EPIPHANIOMETER

In answering the following questions, refer to the abstract and figures, reproduced from the reference.

(a) What is the chemical or physical mechanism that causes "these atoms [to] attach onto the aerosol particles?"

(b) Explain why the device is "most sensitive to particles contained in the accumulation mode."

(c) What is the likely meaning of the phrase "Fuchs surface of the aerosol particles?"

(d) Assume this instrument is to be used for environmental monitoring. Describe briefly one type of investigation that might benefit from an instrument that produces a continuous signal that is proportional to the Fuchs surface of the aerosol particles.

(e) The function of the capillary is to act "as a diffusion barrier for nonattached lead atoms." The capillary has dimensions of 1.5 mm inner diameter and 1 m length. The gas flow rate is 1 liter per minute. Assume that the diffusion coefficient of nonattached lead atoms is 0.05 $cm^2\ s^{-1}$. Estimate the fractional penetration of nonattached lead atoms through the capillary.

(f) The abstract suggests that the instrument can be used for "continuous monitoring of aerosols of any kind." Consider monodisperse particles of diameter d_p. As d_p varies from a very small value (say ~ nm) to a very large value (say ~ 100 μm), will the device continue to perform effectively? Justify your answer in terms on the basis of the physics of airborne particles.

(g) Figure 2 shows the signal recorded by the epiphaniometer as a function of time of day, averaged over a 3-week monitoring period. Identify on the figure the period(s) of high and low particle concentrations. Briefly justify your answer.

Scoring — (a) 1 point; (b) 1 points; (c) 1 point; (d) 1 point; (e) 3 points; (f) 2 points; (g) 1 point

Reference — HW Gäggeler, U Baltensperger, M Emmenegger, DT Jost, A Schmidt-Ott, P Haller, and M Hofmann, The epiphaniometer, a new device for continuous aerosol monitoring, *Journal of Aerosol Science*, **20**, 557, 1989.

Abstract — A new device is described, which allows continuous monitoring of aerosols of any kind. Air is continuously pumped through a closed chamber containing short-lived ^{211}Pb atoms delivered by a ^{227}Ac source. These atoms attach onto the aerosol particles. After transportation through a thin capillary to a filter and counting station the particles are detected by means of an α-detector for measuring the decay of ^{211}Pb (via ^{211}Bi). Due to the relatively short half-life of ^{211}Pb, the system allows continuous monitoring of aerosols without changing or transporting the filter. The measured signal is proportional to the exposed Fuchs surface of the aerosol particles. In the case of environmental applications, the device is therefore most sensitive to particles contained in the accumulation mode. Due to its high sensitivity it also works well at the lowest particle concentrations of less than 100 ng m^{-3} with gas flow rates as low as 1 liter min^{-1}.

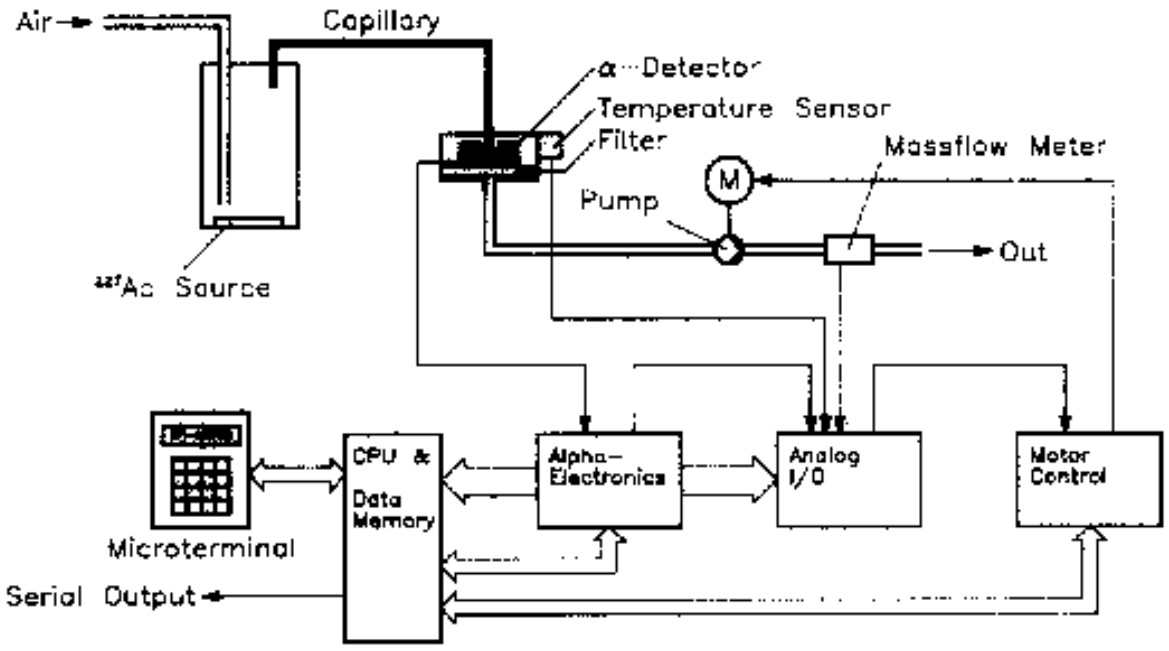

Figure 1. Schematic diagram of the epiphaniometer.

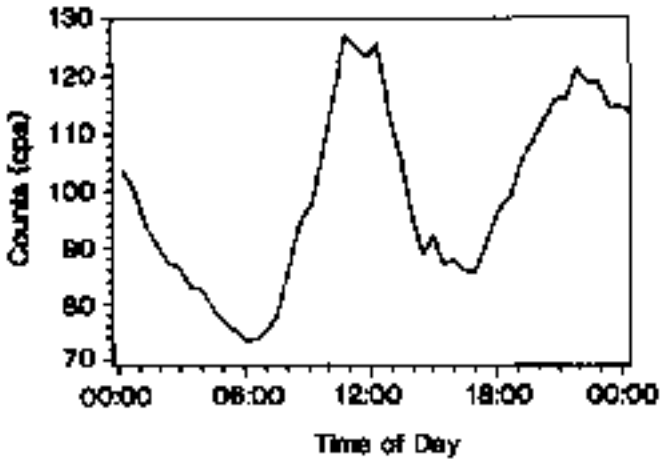

Figure 2. Mean diurnal variation of the epiphaniometer signal, determined at the National Monitoring Network Station for Air Pollution at Dübendorf, from 25 November to 13 December 1985.