Proceedings of ICGG7 (2003): 57–58

ICGG7 2003

Improvement of an automatic device for soil radon measurements

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Abstract. The portable radon detection system AlfaININ was designed to be used in adverse environmental conditions where humidity and high temperature are present in the soil (Chavez et al., 1999). Until now the device has been operating only for alpha decay. In the present time, temperature and humidity sensors were incorporated to the detection system. The performance of the device permits to obtain real time measurements of the three parameters and will store them each hour during 41 days. To prove the response of the whole sensors, its performance in the laboratory and in the soil of a coniferous forest at 3000 m altitude is discussed.

1 Introduction

The automatic device, AlfaININ, was constructed to accomplish radon detection in adverse environmental conditions, for example, those which exist in geothermal fields and areas near active volcanoes, where vapour emission and temperatures above normal are found. In order to study in real time the behaviour of radon as a function of temperature and humidity of the neighbouring zone, a sensitive sensor has been incorporated to the original device.

2 Experimental

A block diagram of the improved AlfaININ is shown in Fig. 1. It consists of an EGG&G Ortec DIAD II that includes an α-detector, a preamplifier, an amplifier and a single channel analyser (SCA); the temperature and humidity sensor; a real-time microprocessor and clock; a RAM memory and finally an interface RS-232. The AlfaININ microprocessor has an integration time from 15 minutes to one day during 41 days.

The humidity and temperature sensors use a complementary metal-oxide semiconductor (CMOS) "micro-machined"

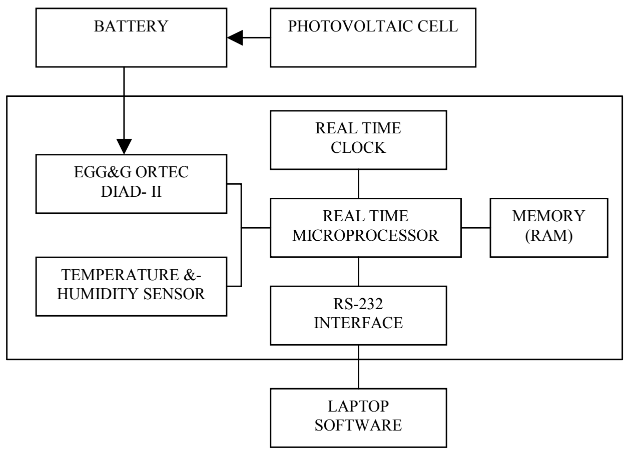

Fig. 1. Block diagram of AlfaININ.

chip technology, with a calibrated digital output. Conventional sensors determine relative air humidity using capacitive measurement technology, in the present case, the sensor element is built from a film capacitor on different substrates (glass, ceramic, etc.). The dielectric is a polymer that absorbs or releases water proportionally to the relative humidity, changing the capacitance of the capacitor, which is measured by an onboard electronic circuit, The temperature is measured using the thermo-electric properties of the materials that constitute the electronic microchip. Both signals are coupled to an amplifier, analog-to-digital (A/D) converter and serial-interface circuit on the same chip.

The electronics are contained in an inox pipe 48 cm long, 6.7 cm diameter with a total weight of 3.5 kg. The power supply is a 12 V battery connected to a photovoltaic cell, which provides permanent working autonomy to AlfaININ.

The detection parameters are the 450 mm^2 surface barrier detector with advanced hybrid electronic incorporated, the minimum α-energy detection is 1 MeV established with an adjusted discriminator. A Laptop computer displays a menu for choosing the time integration period, initiating the count-

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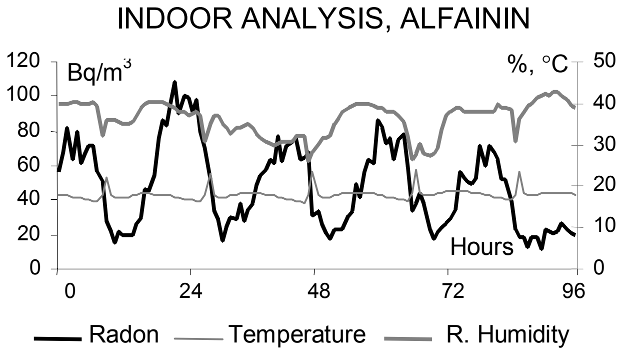

Fig. 2. Radon (Bq/m^3), temperature (°C) and relative humidity (%) indoor variations measured with AlfaININ. Temperature and Relative humidity axis has the same values for the two parameters.

ing and draining the storage data.

3 Results and discussion

AlfaININ was programmed to integrate the data during one hour. Two operation tests of the improved AlfaININ were performed. In the first, AlfaININ was put in a laboratory during 96 h, measuring the environmental variations of the specific concentration of environmental radon, temperature and relative humidity. The results are shown in Fig. 2. Radon variations indicate minimum concentration values at noon and maxima around midnight. It is observed that when temperature increases, relative humidity decreases. The second test was accomplished comparing the results between AlfaININ and AlphaGuard. AlphaGuard was installed at the laboratory and AlfaININ was put 100 cm under land surface on a nearby external area. The AlphaGuard equipment measured environmental radon, temperature and relative humidity and AlphaININ measured the same parameters underground. In Fig. 3 the behaviour of environmental and underground radon in presented showing a similar pattern except for shorter underground radon periods of variation. The temperatures have also the same pattern in the air and the land but with a small decalage. On the contrary, the relative humidity shows a dramatic contrast: while the environmental humidity varies strongly, the underground humidity is constant.

4 Conclusions

The tests accomplished with the improved AlfaININ, permitted to obtain temperature and the humidity data in addition to radon. The knowledge of the whole set of parameters in real time permits to interrelate them. AlfaININ has the versatility to be programmed for integration time and storage of the information. In this way it is possible to improve the models of the influence of humidity and temperature on radon emanation.

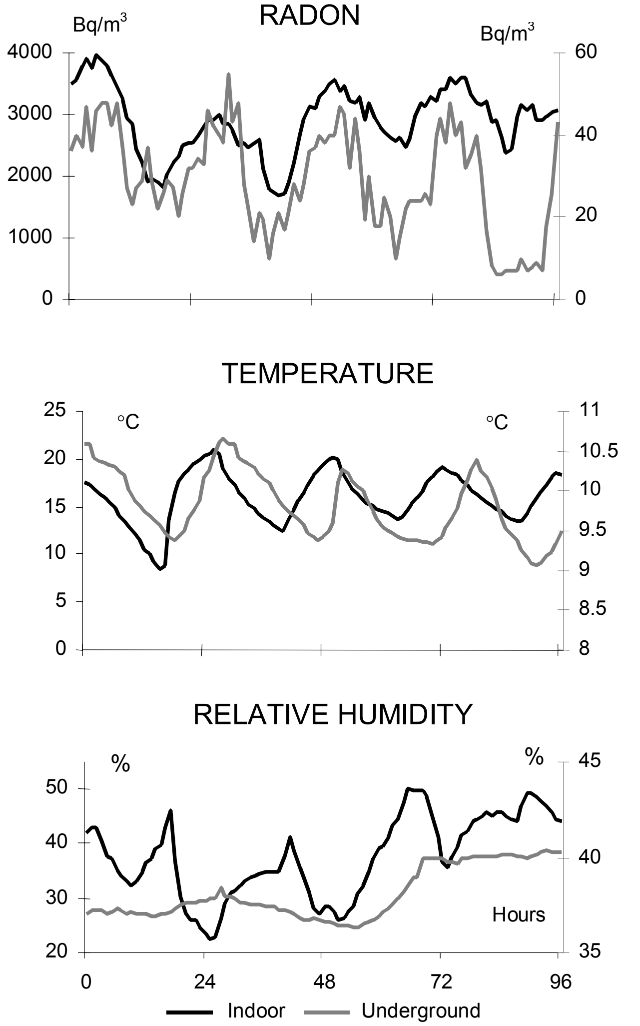

Fig. 3. Radon, temperature and relative humidity measurements. Indoors (right axis) with Alphaguard and underground (left axis) using AlfaININ.

References

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