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Measuring Method to Eliminate Radiation Effects of PFC Used OFS Light Transmission in High Radiation Environment

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1. Introduction

An optical fiber scintillator(OFS) containing Ce^{+3} (cerium) activator is used to convert radiation energy into visible light to detect radiation. In the case of gamma ray detection, OFS detects radiation by interaction of the glass material with gamma rays. If the OFS and PFC are used in conjunction, the flexibility of the PFC makes it easier to detect difficult-to-reach radiation, and because it does not require the use of a preamplifier, it can be used to measure high-level radiation. However, because PFC is also a glass material, it interacts with radiation. This acts as an interference element in obtaining radiation information by the OFS.

Therefore, to select only the light emitted from the OFS, this study was performed an experiment to remove the light from the PFC.

2. Methods and Results

2.1 Measurement System Configuration

As shown in Fig. 1, the measurement equipment of this study consists of a radiation sensor OFS, a passive fiber cable (PFC) for transmitting light, a photo multiplier tube (PMT) for converting light into an electric signal, a pulse counter and an ammeter. The PMT used current output H10721-110 Modules and voltage output H10722-01 of Hamamatsu product. A pulse counter and an ammeter were used for pulse mode and current mode measurements, respectively. Optical connectors and filter assemblies were used to transmit the OFS light to the PMT through the PFC. An optical filter assembly was fabricated to facilitate the optical filter experiment.

If OFS and PFC have different major wavelengths, it can use optical filters to select only the wavelengths generated by OFS. The emission wavelength of OFS containing the active form (cerium) is generally known to range from 350nm to 450nm. However, since the wavelength of the PFC is not known, it has been experimentally examined to what extent the light from the PFC contributes.

In this experiment, three kinds of optical filters of 340±10 nm, 390±10nm and 400±10nm were used respectively to remove the light generated by the PFC. Pulse mode and current mode were applied as measurement methods. The range of radiation dose rate in this experiment was from 100 to 3,000 rad/h. The length and diameter of the OFS is 10cm and 1mm. The PFC is 15 m of 1mm diameter. Of these, 3 m was exposed to radiation fields within the irradiation facility.

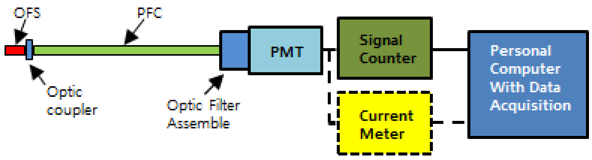
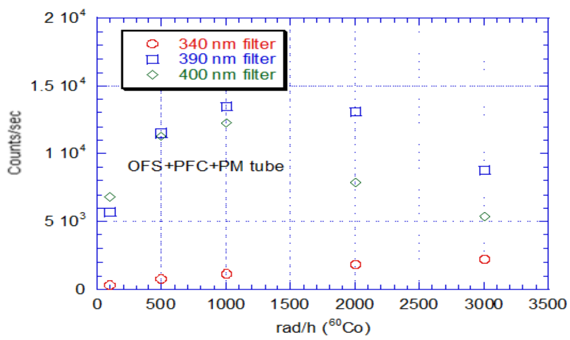


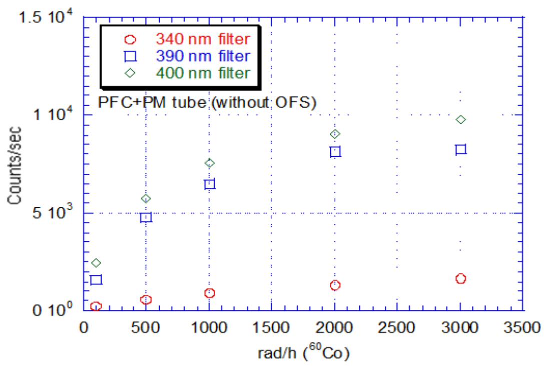
Fig. 1. Measurement system for pulse mode and current mode

2.2 Pulse mode measurement

The pulse mode was experimented with and without OFS for each of the three optical filters used, and the results are shown in Fig. As shown in Fig. 2 (a), the linearity due to dose changes could not be expected, and the results of the unattached experiments showed that linearity was not maintained at about 1,000 rad / h or more. This is believed to be due to a reduction in the efficiency of the counting due to the interference of the pulses.



(a) With OFS



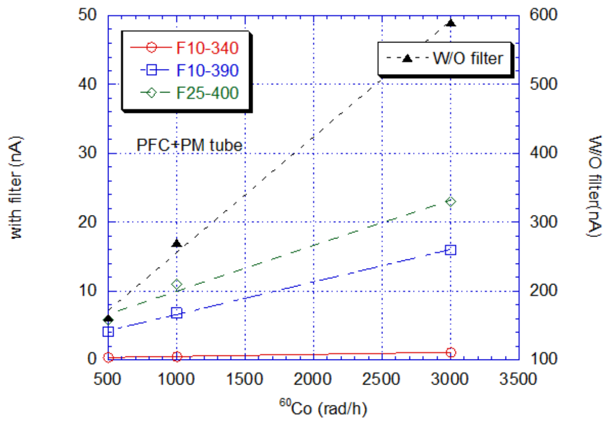
(b) Without OFS

Fig. 2. Pulse mode measurement with and without OF

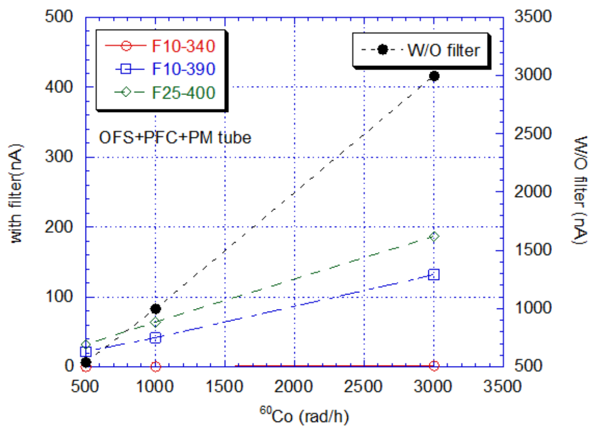
2.3 Current mode Measurement

Experiments were carried out for current mode measurements in the same way as in pulse mode, with or without OFS, and without optical filter. As shown in Fig. 3 (a), the linearity of the used filter 3 was maintained within 5%, and the result of not using the filter also showed good linearity within 5%. Fig. 3 (b) also shows good linearity with no OFS installed. The contribution of the PFC signal to the total signal of OFS and PFC was 64% when the optical filter was not used and 12.1%, 12.3% and 19.7% as shown fig. 4 when the optical filters were used at 400 nm, 390 nm and 340 nm, respectively. From these results, the effect of the optical filter was reduced by about 5 times, but not completely removed by PFC. It is considered that the measurement value using the optical filter 340nm is relatively lower than that of the optical filter 400nm and 390nm, so that it is difficult to apply it as a measuring device.

Therefore, the application of 400nm optical filter in current mode is advantageous for high - level radiation measurement.



(a) Without OFS and optic filter



(b) With OFS and without optic filter

Fig. 3. Current mode measurement with and without OFS

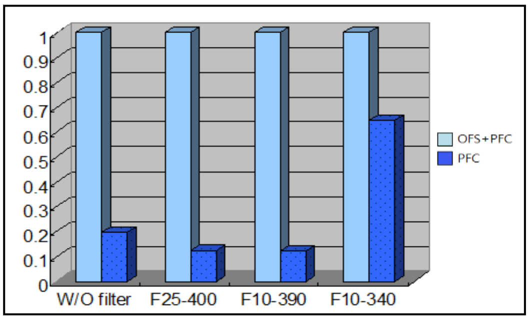


Fig. 4. Contribution of PFC to total measure

3. Conclusions

Since main component of OFS is glass, it has better radiation resistance than other kinds of scintillators, has less influence of temperature and humidity, and can easily change shape and size. In addition, if a system for transmitting light generated from the OFS through a passive fiber cable (PFS) is developed, electronic equipment required for signal detection at the measurement point is not required as well as enables miniaturization and easy access to extreme environments.

In this study, various experiments were performed to remove the light from PFC to accurately measure the high radiation of some local spot using OFS and PFC.

As a result, the measurement of the pulse mode lost the linearity due to the dose change due to the overlapping of pulses. The measurement of the current mode showed linearity within 5%. The optical filter experiment to remove the light from the PFC was removed by about 88% for the optical filters 400 nm and 390 nm, but it was not completely removed.

Therefore, in order to obtain the radiation information of the measurement point accurately and quantitatively, it is a need for a technique for eliminating the radiation influence by the PFC.

REFERENCES

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[2] KAERI, "National Nuclear Material Account and Control Technology Development", KAERI/RR-2212, 2002