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THE DETECTOR ON BASIS OF CdZnTe-GAUGE FOR SYSTEMS RADIATING-TECHNOLOGICAL CONTROL

In the given work it is offered and the device of digital updating of power dependence sensitivity work of a crystal in account a mode is made of modern element base. Inclusion of the CdZnTe-detector in an operating mode pulse proportional ionization chambers allows to raise essentially its sensitivity, to expand a dynamic range of values registered capacity of a doze from background values up to caused with emergency operation of work реакторной installations. Application of a pulse mode allows to realize practically and other opportunities and, first of all, - indemnification of power dependence sensitivity (PDS), so-called «course with rigidity». Experimental samples of the developed detectors have been tested in structure of БДМГ-CZT in conditions of the control of a condition of nuclear fuel of the Zaporozhye atomic power station. The structure of the detector contained the block of strengthening, the power supply, the device of formation of impulses and spectrometer is peak-digitizer.

Keywords: power dependence of sensitivity, CdZnTe-detector, digital updating, dosimetric device, factor change of frequency.

Statement of a problem. Development of modern blocks of the detecting intended for the control of a condition of protective barriers by measurement of capacity of a doze scale-radiation in air, in structure of systems of the radiating control of the atomic power station is the important and actual problem. Blocks of detecting of system ECRS-03 being now in operation have developed the resource (ECRS - equipment of the control radiating safety) [1, 2]. The system developed more 20-ти of years back, not only has developed the resource, but also is morally obsolete [3]. It is obvious, that new blocks of detecting should possess higher metrological and operational parameters. Substantial improvement of metrological and operational characteristics of detectors, as shown above, can be received only on the basis of application of new materials, in particular, with wide zonsemiconductors, such as CdZnTe [4].

Now dosimetric devices with semi-conductor blocks of detecting on the basis of Si [5, 6] serially are issued. Advantages CdZnTe before Si - greater value of sensitivity and smaller value of a power equivalent of noise [7, 8]. However, big effective nuclear number causes also greater (more than 10) value of power dependence sensitivity (PDS).

In the literature the description of a method of hardware correction PDS by means of the device collected on discrete elements with a low degree of integration [9, 10, 11, 12] is resulted. Such device unreliably, dearly, has a low dynamic range. In the given work it is offered and the device of digital updating PDS is made of modern element base at work of a crystal in счетном a mode.

The basic part. Numerical value of factor of change of frequency of impulses on an output of the block of detecting is defined on the basis of analytical dependence of the attitude of sensitivity of the detector to registered scale-radiation $S(E_\gamma, x)$ and sensitivity scale-radiation with energy on which its graduation was spent $S(E_{\gamma k}, x)$:

$$\varepsilon\left(E_\gamma\right) = \frac{\int_{x_{\min}}^{x_{\max}} S\left(E_{\gamma,} x\right) \cdot K(x) dx}{\int_{x_{\min}}^{x_{\max}} S\left(E_{\gamma k,} x\right)(x) dx}, \qquad (1)$$

where $x_{\min}$ - number of the channel corresponding noise level; $\varepsilon\left(E_\gamma\right)$ - the set relative dependence of sensitivity of the detector on energy.

For practical realization of correction target signal of the block detecting it is offered to use piece-linear interpolation of the set relative analytical dependence sensitivity of the detector from energy:

$$\varepsilon(E_\gamma)=\left[\frac{S(E_{\gamma_1},x_1)K(x_1)}{S(E_{\gamma_1},x_1)K(x_1)+S(E_{\gamma_2},x_2)K(x_2)}\right]\times\frac{1}{\int_{N_{\min}}^{N_{\max}}S(E_{\gamma k},x)dx}. \qquad (2)$$

Thus, the problem of correction power dependence sensitivity consists in reception of value *K (x)* for the certain power range of the registered photons E_{γ_j}.

Experimental samples of the developed detectors have been tested in structure of BDPS-CZT in conditions of the control of a condition of nuclear fuel of the Zaporozhye atomic power station. The structure of the detector contained the block of strengthening, the power supply, the device of formation of impulses and spectrometer ADC. The design of blocks of detecting and processing of signals is presented in figures 1 and 2.

Fig. 1. The block of detector (BD)

The preliminary amplifier of a BD has while in service shown conformity earlier to the described parameters. By results of tests are made changes to the design-technological documentation. Electronic blocks of the detector are executed by a method of installation on the printed-circuit-board (fig. 2). The project of the operation manual on the device in a mode of detecting of capacity doze scale-radiation is developed.

Tests of blocks detecting BDPS-CZT in quantity of 5 pieces are lead in conditions of the Kharkov scientific research institute of metrology according to GOST. Results of tests are presented in table 1.

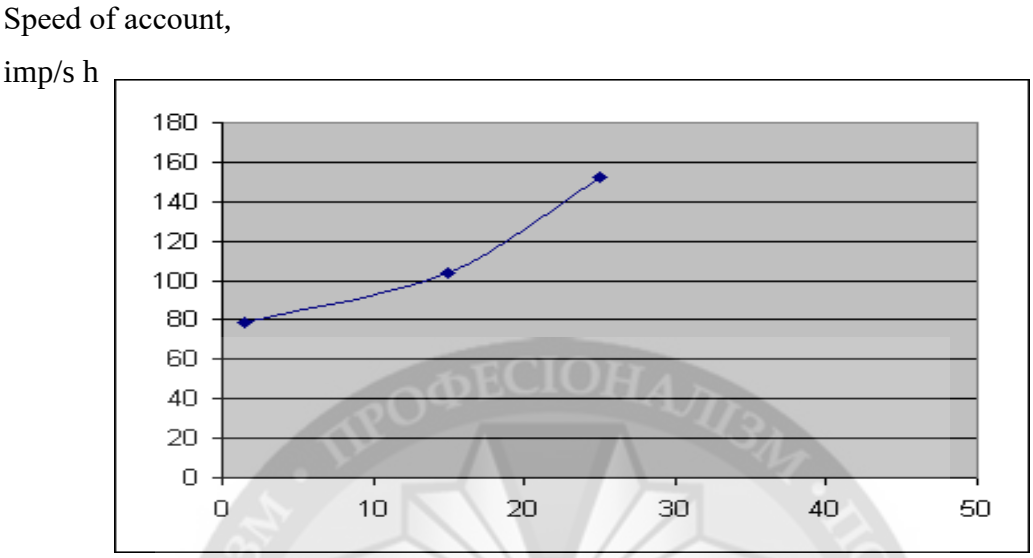
Fig. 2. A design of the block of processing of a signal of the detector BDPS -CZT

Table 1

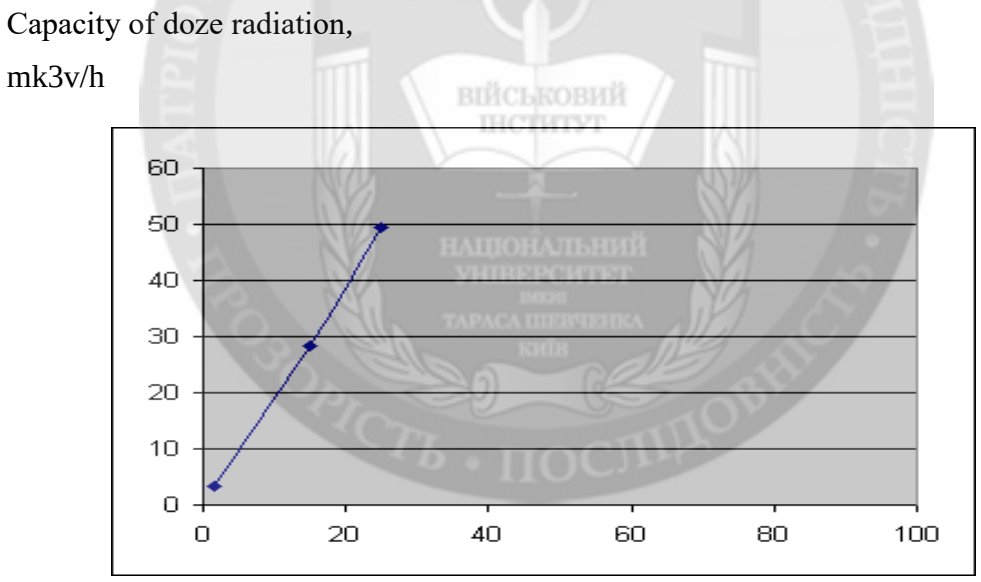
Definition of capacity doze scale-radiation on measurement of speed account impulses

Capacity dozes, mk3v/h	Average value of speed of the account, imp/s					
Block № 2						
1,5	78,8	89	82	75	77	71
15	103,4	102	99	99	104	113
25	152,4	154	171	154	139	144
Block № 3						
1,5	40,4	42	40	40	36	44
15	82,2	89	75	81	79	87
25	142	154	135	143	140	138
Block № 4						
1,5	14,2	21	16	19	9	6
15	82,8	74	88	92	72	88
25	128,2	103	144	128	102	164
Block № 5						
1,5	3,4	3	5	2	5	2
15	28,2	24	28	28	30	31
25	49,4	41	46	49	56	55

According to table 1 schedules of dependence of capacity doze radiation and speed of the account of impulses (fig. 3) are constructed. The analysis of schedules shows an opportunity of adjustment of sensitivity program by without intervention in the scheme of the detector. Besides the opportunity of performance requirements linearity dependence of speed account from capacity of a doze proves to be true.



a



b

Fig. 3. Schedules of transformation capacity doze scale-radiation in blocks BDPS-CZT 2 (a) and 5 (b) (on tab. 1)

Check of working capacity of a breadboard model of the developed block of detecting scale-radiation on the basis of gauge CdZnTe in structure of ECRS-03 on the Zaporozhye atomic power station is lead. Parameters of work of system correspond to regular norms. Tests have shown stability of transformation by the developed block of capacity of a doze scale-radiation in speed of the account of impulses. Parameters of operation, a design of the developed block are executed in full conformity with the technical project. The developed block of detecting scale-radiation BDPS -CZT can be used in system ECRS instead of serial block BDPS -41.

Conclusions. On the basis of the developed model the detector of an ionizing radiation for dosimetry is created. As its basic difference from known devices application as the primary converter scale-radiation (gauge) of crystals CdZnTe serves. The advantages of such decision proved by the previous researches, have allowed to create the detector having:

- greater resolution, no more than 40 keV;
- wider dynamic range of values registered capacity of a doze radiation - from background before emergency operation of work of a reactor;

Smaller value of a power equivalent of noise.

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ДЕТЕКТОР НА ОСНОВІ CdZnTe-ДАТЧИКІВ ДЛЯ СИСТЕМ РАДІАЦІЙНО-ТЕХНОЛОГИЧНОГО КОНТРОЛЮ

У даній роботі запропоновано та виготовлено на основі сучасної елементної бази пристрою цифрового корекції енергетичної залежності чутливості при роботі криштали в рахунковому режимі. Включення CdZnTe-детектора в режимі роботи імпульсної пропорційної іонізаційної камери дозволяє істотно підвищити його сенсивність, розширити динамічний діапазон значень реєстраційної потужності дози від фонових значень до обумовлених аварійними режимами

роботи реакторної установки. Використання імпульсного режиму дозволяє практично реалізувати і інші можливості та, перш за все, - компенсацію енергетичної залежності сенсу (ЕЗС), т.н. «Хода з жорсткістю». Експериментальні зразки розроблених детекторів були випробувані в складі БДМГ- CZT в умовах контролю стану ядерного палива Запорізької АЕС. Структура детектора містить блоку посилення, джерело живлення, пристрої формування імпульсів та спектрометричного амплітудно-цифрового перетворювача.

Ключові слова: енергетична залежність чутливості, CdZnTe-детектор, цифровая корекція, дозиметричний прилад, коефіцієнт зміни частот.

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ДЕТЕКТОР НА ОСНОВЕ CdZnTe-ДАТЧИКОВ ДЛЯ СИСТЕМ РАДИАЦИОННО-ТЕХНОЛОГИЧЕСКОГО КОНТРОЛЯ

В данной работе предложено и изготовлено на основе современной элементной базы устройство цифровой корректировки энергетической зависимости чувствительности при работе кристалла в счетном режиме. Включение CdZnTe-детектора в режиме работы импульсной пропорциональной ионизационной камеры позволяет существенно повысить его чувствительность, расширить динамический диапазон значений регистрируемой мощности дозы от фоновых значений до обусловленных аварийными режимами работы реакторной установки. Применение импульсного режима позволяет практически реализовать и другие возможности и, прежде всего, – компенсацию энергетической зависимости чувствительности (ЭЗЧ), т.н. «хода с жесткостью». Экспериментальные образцы разработанных детекторов были испытаны в составе БДМГ-CZT в условиях контроля состояния ядерного топлива Запорожской АЭС. Структура детектора содержала блок усиления, источник питания, устройство формирования импульсов и спектрометрический амплитудно-цифровой преобразователь.

Ключевые слова: энергетическая зависимость чувствительности, CdZnTe-детектор, цифровая корректировка, дозиметрический прибор, коэффициент изменения частоты.