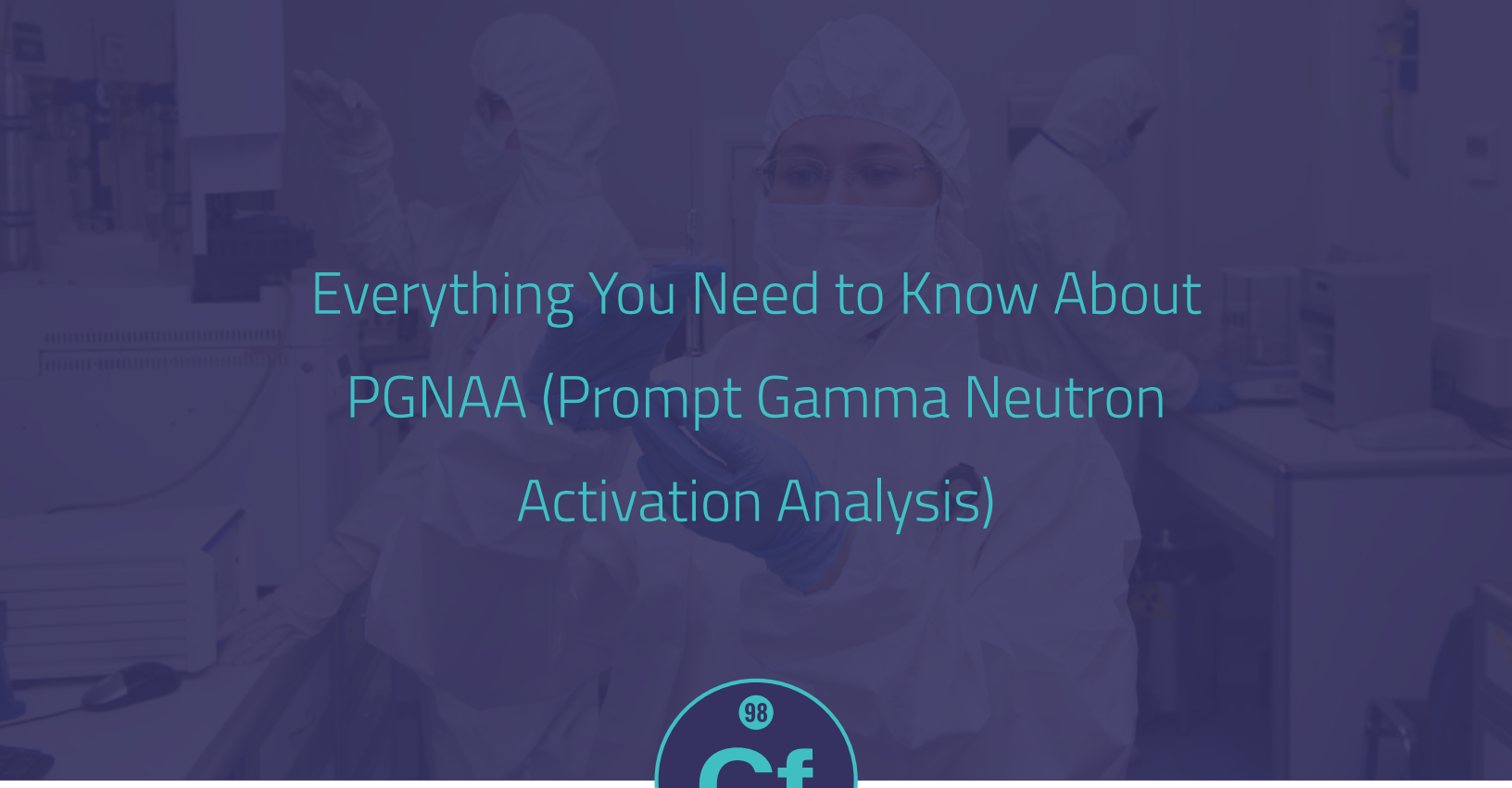
Everything You Need to Know About

PGNAA (Prompt Gamma Neutron Activation Analysis)

Frontier Technology Corporation
WORLD'S EXPERT IN NEUTRON SOURCES



Everything You Need to Know About PGNAA (Prompt Gamma Neutron Activation Analysis)

Prompt gamma neutron activation analysis (PGNAA) utilizes neutron sources—such as californium-252 (Cf-252)—to determine the elemental composition of material samples. It is an efficient and effective method of analyzing materials to guide critical decisions regarding extraction operations.

The following eBook provides a comprehensive overview of the PGNAA process, including what it is, how it works, what advantages it offers, how and where it is used, and the importance of Cf-252.

What Is PGNAA?

PGNAA is a non-contact and non-destructive analytical technique that irradiates a given material sample with a beam of neutrons to determine its elemental makeup. In the coal and cement industries, it is used to obtain information about the composition of material in real time as the coal or cement material moves along the conveyor belt.

How Does PGNAA Work?

PGNAA uses a strong neutron source (such as Cf-252) to generate a stream of neutrons to bombard the sample material with. This interaction between the neutrons and the sample produces unique prompt gamma rays that are then detected and measured using a high-resolution gamma ray spectrometer. The detector picks up both the energy signatures and intensities emitted by the sample as it stabilizes, allowing it to identify the exact elements and concentrations within the sample.

Each element reacts differently to neutron irradiation; elements with higher neutron interaction tendencies produce more gamma radiation than those with lower reactivity tendencies. Analysis can be affected by the size of the sample and the percentage of the elements present in the sample. In addition, since PGNAA is essentially a snapshot of the material during neutron bombardment, the element must produce gamma rays during the detection window.

What Are the Benefits of PGNAA?

As an analytical technique, PGNAA offers numerous benefits, including:

Greater Analytical Power

PGNAA allows operators to locate deposits of desirable materials by providing an elemental analysis of samples taken directly at the extraction site. In addition to determining the type and quantity of the elements present in the sample, it helps users identify the total moisture content and BTU of coal and cement materials. Compared to X-ray fluorescence (XRF), X-ray diffraction (XRD), and other spectral analysis techniques, it accommodates greater sample depths and surface areas. Overall, PGNAA serves as an excellent, reliable method of acquiring a comprehensive snapshot of a sample's composition.

Faster Results

Compared to other material analysis techniques – which can take up to 24 hours from sample extraction to receiving results – PGNAA provides results on a minute-by-minute basis. The ability to determine the composition of materials in real-time allows industry professionals to make timely decisions to improve blending and sorting operations.

Better Measurement and Analysis Reliability and Consistency

PGNAA offers a higher level of accuracy than other elemental analysis processes. However, samples can also be processed with both PGNAA and XRF to enhance analysis results further.

What Does a Typical PGNAA System Look Like?

PGNAA technology is commonly found in the form of bulk material analyzers—also referred to as belt analyzers, crossbelt analyzers, and elemental analyzers—used for analyzing raw materials on conveyor belts in coal and cement processing plants.

A typical system consists of a conveyor, a neutron source, a container for the source, and a control panel. The sample material is conveyed into the analyzer, where the neutron source bombards the sample with neutrons. The elements in the sample absorb the neutrons and emit secondary, prompt gamma rays as they stabilize. This energy is captured by a sodium-iodized crystal and analyzed using a spectrometer. Since each element produces a unique energy signature, the emissions can be analyzed to determine which elements are in the sample. The concentration of each element can be identified by analyzing the intensity of the gamma rays during their emission.

Where & How Is PGNAA Used?

PGNAA allows for reliable and consistent material analysis that can significantly improve processes. Some of the industries that benefit most from the use of PGNAA include:

Coal: PGNAA is an excellent analysis method for mined coal samples, determining their moisture, carbon, sulfur, BTU, and other compositional characteristics. This information allows producers to adjust production to ensure that acquired coal meets industry quality standards.

Cement: Cement producers use PGNAA to ensure that mixing and heating processes are appropriate for the raw material's elemental composition.

Mineral Mining & Production: Mineral and metal mining operations use PGNAA systems to analyze the composition of slurry during the mining process. The results allow miners to quickly determine the viability of a mining site, the quality of the material, and the processes necessary to facilitate optimal mineral extraction.

Military & Defense: PGNAA is used as a non-invasive, safe way to analyze the contents of containers, weapons, and other enclosed materials, allowing users to safetly determine whether they pose a threat.

Academic and Industry Research: Academic and industry labs use PGNAA to analyze materials to determine new uses and material combinations.

Medical: Recent studies have explored the potential for PGNAA systems for in-hospital elemental analysis of in vivo cells.

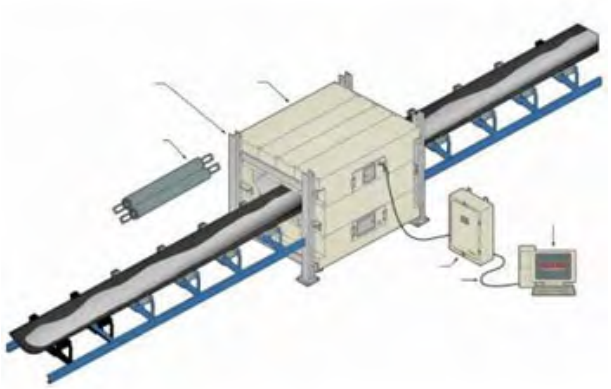
The Role of Californium-252 in PGNAA Systems

Californium-252 (Cf-252) is a powerful neutron source that is implemented in PGNAA systems. Some of its key properties include:

- **Silver-white and metallic color**
- **Melting point of approximately 900° C**
- **Half-life of 2.645 years**
- **Neutron emission rate of 170 million neutrons every minute (for one microgram)**

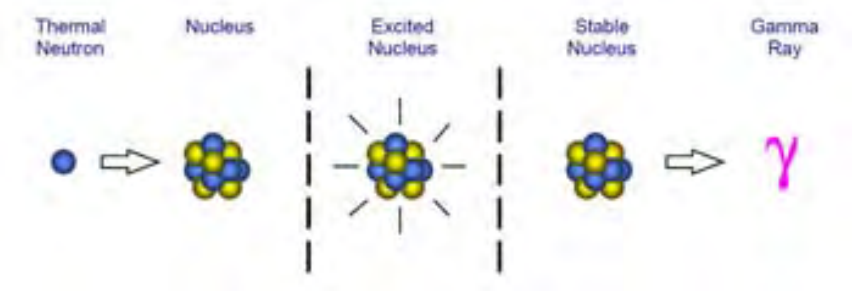
The element can only be created through synthetic production; it is made by bombarding curium feedstock. Once the element decays into Cf-250, it is further bombarded with neutrons to form Cf-252. Other elements used in the material's production include americium, curium, and plutonium.

PGNAA equipment relies on a dependable neutron source. While there are several options available, Cf-252 has been hailed as a superior solution. In a 2011 study published by the Journal of Radioanalytical and Nuclear Chemistry, it was one of four sources used in PGNAA systems for in vivo detection of boron. The Cf-252 based PGNAA system had peak performance—especially regarding reliability and stability—compared with the other systems. For these reasons, among others, Cf-252 is the most commonly used neutron source in PGNAA operations.



Californium-252 and PGNAA Solutions at Frontier Technology Corporation

Frontier Technology Corporation has been a leading global provider of californium-252 sources for over 30 years. Our extensive experience with PGNAA systems and neutron sources is an invaluable resource for customers across a diverse set of industries. We guarantee safe and efficient transport of all source materials using certified Type-A shipping containers. In addition, we provide spent neutron source return and disposal services at no additional cost.



Here are some additional resources that may be helpful:

Explore Our Portfolio

FTC Resources Library

Blog Library

To learn more about PGNAA or our products and services, contact us or request a quote today.

About Us

Frontier Technology Corporation (FTC) is the world leader in Californium-252 neutron source manufacturing and design, and is the foremost expert in logistics and shipping of radioactive material.

Founded in 1984 by Treva Janzow and the late Edward Janzow, Frontier Technology is located in Xenia, Ohio. Frontier Technology has over 40 years of industry experience in providing the highest-quality neutron sources, PINS sources, nuclear start-up rods, TYPE-A shipping containers, WEP shielding, and antimony-beryllium pellets.

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