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EDITORIAL

Dear reader,

It is a great pleasure to provide you with the second issue of Atom Indonesia in 2022, namely Vol. 48 No. 2 (2022). The Atom Indonesia Vol. 48 No. 2 (2022) contains ten articles discussing various aspects and applications of nuclear science and technology. The contributors of those articles are not only from various national institutions and universities but also from international institutions.

"Neutronic Evaluation of Using a Thorium Sulfate Solution in an Aqueous Homogeneous Reactor" was written by D. Pérez from Departamento de Energia Nuclear, Universidade Federal de Pernambuco (UFPE), Cidade Universitária, Recife, Brasil under collaboration with D. Milian from Departamento de Energía Renovable y Eficiencia Energética, Cubaenergía, Habana, Cuba; L. Hernández and D. Lorenzo from Instituto Superior de Tecnologías y Ciencias Aplicadas (InSTEC), Universidad de La Habana, Avenida Salvador Allende y Luaces, Quinta de Los Molinos, La Habana, Cuba; A. Gámez and C. Brayner from Centro Regional de Ciências Nucleares (CRCN-NE/CNEN), Cidade Universitária Recife, PE, Brasil. Radioisotope ^{99}Mo is one of the most essential radioisotopes in nuclear medicine. Its production in an Aqueous Homogeneous Reactor (AHR) could be potentially advantageous compared to the traditional technology, based on target irradiation in a heterogeneous reactor. An AHR conceptual design using low-enriched uranium for the production of ^{99}Mo has been studied in depth. So far, the possibility of replacing uranium with a non-uranium fuel, specifically a mixture of ^{232}Th and ^{233}U, has not been evaluated in the conceptual design. Therefore, the studies conducted in this article aim to evaluate the neutronic behavior of the AHR conceptual design using thorium sulfate solution. Here, the ^{232}Th-^{233}U composition to guarantee ten years of operation without refueling, conversion ratio, medical isotopes production levels, and reactor kinetic parameters were evaluated, using the computational code MCNP6. It was obtained that 14 % 233U enrichment guarantees the reactor operation for ten years without refueling. The conversion ratio was calculated at 0.14. The calculated ^{99}Mo production in the AHR conceptual design resulted in 24.4 % higher with uranium fuel than with thorium fuel.

"Patient Radiation Doses in Interventional Cardiology Procedure" was explored by E. Hiswara, D. Kartikasari, N. Nuraeni, H. Sofyan, and K. Y. P. Sandy from Center for Technology of Radiation Metrology and Safety, National Nuclear Energy Agency (BATAN). Interventional cardiology is a minimally-invasive imaging procedure that allows medical doctor to evaluate and treat structural heart diseases. Due to its main advantages of avoidance of the scars and pain, as well as long post-operative recovery, interventional cardiology procedures have rapidly been growing. However, the increasingly complex and time-consuming procedures in interventional cardiology may increase the radiation exposure received by patients. This paper describes a study to measure patient radiation doses in terms of air kerma and kerma air-product (KAP) for various types of interventional cardiology procedures conducted in Indonesia. The measurements were performed at the interventional cardiology or cardiac catheterization facilities in sixteen hospitals in ten cities in Indonesia during the years of 2015 to 2019. A total of 147 procedures conducted on adult patients were used in this study. The type of procedure, total KAP, and air kerma were recorded after each procedure was completed. The demographic data of the patients were also recorded. The results showed that the mean air kerma and KAP measured for CA (coronary angiography) procedure were 680.73±57.85 mGy and 12.52±5.86 Gy cm^2, respectively, while the values for PCI (percutaneous coronary intervention) procedure were 890.66±38.76 mGy and 20.18±9.37 Gy cm^2, respectively. These results are well within the ranges reported by other previous studies. The results are somewhat affected by the body mass index of patients, while the fatal cancer risks among patients of CA and PCI procedures are comparable with those among interventional radiology procedures patients.

"Elemental Mapping for Characterizing of Thorium and Rare Earth Elements (REE) Bearing Minerals Using μXRF" was written by I. G. Sukadana, I. W. Warmada and A. Harijoko from Department of Geological Engineering, Faculty of Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia under collaboration with F. Pratiwi and T. B. Adimedha from Research Center for Nuclear Minerals Technology, National Research and Innovation Agency (BRIN), Lebak Bulus Raya, Pasar Jumat, Jakarta Selatan, Indonesia, and A. W. Yogatama from PT. Timah, Tbk., Pangkal Pinang, Bangka Belitung Archipelago 33121, Indonesia. Thorium (Th) anomaly was found in Adang Volcanic Complexes, Mamuju Area, West Sulawesi. This element is associated with high-value elements, the rare earth elements (REE). The minerals containing Th and REE were found in veins mineralization with various types of minerals which are very difficult to identify by conventional method. This research aims to understand the distribution and characterization of Th and REE in individual minerals, using Micro X-Ray Fluorescence (μXRF) analysis and completed by Advanced Minerals Identification and Characterization System (AMICS) software. The samples were collected from vein mineralization in Hulu Mamuju Sector. The contents of Th and REE that were analyzed using X-Ray Fluorescence (XRF) completed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) are 11,550-74,480 ppm and 6,244.15-48,036.87 ppm, respectively. The minerals that contain Th and REE are britholite ($(Ce,Ca)_5(SiO_4)_3OH$), aeschynite $(Ce,Ca,Fe,Th)(Ti,Nb)_2(O,OH)_6$, cerite $(Ce,Ca)_9(Mg,Fe)(SiO_4)_3(HSiO_4)_4(OH)_3$, monazite ($REE,Th(PO_4)$), thorite ($Th(SiO_4)$), andthorutite $(Th,U,Ca)Ti_2(O,OH)_6$ associated with other minerals such as pyrite, actinolite, apatite, ilmenite, hematite, zircon and ankerite. Some minerals are uncommon minerals and are only characterized by detailed elemental mapping. The variety of minerals shows the condition of mineralization influenced by carbonatite magma and the hydrothermal process of mineralization.

"Effect of Starch and Chitosan Addition on Swelling Properties of Neutralized Poly(Acrylic Acid)-Based Superabsorbent Hydrogels Prepared by Using γ-Irradiation Technique" was written by D. R. Barleany, H. Heriyanto, H. Alwan, V. Kurniawati, and A. Muyassaroh from Department of Chemical Engineering, Faculty of Engineering, University of Sultan Ageng Tirtayasa, Cilegon, Indonesia under collaboration with Erizal from Center for Isotopes and Radiation Application, National Nuclear Energy Agency (BATAN), Lebak Bulus Raya, Jakarta, Indonesia. Superabsorbent hydrogels are polymers with a 3D network that have attracted the attention of scientists and industrialists because of their fantastic ability to absorb and retain water and aqueous solutions. The most widely used and commercially available superabsorbent hydrogels are synthetic K-acrylate materials. In this novel study, superabsorbent hydrogels have been developed using natural ingredients to have more biodegradable properties. Superabsorbent hydrogels were synthesized from acrylic acid, cassava starch, and chitosan using the γ-irradiation method under different experimental conditions. The γ-irradiation technique was chosen to produce hydrogels free of residues that may remain when chemical crosslinkers are used. The effects of irradiation dose, acrylic acid composition, and the amount of cassava starch and chitosan on the characteristics of produced hydrogels were analyzed. The resulting polymers were further characterized by fourier transform infrared spectroscopy (FTIR) and scanning electron microscope (SEM) to evaluate the structure. The thermal behavior of superabsorbent products at different neutralization doses was tested with differential scanning calorimetry (DSC). FTIR data indicated that the grafting reaction was successfully implemented in this work. SEM analysis showed that the hydrogel produced from this study was porous and there was a reduction in pore size with the addition of starch and chitosan. It can be concluded that the addition of cassava starch and chitosan affects the acrylic acid-based superabsorbent properties, which are pore size, thermal behavior, gel content, antibacterial activity, and swelling capacity in water, salt, and urea solutions. The best hydrogel was obtained by adding 0.25 g of cassava starch and 0.25 g of chitosan, using 50 % acrylic acid neutralization and 5 kGy γ-irradiation doses. The graft polymers possess the maximum swelling capacity of 670 g/g for distilled water, 520 g/g for NaCl solution, and 767 g/g for urea solution (relative to the dry weight). These products were sterile from *Escherichia coli* bacteria and had the potential to be applied as superabsorbent resins for various fields.

"Identification, Selection, and Response of Radiation Induced Towuti Mutant Rice (*Oryza Sativa* L.) in Drought Stress Conditions" was explored by H. Dama from Plant Breeding and Biotechnology Study Program, IPB University Graduate School, Kampus IPB Darmaga, Bogor, Indonesia under collaboration

with S. I. Aisyah and Sudarsono from Department of Agronomy and Horticulture IPB University, Kampus IPB Darmaga, Bogor 16680, Indonesia, A. K. Dewi from Research Organisation of Nuclear Technology, National Research and Innovation Agency (BRIN), Lebak Bulus Raya, Jakarta, Indonesia and K. Wibisono from Research Center for Food Crops, Research Organization for Agriculture and Food, National Research and Innovation Agency (BRIN), Cibinong Science Center, Cibinong, Bogor, West Java, Indonesia. Climate change with the impact of drought stress has become a major environmental problem for rice (*Oryza sativa* L.). The use of gamma ray radiation at a dose of 300 Gy is one way to develop drought tolerant rice varieties with little change to the characteristics of the Towuti variety. However, research is still needed to determine its resistance to drought stress. This study aims to identify characters for selection, genotype selection, and determine the response of Towuti mutant rice to drought stress conditions. The characters that can be used to select rice genotypes under drought stress conditions are plant height, number of leaves, number of tillers, and SPAD chlorophyll value. The Towuti mutant has the best tolerance to drought stress compared to other genotypes. Tolerance to drought stress in the Towuti mutant is not caused by the stay-green gene.

"Structure and Decay Properties of Th Isotopes Using E-RMFT Formalism" was written by M. Das, K. C. Naik, N. Biswal and R. N. Panda from Department of Physics, Siksha 'O' Anusandhan Deemed to be University, Bhubaneswar, India. In the present scenario, the search for the thermally fissile nuclei is crucial and also important not only for the research background of nuclear physics but also for the great social and economic impact on the country. Many theoretical works have been performed to analyze a series of Th and U-isotopes and found that some of these isotopes are stable against α-decays and spontaneous fission. Here, we have chosen the isotopic chain of Th-nuclei for the present analysis using relativistic mean-field formalism. The work also explores a few stable isotopes in this region of the nuclear landscape, which is crucial for understanding the exotic region of the nuclear landscape. The objective of this work is to study the bulk properties such as binding energies, root mean square charge radii, neutron-proton radii, neutron skin-thickness as well as intrinsic properties such as excitation energy and specific heat for the $^{216\text{-}238}$Th-isotopic chain. Furthermore, the stability of these isotopes is investigated through their possible decay chain analysis. The relativistic mean-field theory was used to obtain the nuclear bulk properties, namely, binding energies, root-mean-square charge radii, neutron skin-thickness, and excitation energy. The steady solution of the temperature-dependent effective relativistic mean-field equations was obtained self-consistently by taking different inputs of the initial deformations. All the calculations were done for NL3, FSUGarnet and IOPB-I parameter sets for $^{216\text{-}238}$Th-isotopes. The decay energy of α (Q_α) and β-decay (Q_β) were calculated from the binding energies and were further used to obtain the corresponding half-lives. We have analyzed the structural and decay properties of $^{216\text{-}238}$Th isotopes. The excitation energy and specific heat are also estimated for these considered nuclei by using the temperature-dependent effective relativistic mean-field (E-RMFT) formalism for NL3, FSUGarnet and IOPB-I parameters sets. The calculated results are compared with the available experimental data and found similar observations for all the parameter sets at a given temperature. The excitation energy study signifies the shell melting point where maybe the shape transition occurs. Three phenomenological formulae such as Viola-Seaborg, Royer and modified universal decay law are adopted for the calculation of α-decay half-lives. We found lower values of α-decay half-lives indicating a higher rate of β-decay for the isotopic chain.

"Potentials of Alginates as Capping Agent for Oral Colon Delivery of Radiosynthesized Silver Nanoparticles: A Review" was explored by D. P. Perkasa from Doctoral Program in Biomedical Science, Faculty of Medicine, Universitas Indonesia, Salemba Raya, Jakarta, Indonesia and Research Center for Radiation Process Technology, Research Organization for Nuclear Energy, National Research and Innovation Agency, Lebak Bulus Raya, Jakarta, Indonesia under collaboration with W. Arozal from Department of Pharmacology and Therapeutics, Faculty of Medicine, Universitas Indonesia, Salemba Raya, Jakarta, Indonesia and Suhaeri from Unit of Education, Research, and Training, Universitas Indonesia Hospital, Universitas Indonesia, Depok, West Java, Indonesia. Radiosynthesized silver nanoparticles (AgNPs) offer benefits for treatment of chronic colon inflammation due to their anti-inflammatory activity. Targeted delivery of AgNPs to the colon allows topical treatment at high concentration but at reduced systemic side effects. Meanwhile, related to drug administration, oral route is a common method.

However, the physiology of the gastrointestinal (GI) tract limits the AgNPs ability to achieve their therapeutic level. This is specifically related to the acidic environment of the stomach and mucus layer of the GI tract. Concurently, alginates are one of the most extensively explored biomaterial classes for drug delivery system due to its biocompatibility, gel-forming ability at mild condition, anionic nature, sensitivity, and mucoadhesiveness. In this review we provide an overview of appropriate features of alginates as capping agent for oral delivery of radiosynthesized AgNPs to the colon. As capping agents, alginates play multiple roles specific to its processing stages, i.e., radiosynthesis, stabilization of nanoparticle system, and oral colon delivery devices of AgNPs. Additionally, we describe outstanding features of alginates as capping agents for drug delivery device as well as the positive contributions of radiation processing on improving the functional effects of alginate.

"Assessment of Radiological Hazards in Soil, Water and Plants Around Coal Power Plant" was written by S. Murniasih, D. S. Prabasiwi and Sukirno from Center for Accelerator Science and Technology, Babarsari, Yogyakarta, Indonesia. The existence of a Coal-Fired Power Plant (CFPP) is suspected to affect the environment quality, especially the increment of natural radionuclides content which is found in coal as raw material.Therefore, systematic analysis of natural radionuclides (^{210}Pb, ^{234}Th, ^{238}U, ^{228}RA, ^{40}K, ^{226}RA and ^{232}Th) in water, soil, and plantwere conducted to establish a database of environmental contamination in the area around a CFPP. This research was conducted in the area around Adipala Cilacap CFPP which operates with two towers. Samples were taken from three locations around the Adipala CFPP based on the secondary wind direction data from Indonesian Agency for Meteorological, Climatological, and Geophysics in the 2018 dry season. Samples were prepared in the Radiochemistry Laboratory, Center for Accelerator Science and Technology, BATAN. The concentration of radioactivity in environmental samples were analyzed using gamma spectrometry with a high purity germanium detector for 24hours after reaching its secular equilibrium. The result of samples analysesshown that the mean value of the radionuclides specific activities (^{210}Pb, ^{234}Th, ^{238}U, ^{228}RA, ^{40}K, ^{226}RA and ^{232}Th) for water, cassava leaves, grass, and soil were 0.789 Bq/L, 14.685 Bg/kg, 15.036 Bq/Kg, and 75.083 Bq/kg, respectively. The mean of radium equivalent activity (Ra_{eq})for water, cassava leaves, grass, and soil were 1.692, 30.792, 18.699 and 137.513 Bq/kg, respectively. The absorbed dose rate (ADR) for water, cassava leaves, grass, and soil were0.775, 14.332, 8.627, and 64.135 nGy/h, respectively, whilst the annual effective dose rate (AEDR) were 0.004, 0.070, 0.042, and 0.315 mSv/y. The mean of external and internal hazard indices (H_{ex} and H_{in}) for water, cassava leaves, grass, and soil were 0.005 and 0.006, 0.083 and 0.129, 0.050 and 0.078, and 0.371 and 0.554, respectively, while the mean of excess lifetime cancer risk (ELCR) wre 0.014×10^{-6}, 0.246×10^{-6}, 0.148×10^{-6}, and 1.101×10^{-6}. According to the calculation of radiation hazard index in this research, it was understood that all parameters of all samples were within acceptable limits by the world average value reported by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

"Investigation of Electron Contamination on Flattened and Unflattened Varian Clinac iX 6X and 15X Photon Beam Based on Monte Carlo Simulation" was explored by F. Haryanto from Department of Physics, Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Bandung, West Java, Indonesia under collaboration with M. F. Rhani from Department of Radiology, Tan Tock Seng Hospital (TTSH), Singapore, C. Anam from Department of Physics, Faculty of Sciences and Mathematics, Diponegoro University, Semarang, Indonesia and S. Yani from Department of Physics, Faculty of Mathematics and Natural Sciences, IPB University (Bogor Agricultural University), IPB Dramaga, Bogor, Indonesia. The aim of this study was to characterize electron contamination of a flattened (FF) and an unflattened (FFF) Varian Clinac iX 6X and 15X photon beams using Monte Carlo (MC) simulation. EGSnrc MC technique was used to model the flattened and unflattened head and simulate dose distribution of 6X and 15X of FF and FFF photon beam in water phantom. The materials and geometrical data of FF linac were provided by Tan Tock Seng Hospital (TTSH) Singapore. The FFF linac was modeled by removing the flattening filter component in the FF linac. Phase space files were scored after flattening filter and in the phantom surface. The phsp files were analyzed to characterize the particles produced by the linac head using BEAMDP. The contaminants contribute around 1 % and 2 % in the phsp1 for flattened and unflattened beams, respectively. The photons are scattered in smallangle in the range of 0 - 40. The contaminant electron contributes up to one hundredth compared to the photons. The increase of field area affects the increase in

contaminants and penumbra width due to the increasing number of particles scattered out of the field area. The unflattened beam affects the increase in the number of electron contamination and surface dose. The penumbra width of the flattened beams was smaller than the unflattened beams for the same field size and energy.

"The Establishment of Institutional Diagnostic Reference Levels (DRLs) in the Cipto Mangunkusumo Hospital" was written by T. Amalia and K. Nurcahyo from Installation of Radiology and Nuclear Medicine, dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia under collaboration with B. Zulkarnaien from Medical Staff Group of Radiology and Nuclear Medicine, dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia, C. Anam from Department of Physics, Faculty of Sciences and Mathematics, Diponegoro University, Semarang, Indonesia, H. Tussyadiah from Integrated Heart Service Installation, dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia and D. E. Pradana from RSCM-Kiara, dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia. Institutional diagnostic reference levels are used for quality assurance in radiology departments. The purpose of this study was to establish an institutional diagnostic reference level (DRL) and to provide a practical tool in diagnostic radiology and nuclear medicine. For each type of procedure/examination, it needs at least 20 patients. The patients with regular size (average body size is 65 ± 10 kg for adult patients and 15±15 kg for pediatric patients) were enrolled in this project. The 75 percentile values of doses were used as institutional DRLs. For nuclear medicine, the administered activities was based on the dose of activity to produce a good image. The DRL values were obtained for general radiography, nuclear medicine, mammography, CT examination, and interventional radiography. The DRL's result was compared to national DRL (NDRL) and values in other countries. The DRL values for general radiography in this study are higher compared to NDRL and Japanese study. The administered activities (MBq) for nuclear medicine in this study are higher compared to European Commission but lower when compared to a Japanese study. The DRL values for mammography in this study are higher compared to ARPANSA; however, they are lower than NDRL and UK studies. The DRL values for CT examination in this study are higher compared to Netherland, Canadian, and USA studies but lower than NDRL. The DRL values in interventional radiography (IR) in this study are lower compared to the IAEA study. This finding indicates that it is still necessary to optimize procedures in the future. The established institutional DRL values can be used as a tool for optimization.

On behalf of Atom Indonesia, I would like to thank you all for your contributions and endless support that have allowed Atom Indonesia to reach an outstanding performance over all the years. This outstanding achievement could not have been reached without great efforts and cooperation from the editors, reviewers, management personnel, authors, and readers.

Editor in Chief