§3. Effect of Air Condition on Two-Parameter Spectra Measured by Proportional Gas Counter

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For the purpose of certifying that the concentrations of tritium in the exhaust gas do not exceed their legal limits, a high-sensitivity tritium gas monitoring system is currently under development. In the previous study, the tritium gas monitoring system was constructed by employing ingenious techniques including a two-parameter-pulse height analyzer, in which two parameters were a pulse height and rise time of signal arose from radiation detection. The pulse height corresponds to the full energy of radiation detected by the detector and the rise time corresponds to the rising speed of the pulse. In the case of tritium, it could be supposed that the pulse height was very low and rise time was very fast because the energy of beta-rays emitted from tritium were very low and electron-ion pairs were ionized in a narrow space, being quickly collected by an anode of the detector and causing pulses with very fast raise time. Consequently, pulse due to tritium beta-rays can be effectively distinguished from other types of radiation using the pulse height and rise time.

In fiscal 2011, several two-parameter-spectra were measured with an enclosed radiation source of ^{55}Fe that emits 5.9 keV X-rays and their features were examined. The ^{55}Fe-radiation source was used because energy of X-rays was almost the same to the average energy (5.7KeV) of beta-rays emitted from tritium. A typical two-parameter-spectrum with the ^{55}Fe-radiation source is shown in Fig. 1 (A), where a peak corresponding to the source appears and the other areas contain background noise.

Figure 1 includes two small sub-spectra (B) and (C). The sub-spectrum (B) is a projection image of (A) called an energy spectrum and (C) is a projection image of (A) called a rise time spectrum. Three peaks found at lower channel region in the three spectra attribute to X-rays emitted from ^{55}Fe. The spectrum (A) in Fig.1 was measured by using pure methane as counting gas of the proportional counter. However in actual monitoring, a proper amount of air sample is mixed in the methane beforehand and the tritium concentration contained in the air sample is measured using the mixture of methane and air sample as counting gas of the counter. So, to examine effects of air conditions on the actual measurement, two-parameter spectra of the ^{55}Fe-radiation source were measured using mixture of methane and air samples instead of pure methane as counting gas. Figure 2 shows the three rise time spectra which were derived from two-parameter spectra measured using the pure methane and two mixtures with 5 and 10% in air concentration. The peaks are corresponding to X-rays emitted from ^{55}Fe and the other areas are from mainly background radiation which was rather broader.

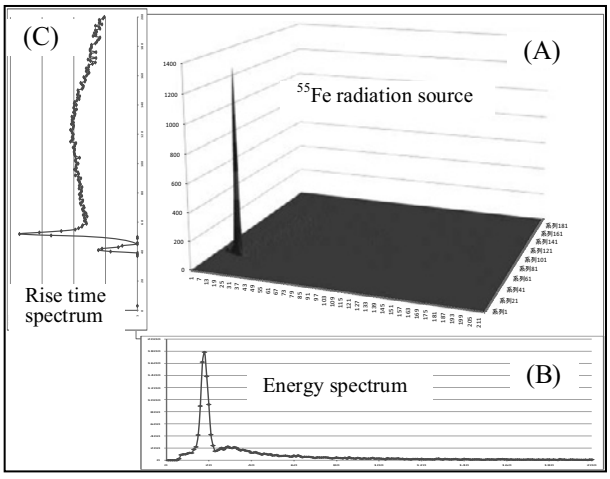

Fig.1 Two-parameter-spectrum of ^{55}Fe of a proportional counter filled with pure methane gas.

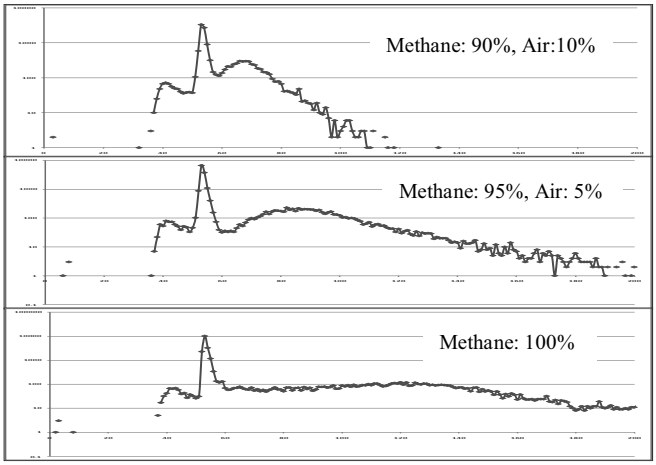

Fig.2 Effects of air condition on rise time spectrum.

Comparing three rise time spectra in Fig.2, it is found that the broader background area becomes narrower moving to the lower channel of the spectra as air concentration increases and gradually gets into under the peak of ^{55}Fe. This movement of background area might degrade signal-to-noise ratio in two-parameter spectra. The effect might not be small. In the end the presence of air will degrade the detection limit of the detector. From this results suitable ratio between air and methane seems to be roughly less than 10%. As nitrogen has low electron attachment coefficient in air, oxygen and/or moisture might cause this shift. For clearing the mechanism of the movement, future studies are necessary.