Neutron Activation Analysis to quantify Calcium element in Portland cement samples using the Argonauta Reactor

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This report presents a study to evaluate the elemental concentration of Portland cement using the Neutron Activation Analysis (NAA). The determination of the mass fraction concentration of elements that form cement are very useful to ensure the quality control of the construction industry. This work seeks to differentiate and quantify Portland cement type II (CPII) samples using the Instrumental Neutron Activation Analysis technique with the aid of the Argonauta research reactor. The focus was on obtaining Ca concentration in Portland cement from a famous brand marketed in Brazil, studying (n, γ) capture reactions. NAA consists of irradiating a sample, bombarding its nucleus with neutrons activating the sample [1]. The possibility of these nuclear reactions occurring depends on the characteristics of the target nucleus, the energy of the incident neutrons, isotopic abundance and the half-life of the radionuclide produced. The NAA technique presents sensitivity, selectivity and analytical capacity to determine chemical elements present even in the concentration of traces in a sample. These properties make NAA an extremely powerful analytical tool. The most common reaction in NAA is radioactive capture via reaction (n, γ). This configuration is illustrated in Figure 1 [2].

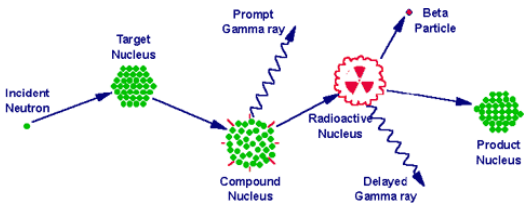

Figure 1. Schematic representation of Neutron Activation Analysis

The instrumental procedure of the neutron activation analysis was performed using the Argonauta research reactor. The samples were positioned in channel J9 of the reactor, because it is closer to the nucleus resulting in a more intense flux of neutrons. The positioning of the sample within the channel is shown on Figure 2.

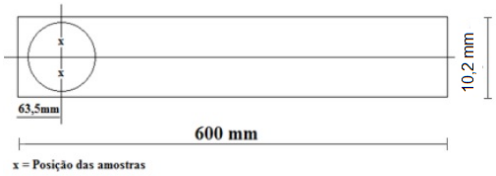

Figure 2. J9 channel interior segment

The most relevant element in Portland cement composition is the cement, as shown in Table 1 [3].

Table 1 - Chemical compounds of cement.

Compound of Cement (wt %)	
Al_2O_3: 3.772	MnO: 0.127
SiO_2: 14.317	Fe_2O_3: 4.320
SO_3: 3.923	ZnO: 0.052
K_2O: 0.626	SrO: 0.307
CaO: 72.160	TiO_2: 0.324

The results for the CP II gamma spectrometry is shown on Figure 3.

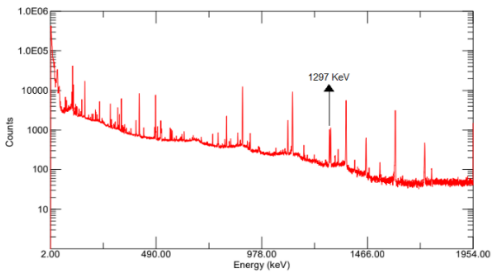

Figure 3. Gamma Spectrometry to quantify Ca in Portland cement

Since calcium is the major element in Portland cement. Portland cement is rich in tricalcium and dicalcium silicates, which allows to observe the peak for major ^{47}Ca (1297 keV). The percentage of calcium obtained in this brand was 34.87%. Which is within the acceptable range, for CPII cements sold in the country. In the near future, more elements will be quantified, as well as other types of cement.

References

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