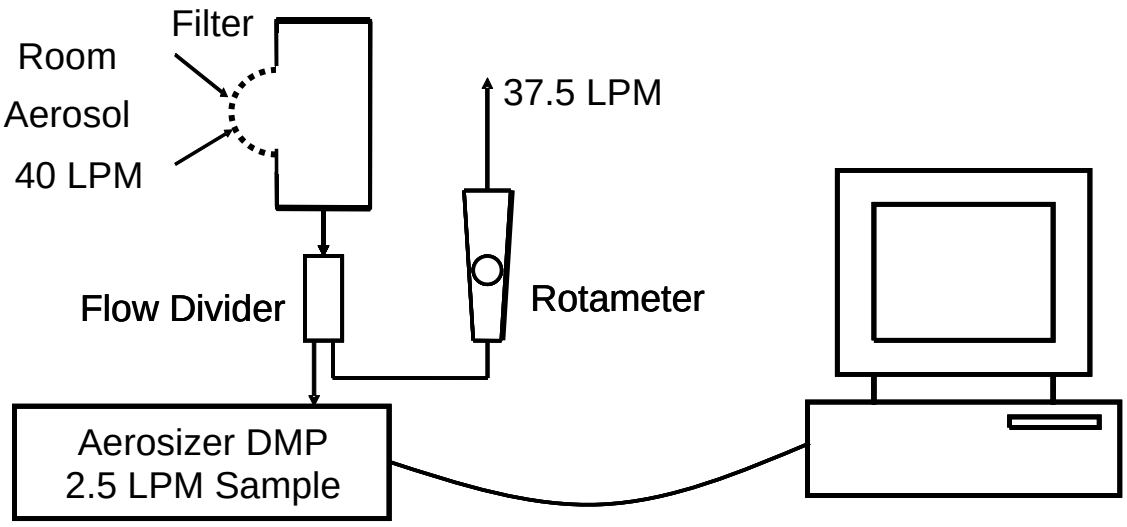
Objective

The purposes of this laboratory are: (a) to develop data to compare with theoretical estimates of filter efficiency, and (b) to characterize the efficiency of two filters sold commercially for respiratory protection: a "dust mask" and a NIOSH certified N-95 respirator.

Procedure

We will use the Aerosizer to measure the efficiency of these two filters on particles in room air. Through this test we hope to establish whether these filters collect incoming particles of all sizes, as they should.

Each filter will be mounted on a plastic "head" using electrical tape. Try to estimate the surface area of each filter. Your measurement does not need to be exact. This measurement is necessary to determine the air velocity through the filter.



The figure above shows how the equipment will be set up. Room air at 40 LPM will flow through the filter and to a flow divider. Air flow into the instrument can be set using the computer that controls the Aerosizer itself. For this experiment, the air flow into the Aerosizer should be 2.5 LPM. The balance of the flow will go to a rotameter connected to lab vacuum. The rotameter uses units of ft^3/hr; to provide 37.5 Lpm set the rotameter at 80 ft^3/hr.

The Aerosizer will be used with the filter and "head" attached to its inlet, then with the "head" removed, then with the "head" attached again, removed again, and attached again for a

total of five measurements: F, No F, F, No F, F. Filter penetration, Pt, will be the average number of particles measured when the filter is attached, divided by the average number of particles measured when the filter is not attached. Penetration can be calculated for particles of each size measured by the Aerosizer.

$$Pt = \frac{N_{\text{filter attached}}}{N_{\text{no filter attached}}}$$

From your five measurements of particle count you will be able to calculate four values of penetration using the same procedure you used in the experiment to measure cyclone efficiency. From these four penetration measurements, you can calculate the average penetration and standard deviation for particles of each size.

To calculate theoretical values of penetration, you will need to measure the diameter of the fibers in both filters using the optical microscope. In addition, you will need to measure the solidity, α, and the thickness, L, of both filters. The solidity of the filter can be determined from its volume and its weight.

$$\alpha = \frac{\text{solids volume}}{\text{filter volume}} = \frac{\text{filter mass} \,/\, \text{fiber density}}{\text{filter volume}} \qquad (1)$$

Weigh the filter to determine its mass. Assume a value for fiber density. The density of glass is about 2.6 g/cm^3. The filter volume can be determined from its surface area and its thickness. Measure the filter thickness using a micrometer or a dial caliper. You will need to figure out how to avoid inaccuracies in your measurements due to the metal strip and the elastics mounted to the filter. You could, for example, decide to remove these items before you weigh the filter.

Measured Efficiency – Measure collection efficiency for a range of particle sizes.

Theoretical Efficiency – Calculate the relationship between collection efficiency, η, and particle diameter for each filter at each of the same flows. The spreadsheet from class can be useful here.

Report

Outline briefly what you did. Plot efficiency against particle diameter for each filter. Account for any differences between the theory and the measurements. Briefly discuss the effectiveness of each filter.

Your report must not exceed four pages. The first page should contain only your name, the date, and a brief paragraph that summarizes your work and findings. You may attach appendices if necessary to present your data or details of your calculations.