



## INVESTIGATION BY GAMMA-RAY SPECTROMETRY AND INAA OF RADIOACTIVITY IMPACT ON PHOSPHATE FERTILIZER PLANT ENVIRONMENT

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The radioactive polluting effect of a phosphate fertilizer plant on the environment was investigated by gamma-ray spectrometry and neutron activation analysis (INAA). The hazards could arise from industrial plants using raw phosphate materials to prepare fertilizers for agricultural purposes due to the phosphate rock which depending on the type and geographical zone of provenance may contain rather large amounts of uranium. The fertilizer plant under study is situated about 4 km from the town of Turnu Magurele on the left bank of the Danube River in Romania. The main by products of the factory are nitrophosphate type fertilizers (NP, NPK), Ammonia, Nitric acid, Ammonium nitrate, Urea, Sulfuric acid, Phosphoric acid, Sodium fluorosilicate and Aluminum sulfate.

Gamma-ray spectrometry was used to determine activity concentrations of naturally occurring radionuclides ( $^{226}\text{Ra}$ ,  $^{235}\text{U}$ ,  $^{238}\text{U}$ ,  $^{232}\text{Th}$  and  $^{40}\text{K}$ ) as well as  $^{137}\text{Cs}$  man made radionuclide in surface soils collected from semicircular areas within radii of 0.5 and 15 km of the plant. In addition, different NPK type fertilizers and phosphate rocks were investigated. The samples (mass of about 100-g each) were kept tightly closed for one month to permit  $^{226}\text{Ra}$  to establish radioactive equilibrium with its decay products. This method makes it possible to assess U, Th and K contents in samples by measuring  $^{238}\text{U}$  and  $^{232}\text{Th}$  (in equilibrium with their radioactive daughters) and  $^{40}\text{K}$  radioactivity. Taken into account that 1g of U, Th and K yield 12358 Bq  $^{238}\text{U}$ , 569 Bq  $^{235}\text{U}$ , 4057.2 Bq  $^{232}\text{Th}$  and 33.11 Bq  $^{40}\text{K}$  respectively.

The spectrometrical chain was based on a HPGe (EG&G Ortec) detector of 30 % relative efficiency and 2.1 keV resolution at 1332 keV of  $^{60}\text{Co}$ .

INAA technique (neutron irradiation at TRIGA reactor of SCN Pitesti) was used to determine macro, micro and trace elements in samples collected from both technological shops of the factory (air dust and drinking tap water) and its surroundings (surface soil, tree leaves and crop vegetation). The main concentration results obtained for U, Th and K in the examined samples are discussed. In the case of soil and phosphate rock, their values were found to be in agreement with those determined by gamma ray spectrometry. An assessment of the radioactivity impact on phosphate fertilizer plant environment was performed by a comparison with control samples, literature data and norms for environmental radioactivity.

**Keywords:** Gamma radioactivity, neutron activation analysis, fertilizer plant, environmental samples

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