IMPROVEMENT OF RADON SUPPRESSING AEROSOL MONITORING TECHNIQUES

T. M. Ibach, R. Scheuer, P. Guglhör

Technical Inspectorate of Bavaria (TÜV Bayern Sachsen, München)

ABSTRACT

Subject of this presentation is the improvement of the effectiveness of different radon-suppressing techniques for Alpha aerosol monitoring in working areas.

Due to the very high dose factors of Uranium and Transuranium Aerosols the limit of detection for airborne concentrations derived from statistical considerations has to be very low, i. e. about 100 mBq/m³ after a few hours.

ABPD (Alpha/Beta Pseudo Coincidence Discrimination)- and AERD (Alpha Energy Range Discrimination)- techniques can reach that goal when the Alpha emitting radon decay products do not change their equilibrium. When measuring continuously in real conditions, this is disturbed by systematic errors, such as the influence of Po 214, which sometimes changes its equilibrium with the suppressible Po 218.

As a result of our investigation we changed the ABPD- and the AERD- method by stopping the air flow through the measuring filter for a short time and watching the decay and build up of Po 214 by means of an on-line least squares fit.

INTRODUCTION

The implementation of the newer findings about the high biological effectiveness of Alpha-radiation, mainly of Uranium and Thorium, resulted in lower limits of intake and lower limits of airborne radioactivity concentration.

The permanent presence of an airborne Alpha concentration of 0.2 Bq/m³ would be equivalent to the yearly limit of intake, as it is given by the German Radiation Protection Ordinance of 1989. Accordingly high are the demands on aerosol-monitoring, which should detect the presence of such an airborne Alpha concentration as early as possible. In that case continuous monitoring is the appropriate method.

When monitoring Aerosols, it is an unwelcome side effect that the radon-followers give a varying contribution to the Beta-signal as well as to the Alpha-signal. This varying contribution presents the essential restriction to the lower limits of detection, mainly when measuring continuously.

Apart from continuous Alpha-spectrometry the most important measuring techniques to minimise such a restriction are the ABPD (Alpha/Beta Pseudo Coincidence Discrimination)-technique (1) and the AERD (Alpha Energy Range Discrimination)-technique (2). These methods can also be combined (3).

Both these techniques use the specific detectability of Po 214 of the Radon decay chain (resp. Po 212 of the Thoron decay chain). Po 214 (resp. Po 212) is representative for the natural activity (including e.g. Po 218 resp. Po 216), which can then be deducted from the total activity to get the artificial (Uranium, Transuranium) Alpha activity as a result.

This presentation was developed in the course of the research project: Room Air Monitoring of Uranium and Transuranium, supported by the Ministry of Environment (Bundesministerium für Umwelt) of the Federal Republic of Germany with the Project Number StSch 4055

The ABPD-technique uses the short lived succession of the decay of Bi 214 and Po 214 in the Radon decay chain (resp. of Bi 212 and Po 212 in the Thoron decay chain) whereas the AERD-technique takes advantage of the range of the Alphas of Po 214 (resp. Po 212), which is high compared to the case of long lived Alpha-Emitters, like Uranium or Transuranium nuclides.

The following simplified part of the nuclide chart explains it:

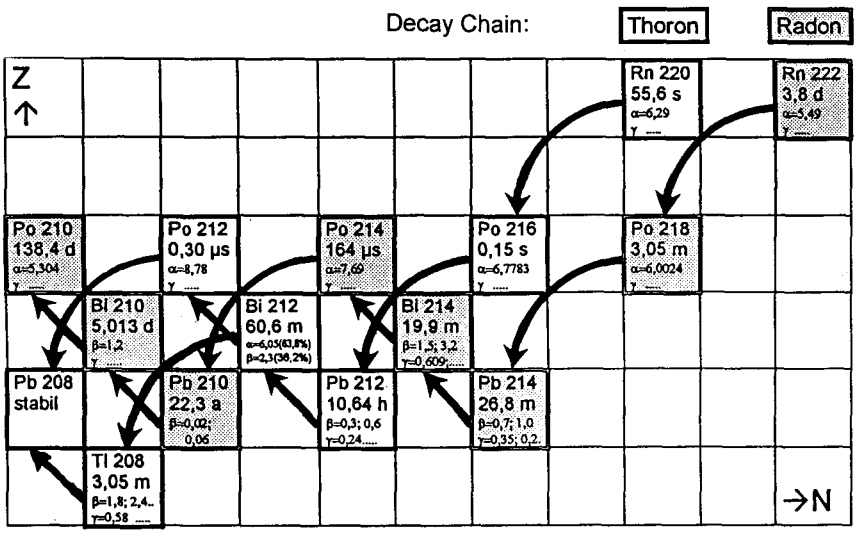

Figure 1: Extract of the Karlsruhe Nuclide Chart with the Radon and Thoron decay.

INTERFERENCES

The theoretical detection limits of these radon-suppressing techniques are about 0.2 Bq/m³ when that concentration is present for at least 1 hr in an atmosphere of 10 Bq/m³ Radon Gas in the state of equilibrium of the Radon daughters (4). When comparing these theoretical detection limits with the ones achievable in real cases, it shows that there are systematic interferences due to the disturbances of the equilibrium of the radon decay products. One example should explain this:

If there is a system for circulating and filtering air, that works optionally, the long-lived radon decay product Po 214, which is the basis for the compensation, is filtered out, while the short-lived Po 218 is rebuilding quickly. So switching on that system leads to an undercompensation of the Radon daughters, if the monitor's compensation was adjusted before - or, even worse - switching off that system leads to an overcompensation of the adjusted system.

It is obvious that similar effects appear, after doors of monitored rooms are opened ore closed.

SOLUTION

We have tried to separate the influence of Po 218 by stopping the air flow through the measuring filter of an ABPD-monitor regularly for a short time and watching the Alpha-signal. The part of the signal due to Po 218 falls exponentially with a half-life-time of 3.05 min. The count rate, collected every 10 seconds, is fitted by a least squares fit using a transputer system to get the Po 218 concentration. The same method,

but using the rebuild of Po 218 is also used, when the air flow is started again. The Po 214 concentration is known by the pseudo coincidence rate.

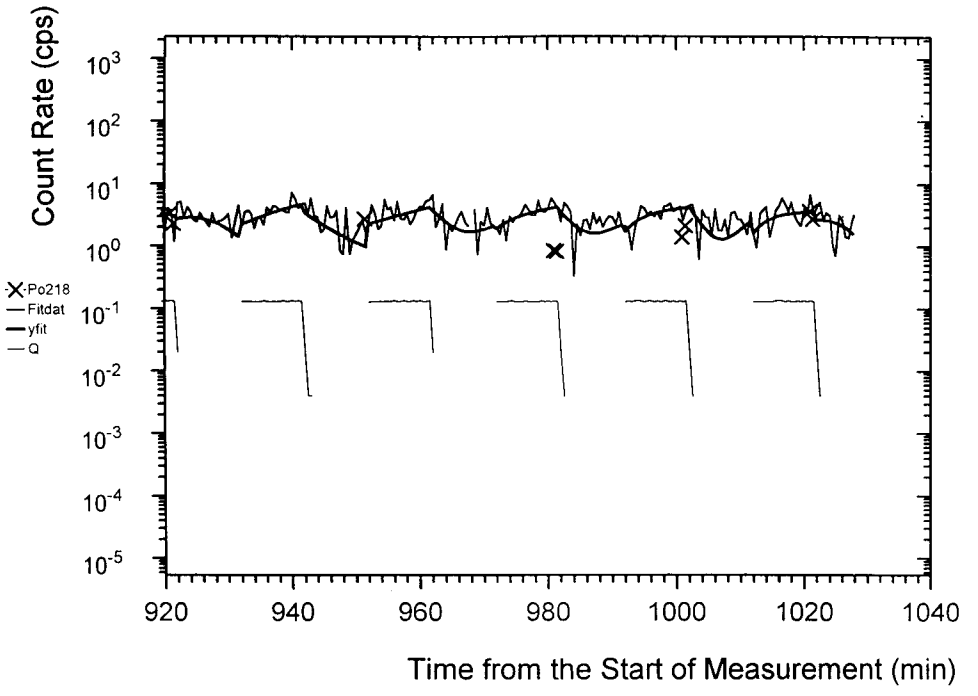

Figure 2: Results of the first on-line measurements with the extended ABPD-Monitor
The Po 214-compensated count-rate is fitted to get the equilibrium count-rate due to Po 218
The measured flow rate through the monitor is given as Q and is about 42 m^3/h

With that system, working in intervals of 10 min for accumulation and stopping, the problem of wrong compensation is solved, but a contamination burst in the stopping time cannot be seen. It is planned to upgrade the system, so that it only stops the accumulation if a malcompensation or significant airborne contamination is obvious. In this case the system can decide by doing the Po 218-decay fit.

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