Contribution ID: **20** Type: **ORAL**

Uranium Extraction Technology in the Philippines: The Next Step

Monday 25 June 2018 15:20 (20 minutes)

The phosphate fertilizer industry is one of the key player in sustaining and the continuing development of the vastly agricultural Philippine economy. Since 2002, phosphate-based fertilizers have become one of the most important and consumed fertilizer next to nitrogen-based fertilizers [1]. About 60% of produced and imported fertilizers are consumed by major and staple food crops such as rice (38%) and corn (21%), fruits and vegetables (19%), sugar accounts (7%) and other crops (15%) (Mojica-Sevilla, cited in [1]). Currently, domestic fertilizer production is being sourced from five fertilizer companies. The Philippine Phosphate Fertilizer Corporation (PHILPHOS), located at the Leyte Industrial Development Estate, Isabel, Leyte, is the biggest and the leading fertilizer production company in the country, which has been in operation for the past 28 years.

Phosphate rocks are potential sources of uranium (66 –145 ppm), thorium (1 –20 ppm), rare earth elements (108 - 1,085 ppm), and almost all elements in the periodic table [2]. Annually, more than 1.97M Mt of imported phosphate rocks are being used as raw materials and are being processed producing 1.17M Mt of diammonium phosphate (DAP) fertilizers at PHILPHOS. During the digestion of phosphate rocks with sulfuric acid, most of the uranium and other trace elements are being transferred into the phosphoric acid and ultimately producing uranium contaminated fertilizers. Around 44.97 Mt of uranium per year are lost into agricultural fields upon fertilizer application putting human and environmental safety at high risk [3].

The Philippine Nuclear Research Institute (PNRI) has pioneered the Uranium Extraction from Wet Phosphoric Acid (UxP) Technology in the country to recover uranium and critical elements from phosphate processing, thus, translating these problems into opportunities.

URANIUM RECOVERY BY DEHPA-TOPO METHOD

In 1987, the PNRI initiated the uranium recovery from phosphoric acid utilizing the liquid-liquid extraction method using the synergistic mixture of di-2-ethylhexyl phosphoric acid and trioctyl phosphine oxide (D2EHPA - TOPO). Although this method is already established and widely used, it has to be optimized to suit the Philippine phosphoric acid, which is a mixture of different phosphate rocks imported from several countries such as Israel, Egypt, Morocco, Jordan, etc. The team conducted only up to the first cycle solvent extraction and first cycle acid stripping, which had recovery ranging from 64% to 75% [4]. However, this initiative was discontinued due to downtrend of nuclear energy and there was a slump in the global price of uranium.

Sometime in 2011, there was renewed interest to continue the UxP Project through the IAEA Technical Cooperation Project PHI/2/010 entitled "Enhancing National Capacity for Extraction of Uranium and other Valuable Elements from Phosphoric Acid". The project was locally funded by the National Research Council of the Philippines (NRCP) through the project entitled "Comprehensive Extraction Of Uranium, REE and Other Valuable Resources From Wet Phosphoric Acid". This time around, the PNRI has successfully developed and built its capacity to conduct static laboratory-scale extraction of uranium through trainings, fellowships and expert missions and the upgrade in laboratory infrastructure, which included the procurement of Wavelength Dispersive X-Ray Fluorescence Spectrometer (WDXRF), Fluorometer and portable gamma-ray spectrometer. The process parameters on uranium recovery by D2EHPA-TOPO method from pretreatment of raw phosphoric acid (absorbent materials, optical density, mixing time, and mixing intensity), to extraction (optical density, Organic/Aqueous ratio, P2O5 concentration, and contact time), to stripping (Aqueous/Organic ratio,

amount of Fe, temperature) and to precipitation of uranium yellowcake were optimized during the three-year implementation of the project. The project ended on 2017 and demonstrated a feasible UxP technology in a laboratory-scale setup.

THE NEXT STEP

The UxP research and development undertakings, which started from basic research, will enhance indigenous capabilities and competence to execute the goal of building the first industrial scale UxP facility in the country. As a next step in this endeavor, a newly approved IAEA TC Project PHI/2/013 entitled "Enhancing Bench-scale Simulation for the Development of Continuous Extraction Technology of Uranium and Other Valuable Elements from Phosphates - Phase II"will be implemented for three years, 2018 –2020, in cooperation with PHILPHOS. The project will develop the comprehensive and environmentally acceptable continuous uranium extraction process, which specifically aims to: (1) perform a scaled-up test, from static laboratory-scale into continuous recovery, for the extraction of uranium; (2) provide engineering design parameters for pilot-plant or commercial scale operations; and (3) determine waste minimization technologies. A bench-scale continuous laboratory-scale extraction system will be installed to validate the results from Phase I project and to obtain a more reliable and realistic process parameters that would better simulate conditions in an industrial/commercial setup. Financial assistance from local funding institution, Philippine Council for Industry Energy and Emerging Technology Research and Development (PCIEERD), through the project "Laboratory/micro-scale Continuous Extraction System for the Recovery of Uranium from Philippine Wet Phosphoric Acid: Phase I"is already in the pipeline. This will sustain other requirements of the project.

With the deep dedication of the PNRI Team to develop a comprehensive extraction technology from phosphate resources, a Phosphogypsum Research entitled "Extraction of Radionuclides, Rare Earths and Other Valuable Industrial Elements from Philippine Phosphogypsum Tailings: Phase I"is conceived as a spin off project. The long-term goal of the project is to demonstrate and execute a technology of the recovery of radionuclides, rare earths and other valuable industrial elements in phosphogypsum resources from phosphate fertilizer plants. This project is also in the pipeline and will be financially supported by PCIEERD, as well.

The growing capacity in this area in PNRI will have long-term impact in terms of a more sustainable and environmentally friendly methods of mining and extraction in the country. Uranium recovery from phosphates is a prime example of this safe and balanced sustainable management and use of natural resources promoting sustainable socio-economic and environmental development to address the country's needs in regard to food, energy and water security. This will lead to (1) minimal environmental impacts and protection of human health by producing cleaner fertilizers with greatly reduced uranium content; (2) zero waste and maximized resource utilization; (3) additional revenue in the phosphate processing industry; and (4) an opportunity to utilize uranium in the nuclear fuel cycle if the Philippines decides on the nuclear option.

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Country or International Organization

The Philippines

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Session Classification: Uranium from Unconventional Resources

Track Classification: Track 8. Uranium from unconventional resources