§5. Effectiveness of Decompression Procedure for Reducing Adverse Influence of Air on Energy Spectra Measured by Proportional Gas Counter

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In an actual monitoring system containing a proportional gas counter (PG), a quantity of sample air is mixed with counting gas followed by counting of the mixed gas. However, air contains oxygen with a high electron attachment coefficient and removes electrons from electron-ion pairs generated through ionization by the radiation in the counting gas. This electron trapping depletes the number of electrons, which reduces radiation counts. In the present study, a decompression procedure method was proposed to reduce the influence of air and its effectiveness was investigated.

When applying the decompression method, the pressure of counting gas inside the PG counter is reduced below one atmospheric pressure (atm) before the radiation count is obtained. To determine the effect of decompression, energy spectra were measured simultaneously under 1 and 0.5 atm using methane-air mixtures in addition to pure methane as the counting gas.

For these measurements, a cylindrical proportional gas counter with a length of 400 mm and an inside diameter of 60 mm was manufactured out of stainless steel pipe. A gold-coated tungsten wire 0.02 mm in diameter was stretched along the centerline of the counter. The active volume of the PG counter was approximately 1000 cm^3. An unsealed ^{55}Fe radiation source was used to simulate beta rays emitted from tritium and mixtures of methane and air (5.0, 10, and 15%) were prepared as counting gas containing air. For these measurements, the voltage applied to the PG counter was fixed at 2300 V. Results are shown in Figs. 1(A) and (B).

Figure 1(A) shows four energy spectra obtained at a pressure of 1 atm. Only the spectrum obtained using 0% air contained one complete peak, and the other three peaks were indistinct because they moved to the zero channel side and their peak height decreased in proportion to the amount of added air. Thus, peaks produced in energy spectra shrank significantly due to the presence of air in the counting gas when compared to spectra produced with no air.

By contrast, definite peaks occurred in the spectra for all four counting gases, as shown in Fig. 1(B). The width of the peaks narrowed upon shifting to the lower energy channel side as the proportion of air increased, and peaks were well formed even when 15% air was allowed in the counting gas under 0.5 atm..

To quantitatively evaluate the effectiveness of the decompression procedure for reducing the adverse influence of air, peak areas were evaluated for the energy spectra in Figs. 1(A) and (B). Results, shown in Fig. 2, indicate that peak areas in energy spectra measured at 1 atm decreased dramatically as percentage of air increased. The peak areas obtained at 5, 10, and 15% air were less than 3% of the peak areas in the spectrum produced with no air in the counting gas (pure methane). However, in spectra obtained at 0.5 atm, peak areas were not affected by the amount of air in the counting gas. In these spectra, peak areas for 5, 10, and 15% air were 94% larger than those in the spectrum obtained with no air in the counting gas.

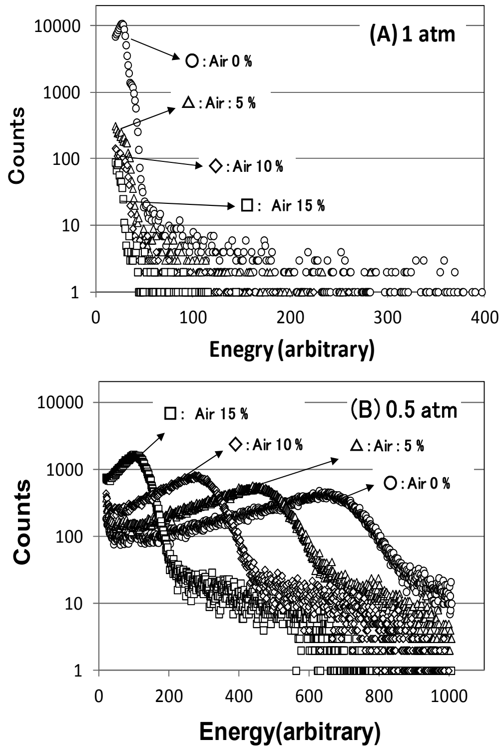

Fig. 1. Reduction in the effect of air on energy spectra by lowering counting gas pressure with an applied fixed voltage of 2300 V to a proportional gas counter at (A) 1 atm and (B) 0.5 atm.

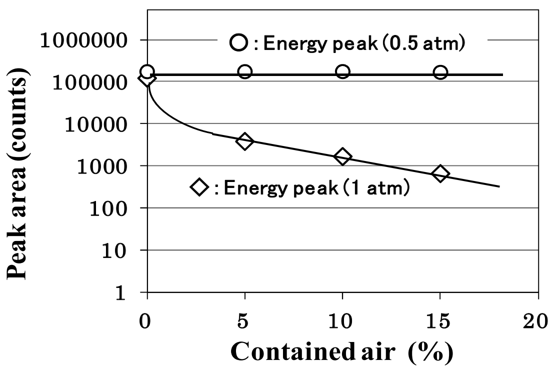

Fig. 2. Dependence of peak area on amount of air contained in counting gas in both energy and rise-time spectra.

These results demonstrate that air in the counting gas influences the energy spectra, but that the decompression procedure appears to effectively eliminate or reduce the adverse influence of air on peaks in energy spectra. This new method enables measurement of tritium concentration while eliminating the influence of up to 15% air in the counting gas.