§2. High-Sensitivity Tritium Gas Monitoring System Using Two-Parameters Pulse Height Analyzer

Kawano, T., Tanaka, M.,
Isozumi, Y., Tosaki, M. (RRC, Kyoto Univ.),
Sugiyama, T. (Nagoya Univ.)

The exhaust gas at radiation facilities is regularly monitored for the purpose of certifying that the concentrations of radioisotopes in the exhaust gas do not exceed their legal limits. Thus, the monitor employed for this purpose must have sufficient sensitivity to be able to detect the concentration limits of the radioisotopes that are handled at the facilities. The legal concentration limits depend both on the kind of radionuclide and on its chemical form. For example, in the case of tritium, the legal concentration limit according to Japanese law for tritiated hydrogen is 70 Bq/cm^3, while that for tritiated water vapor is 5×10^{-3} Bq/cm^3. This legal concentration limit for tritiated water vapor is very low compared with the tritium sensitivity of a conventional gas monitor. For this reason, several monitors dedicated to monitoring tritium are being developed at various laboratories.

The tritium gas monitoring system developed at our laboratory is shown in Fig.1, employing ingenious techniques including a two-parameter-pulse height analyzer, in which two parameters are a pulse height and a rise time of signal arose from radiation detection. The tritium gas monitoring system developed was composed of five parts: (1) Tritium detector (PCTD-1), (2) Nuclear radiation analyzer for proportional counter (PCTA-1), (3)Two-parameters pulse height analyzer (PHAS2-1), (4) Control data analyzer (SDA-1), (5) Two-channel oscilloscope, which is schematically shown in Fig.1. The tritium detector (PCTD-1) is a cylinder shaped proportional counter that was manufactured of stainless steel with 400 mm in length and 60 mm in inside diameter. An active volume is 1 liter. A gold-coated tungsten wire with 0.02 mm in diameter is stretched along the centerline of the cylinder of the detector. Pure methane is used as counting gas. The nuclear radiation analyzer for proportional counter (PCTA-1) contains circuits including a Pre-amp unit and HV power supply. The HV supply can apply necessary high voltage (up to 3000V) to the tritium detector. The Pre-amp receives pulses generated by the detector and sends them to the two parameters pulse height analyzer through the Gain & Amp unit. The two parameters pulse height analyzer consists of a PIC (Peripheral Interface Controller) control unit, a Signal processor and a Universal DC battery. The pulse sent from the nuclear radiation analyzer examines their height and rise time. The pulse height reflects the energy of radiation detected by the detector. The rise time reflects a rising speed of the pulse. A pair of the pulse height and the rise time is created for respective pulses and sent to Control data analyzer. In the case of tritium beta-rays, the pulse height is very law, because the energy of tritium beta-ray is 18keV at Max. And the rise time of pulse due to tritium beta-rays is very fast compared to other types of radiation because the low-energy beta-rays ionize a small amount of counting gas that occupies a narrow space. The ionized electrons are quickly collected by the center anode wire of the detector, causing a fast raising pulse. The developed high-sensitivity tritium gas monitoring system employs the two-parameter pulse height analyzer for strictly separating the signal caused by tritium beta ray from all other ones. The prototype system has been constructed, and detail examination will be performed next year.

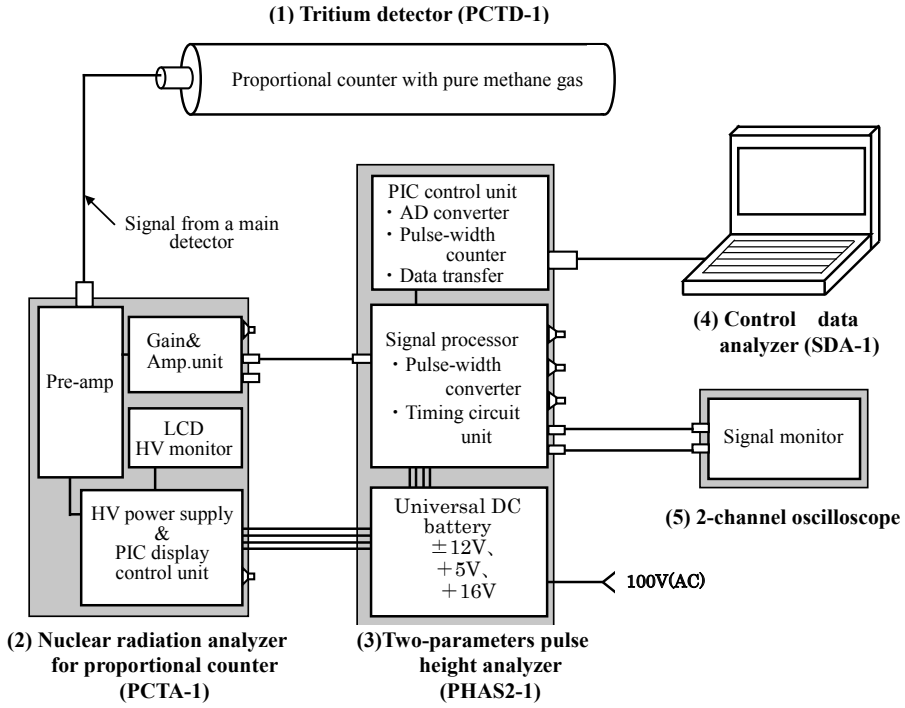

Fig.1. High-sensitivity tritium gas monitor using two-parameters pulse height analyzer