through the measuring cell has to be set (advice 1 min), and the counting time can be set in the range 1 .. 99 min. In case the natural diffusion of air into the measuring cell is selected, the pumping time is set to zero. Selection of review of the measuring results enables to read out up to 8000 measurements stored in the memory. In the mode of transmission of data, the measuring results stored in the controller memory are transmitted through the series port RS232C to an external computer or to a serial printer. In the mode of setting time the date and time of measurement are set.

The probe is supplied from three spark-proof, lithium non-rechargeable, batteries 3.76 V; 13 Ah and one alkaline battery 12 V. Two lithium batteries supply the microprocessor system and the analog channel, the third battery supply the air pump. To supply the semiconductor detector the alkaline battery is used. Power consumption of the detector, the microprocessor system and the analog channel is very low and the batteries are sufficient for 3 years of operation. The battery supplying the air pump at a 1 min pumping time is sufficient for approx. 4700 measuring cycles, e.g. at a counting interval of 90 min is sufficient for 360 days of operation.

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CONTINUOUS MEASUREMENT OF RADON IN AIR WITH LUCAS CELL

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Introduction

Lucas cell [1, 2] was investigated as an α-radiation detector for continuous measurement [3] of radon concentration in air with air sampling by means of a pump. The investigations indicate that all the short lived radon decay products produced inside the Lucas cell ϕ54x74 mm (0.17 L) are attached to the internal walls of the cell and are not removed when the cell is flushed with some fresh air. This effect, and the well known effect of increase of the α particle concentration when only radon is introduced into the cell, result in a dynamic error due to delayed response of the gauge to variations of the radon concentration. To cope with this phenomenon, a way of processing of the signal from the Lucas cell is proposed, which decrease the dynamic error.

Sensitivity of the Lucas cell for the detection of low radon concentration is limited by random errors due to statistical fluctuation of the signal. Principal Component Analysis (PCA) was applied to the Lucas cell signal, to see if this kind of processing can improve the sensitivity of Lucas cell. Count rates were measured at 1 min intervals in the period up to 180 min since radon was introduced into the Lucas cell. Achieved in such a manner set of characteristics for different radon concentration were then PCA processed. It was found that PCA processing considerably decreases random fluctuations. The PCA method of signal processing can be employed in the case of continuous measurements with a long period of repetitions and flushing the cell with clean air after each measurement, or in standard non-continuous measurements.

Dynamic error of the Lucas cell

Measurements carried out showed, that for the Lucas cell 0.17 L in volume, all the radon daughters produced inside the Lucas cell are attached to the internal walls of the cell and are not removed. In consequence the alpha activity that is registered by the Lucas cell, decreases within approx. 3 h due to decay of the attached radon daughters. A similar effect but of opposite direction takes place when radon is introduced into the cell. Thus the indication of Lucas cell for a step radon concentration variation is loaded with a dynamic error. Simulating computations [4-6] of radon concentration showed by the Lucas cell, expressed in the fraction of radon concentration at radiation equilibrium, in consecutive 15 min measuring intervals is: 0.5902; 0.7178; 0.772; 0.8248; 0.8712; 0.9087; 0.9375; 0.9587; 0.9739; 0.9844; 0.9914; 0.9959, after radon was introduced into the cell. The relation between the count number r_o at radiation equilibrium and the radon concentration C_o at t=0 is given by the equation:

$$C_o = \frac{r_o}{60}\frac{1000}{v}\frac{1}{3\varepsilon}\frac{1}{k}\ [\mathrm{Bq/m^3}]$$

where: v - volume of measuring cell [L], ε - counting efficiency of α-particles, $k \cong 0.97$ - coefficient for a decrease of the radon activity until radiation equilibrium is achieved.

Correct indication of the Lucas cell can be obtained after first reading of the Lucas cell if the count rate from the Lucas cell is processed as shown below, for eight counting intervals, and for k1 .. k8=0.5902; 0.7178; 0.772; 0.8248; 0.8712; 0.9087; 0.9375; 0.9587:

- Mean count rate r is computed from the measured count number R in the first counting interval j=1. Mean count rate corresponding to radiation equilibrium is computed $r_o = r/k1$ [cpm]. Mean count rate in successive 8 intervals are computed: $r(1,2)=r_o \cdot k1$, $r(1,2)=r_o \cdot k2$ ..... and remembered as shown in Table. Radon concentration C_o is computed from equation and displayed. C_o is remembered as C_l (last).
- Mean count rate r is measured in the second time interval j=2. The count rate r is compared with the expected count rate $R_{e2}=\sum_i r(i,2)$. If r is equal