NUCLEONIC CONTROL SYSTEMS AND ACCELERATORS

PRINCIPAL COMPONENT REGRESSION DATA PROCESSING IN RADON PROGENY MEASUREMENTS

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Random errors due to fluctuation of count rate originating from radon progeny disintegration, due to errors of air volume passed through an air filter and due to deposition errors, the accuracy of measurement and a minimum detectable concentration that can be measured are limited. The errors can be made lower by increasing airflow through the air filter, but this requires more energy and larger batteries that is in a portable gauge inconvenient. Much better solution is data processing that can decrease random errors. Principal component regression (PCR) is a processing method that is able to improve accuracy of a radon progeny monitor [1-2]. To investigate random error due to fluctuation of pulse count rate originating from disintegration of radon progeny, a computer program was developed for simulation of activity of radon progeny deposited on air filter [3]. Count rate corresponding to such activity was then randomized and such randomized count rate was PCR processed [4]. Investigations showed that random error could be made three times lower when the data were PCR processed comparing to readings without PCR processing. A further step in investigation of PCR processing for radon progeny monitor, presented here, were real measurements of radon progeny concentration in a radon chamber and their processing with the PCR method [5].

A series of 16 measurements, made with an RGR-40 radiometer [6], of radon progeny ^{218}Po, ^{214}Pb, ^{214}Po and PAE (potential alpha energy) concentration and corresponding to the 1 min mea-

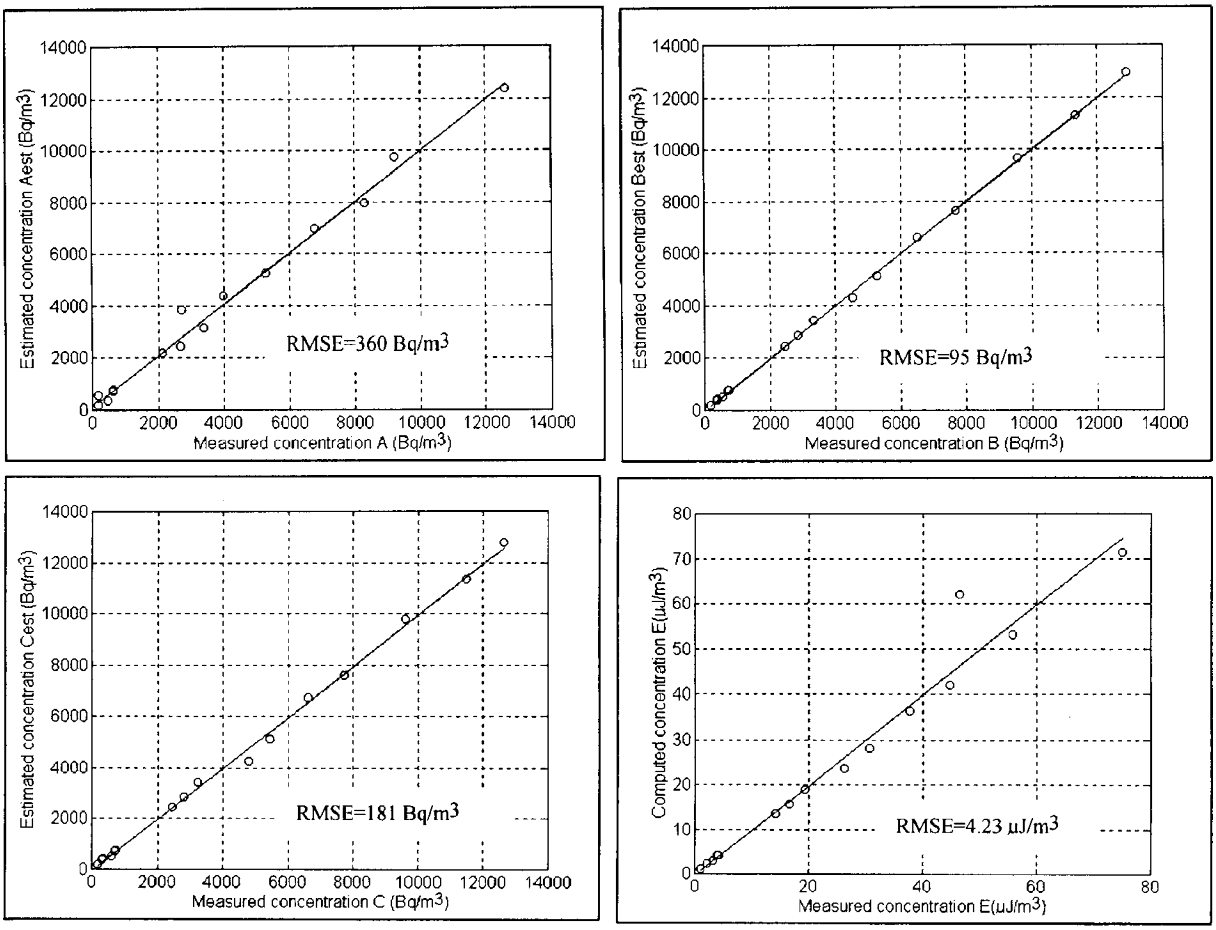

Fig. PCR estimated A_{est}, B_{est}, C_{est} and PAE_{est} concentration against measured concentration A (^{218}Po), B (^{214}Pb), C (^{214}Po), E (PAE) of radon progeny.

surement count rates were PCR processed. Estimated radon progeny concentration from PCR processing against the measured progeny concentration and root mean square error (RMSE) is shown in Fig. The RMSE that is a measure of random error due to pulse count fluctuation and other contributing random errors is: 360 Bq/m^3, 95 Bq/m^3, 181 Bq/m^3, and 4.23 μJ/m^3 for ^{218}Po, ^{214}Pb, ^{214}Po and PAE, correspondingly. RMSE for three interval model presented in [7] is: 469 Bq/m^3, 507 Bq/m^3, 285 Bq/m^3, and 4.35 μJ/m^3 for ^{218}Po, ^{214}Pb, ^{214}Po and PAE, correspondingly. On the average, the RMSE for ^{218}Po, ^{214}Pb and ^{214}Po is 2.7 times higher than for PCR processing. The slope of regression line for ^{218}Po and ^{214}Pb differs from unity by approximately 10% (the slope is 0.9 for ^{218}Po, and 1.08 for ^{214}Pb).

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RADIATION SOURCE CONTROLLER KAI-2

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During production of medical radiation sources on production line, every 12 s a new capsule containing ^{131}I isotope is packed into a lead container. Packed in the lead container sources are then delivered to hospitals and clinics. To exclude the case when because of faulty operation of packing mechanism, the capsule with radiation source was not packed into the lead container, additional control of the containers leaving the production line is needed. Such control is ensured by the radiation source controller KAI-2. Block diagram shown in Fig. illustrates the principle of operation of the controller.

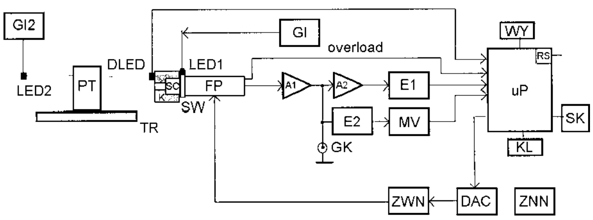

Fig. Block diagram of the controller: PT – source container with the source; TR – transport conveyor; K – collimator; LED1 – reference light pulse source; GI, GI2 – pulse generators; LED2 – IR light beam source; DLED – IR sensor; SC – NaI(Tl) scintillator; SW – lightguide; FP – photomulltiplier tube; A1, A2 – pulse amplifiers; E1 – discriminator of ^{131}I pulses; E2 – discriminator of LED1 pulses; MV – monovibrator; uP – microprocessor system; RS – serial port; WY – display; KL – keyboard; SK – control signals (ready, measurement, alarm); ZWN – high voltage power supply; ZNN – low voltage power supply; DAC – digit-to-analog converter; GK – control socket.

The container with the ^{131}I source in measuring position in front of the scintillation probe is sensed with an infrared (IR) light beam source and an IR sensor. Radiation collimator in front of the scintillation detector ensures that the radiation from the neighboring containers is not incident on scintillation detector. After amplification and shaping of the pulses originated from ^{131}I, the pulses are passed through pulse discriminator E1 and are counted by pulse counter under the control of microprocessors unit. Count rate, a few times higher than the background count rate, indicates that the source container is packed with the source. Counting time is fixed and is equal to 5 s. To handle the wide variation of radiation intensity in the span 1:300, dc current of the last dynode of photomultiplier tube (PMT) is measured that, at very high pulse count rate, produces an "overload" signal. For a very high count rate of paralyzing pulse measuring channel, the overload signal is an indicator of radiation source in the source container. To ensure stable operation of the scintillation detector, an automatic gain control circuit of PMT is used. Reference light pulses are generated by reference light emitting diode. The diode is coupled with the PMT by means of a lightguide. The PMT high voltage is increased or decreased as to get pulse amplitude originating from light emitting diode equal to discrimination level E2. In such a case, at the monovibrator output logic "1" is produced that is sensed by the microprocessor. The high voltage of the PMT is regulated by the microprocessor through digit-to-analog converter controlling high voltage power supply. The PMT gain is automatically controlled at the beginning of each counting interval.

Control of the containers is carried out in a closed loop cycle: PMT automatic gain control (1 s) – awaiting for the container in measuring position – count rate measurement (5 s) when the container in measuring position. Measured count rate is displayed, stored in the controller memory and is sent to an external computer by RS485 serial port. Alarm signal is generated in case when no source in the source container is detected. The controller is equipped with functions enabling check up proper operation of the controller and facilitating installation of the controller at production line.