



Radon detectors for continuous environmental monitoring applications

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Summary. The two-filter method is presently the best technique available for real-time low-level counting of atmospheric ^{222}Rn . The Australian Nuclear Science and Technology Organisation has developed and deployed a range of dual flow loop, two-filter radon detectors around the world for various applications. The detectors have a response time of 45 minutes, and can be custom built for specific purposes. The largest detectors have a lower limit of detection of $\sim 10 \text{ mBq m}^{-3}$.

Introduction

At present, the two-filter detection method [Thomas and LeClare, 1970] is the best technique for low level counting of radon in air. Other detection techniques, which rely upon the use of radon progeny as a radon proxy, necessitate concomitant assumptions regarding equilibrium, or establishing the degree of disequilibrium, of the progeny with respect to the ambient radon [Larson and Hoppel, 1973; Lambert *et al.*, 1970].

The Australian Nuclear Science and Technology Organisation (ANSTO) has developed and trialed a novel set of dual flow loop two filter detectors for long term continuous monitoring of radon concentration in air for a wide range of applications including geophysical research, atmospheric research [Whitlstone and Zahorowski, 1998] and compliance monitoring. Geophysical research applications include radon monitoring in coal mines as a precursor of imminent outbursts. Atmospheric research applications include pollution studies, air mass tracking and numerical model evaluation. Compliance monitoring is conducted at plant perimeters, as well as the evaluation of remission strategies and estimation of efficacy of radon covers for tailings dams.

Principle of operation and performance

The radon detectors currently used by ANSTO are dual flow loop, two-filter, detectors (Figure 1). Air is drawn through the detector from the sampling point by the external flow loop. As air enters the detector it passes through the first filter, which removes aerosols and ambient radon progeny. Once inside the detector, the internal flow loop recirculates the air at a high flow rate, through the second filter (a fine wire mesh), which collects recently formed radon progeny. Alpha decays of the captured radon progeny are counted

using a zinc sulphide scintillator – photomultiplier combination, and subsequently related to a radon concentration.

The detector volume and flow rate of the external flow loop control the sample residence time within the detector. The sample residence time, flow rate of the internal flow loop, and progeny collection efficiency control the detector sensitivity and lower limit of detection. Existing models vary in size from 32 to 5000L. The lower limit of detection of the 5000L model is 10 mBq m^{-3} . Detectors may be custom built to suit specific requirements. The detectors have a 45 minute response time and typically a 30 minute sampling frequency. They are designed for continuous operation, have low maintenance requirements, low power consumption and can be monitored remotely.

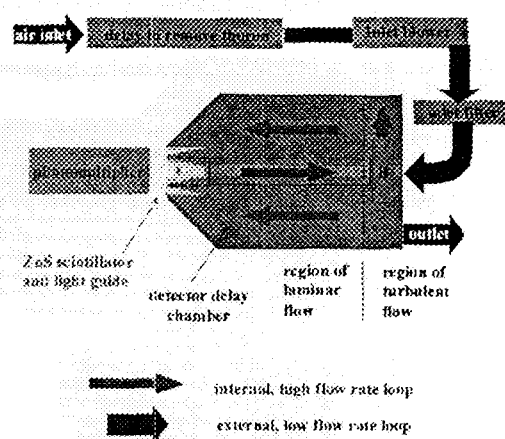


Figure 1: Schematic diagram of the ANSTO dual flow loop, two-filter radon detector.

Monitoring network and collaboration

ANSTOs radon monitoring capabilities have led to participation in prominent multi-disciplinary national and international scientific programs involving the Bureau of Meteorology, CSIRO, Australian National Antarctic Research Expeditions, World Meteorological Organisation's Global Atmospheric Watch, National Oceanic and Atmospheric Administration Climate Monitoring and Diagnostic Laboratory, Pacific Marine Environment Laboratory and the International Global Atmospheric Chemistry Project.

ANSTO built radon detectors are presently operating in Sydney (New South Wales), Cape Grim (Tasmania), Melbourne (Victoria), Jabiru (Northern Territory), Rottnest Island (Western Australia), Cape Point (South Africa), Mauna Loa Observatory (Hawaii), Edinburgh (Scotland), Macquarie Island, Seattle (Washington), Hok Tsui (China), Gosan (South Korea), and Sado Island (Japan). Mobile (ship-borne) detectors have also been employed on the CSIRO research vessel Southern Surveyor, the NOAA research vessel Discoverer and the research vessel Ron Brown.

References

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