Geological Exploration

Detector Applications Information Note

Scintillation detectors have proven to be valuable tools in geological exploration - the search for oil, gas and mineral deposits. Applications using radiation detectors include wireline logging (borehole monitoring), Measurement While Drilling (MWD) multiphase flow metering and aerial surveys. NaI(Tl), CsI(Na) and BGO are the most common scintillation crystals used for these applications. Other available materials that may be appropriate in high temperature logging applications include YAP:Ce and glass scintillators.

NaI(Tl) has been the most popular scintillation crystal for geophysical applications because of its relatively high scintillation efficiency. BGO has gained acceptance for oil well logging because of its relatively high atomic number and density. These parameters result in increased stopping power and, at higher γ-ray energies, an increase in the photopeak-to-total ratio versus NaI(Tl) and CsI(Na). However, because of its reduced scintillation intensity at elevated temperatures, BGO is typically used in low-temperature wireline applications.

$LaBr_3$:Ce crystal has almost twice the light output of NaI(Tl), almost 75% of the density of BGO and loses less than 6% of its light output at +150°C.

Although scintillators can be packaged in aluminum and steel housings, our Titanium series of designs yields additional advantages for crystal size and light output. The package uses a titanium housing and a selected sapphire window assembly, the combination of which increases scintillation performance.

Wireline Logging

In wireline logging, the detector is lowered into the borehole, often accompanied by a radioactive source. The measurements made by the detector can indicate the formation's density, mineral composition, and the presence of hydrocarbons or water in the porespaces.

Wireline logging requires that the detector perform in environments that typically subject it to shock, vibration and elevated temperature. The scintillation crystal needs to be encapsulated in a package that withstands a temperature of 175°C, shock of 100g, and vibration of 5g rms, 50 to 500Hz. Detectors with NaI(Tl) and CsI(Na) crystals as large as 51 mm (2.0") in diameter and 30.5 cm (12") in length have been engineered to meet these requirements.

Measurement While Drilling (MWD)

The measurements for MWD are very similar to wireline but the environment in which the detector must operate is more demanding. The radiation detectors may be placed in drill collars directly above the drill bit, with measurements being made during the drilling operation.

Ruggedized detectors for MWD must withstand shock of 1000g and vibration of 20g rms, 50 to 2000Hz.

Multiphase Flow Metering

As liquids, hydrocarbons and water are being pumped from a well, a multiphase flow meter is used to measure the gas/liquid ratio in a sample stream. One method of determining this ratio is by using gamma radiation to measure the density of the flow. The measurement examines the gamma absorption in proportion to the density of the stream. When multiple gamma ray energies are used, the system can discriminate the associated fraction of gas, oil and water. Typically, multi-phase flow metering equipment manufacturers incorporate a sodium iodide detector in the densitometer assembly.

Aerial Survey

Aerial survey is a method used to locate uranium as well as oil deposits. Radiation detectors are carried on planes or helicopters to cover large areas in a relatively short time span. These radiation detectors are typically NaI(Tl) or CsI(Na) crystals, as large as
10 x 10 x 40 cm (4" x 4" x 16"). They are used primarily to detect the naturally occurring radioactive isotopes of potassium, uranium and thorium.

The detectors used in aerial survey are engineered to withstand the rigors of flight and provide good pulse height resolution and uniformity.

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