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Contents

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EDITORIAL

Dear reader,

It is a great pleasure to provide you with the third issue of Atom Indonesia in 2022, namely Vol. 48 No. 3 (2022). The Atom Indonesia Vol. 48 No. 3 (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.

"Noise Suppression of Computed Tomography (CT) Images Using Residual Encoder-Decoder Convolutional Neural Network (RED-CNN)" was written by H. B. Cokrokusumo, L. E. Lubis, P. Prajitno and D. S. Soejoko from Department of Physics, Faculty of Mathematics and Natural Sciences (FMIPA), Universitas Indonesia, Indonesia under collaboration with I. Hariyati from Department of Radiology, Gading Pluit Hospital, Jakarta, Indonesia. In this study, an in-house residual encoder-decoder convolutional neural network (RED-CNN)-based algorithm was composed and trained using images of cylindrical polymethyl-methacrylate (PMMA) phantom with a diameter of 26 cm at different simulated noise levels. The model was tested on 21 × 26 cm elliptical PMMA computed tomography (CT) phantom images with simulated noise to evaluate its denoising capability using signal to noise ratio (SNR), comparative peak signal-to-noise ratio (cPSNR), structural similarity (SSIM) index, modulation transfer function frequencies (MTF 10 %) and noise power spectra (NPS) values as parameters. Evaluation of a possible decrease of image quality was also performed by testing the model using homogenous water phantom and wire phantom images acquired using different mAs values. Results show that the model was able to consistently increase SNR, cPSNR, SSIM values, and decrease the integral noise power spectra (NPS). However, the noise level on either training or testing data affects the model's final denoising performance. The lower noise level on testing data images tends to result in over-smoothed images, as indicated by the shift of the NPS curves. In contrast, higher simulated noise level tends to result in less satisfactory denoising performance, as indicated by lower SNR, cPSNR, and SSIM values. Meanwhile, the higher noise level on training data images tends to produce denoised images with reduced sharpness, as indicated by the decrease of the MTF 10 % values. Further studies are required to better understand the character of RED-CNN for CT noise suppression regarding the optimum parameters for best results.

"Determination and Distribution Map for Radionuclides in Soil Samples from Different Location by Gamma Spectrometry Using Software Analysis" was explored by H. Mansour from Department of Physics, College of Science and Arts, Qassim University, Ar Rass, Saudi Arabia and Physics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, Egypt, under collaboration with L. A. Najam from Physics Department, College of Sciences, Univ. of Mosul, Mosul, IRAQ, and S. A. Abd El-Azeem from Physics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, Egypt and Physics Department, College of Science and Humanities in Al-Kharj, Prince Sattam bin Abdul Aziz University, Saudi Arabia. The fundamental goal of the current study is to determine the mean activity concentrations of natural and artificial radionuclides of ^{226}Ra, ^{232}Th, ^{40}K, and ^{137}Cs using gamma spectrometry for three locations, in Egypt, Saudi Arabia, and Iraq, which are significant and vital countries in the Middle East. The mean absorbed dose rate equals 22.35, 28.96, and 43.34 nGy h^{-1} for Egypt, Saudi Arabia, and Iraq. The results are consistent with international reports. The dose contribution percentages for investigated locations are 24 %, 30 %, and 46 % for Egypt, Saudi Arabia, and Iraq, respectively. The obtained results were clarified by statistical measurements using one-way ANOVA test to determine the distribution and differences between the averages of the three groups under study, as they may be influenced by geological variations and human intervention. It was found that the Iraq samples followed a symmetrical, standard normal distribution, while samples from Egypt and Saudi Arabia did not. Statistically significant differences were found between the data from the three countries.

"Efficient and Practical Radiosynthesis of Novel [131I]-Xanthine and [131I]-Hypoxanthine" was written by H. Wongso from Research and Technology Center for Radioisotope, Radiopharmaceutical, and Biodosimetry - National Research and Innovation Agency (BRIN), Serpong, Tangerang Selatan, Indonesia and Research Collaboration Center for Theranostic Radiopharmaceuticals, National Research and Innovation Agency (BRIN), Sumedang, Indonesia, under collaboration with W. Nuraeni and E. Rosyidiah from Directorate of Laboratory Management, Research Facilities, and Science and Technology Park, National Research and Innovation Agency (BRIN), Bandung, West Java, Indonesia. Natural products (NPs) have been the basis for the discovery and development of pharmacologically relevant drug-related molecules, including radiopharmaceuticals. Xanthine (3,7-dihydropurine-2,6-dione) and hypoxanthine (1,9-dihydro-6H-purin-6-one) are purine-based natural heterocyclic alkaloids that are generally found in some plants, animals, and the human body (e.g., muscle tissue, blood, and urine). The purpose of this study was to label xanthine and hypoxanthine with radioactive iodine-131 (a theranostic radionuclide) by a direct labeling method using chloramine-T as an oxidizing agent. Several experiments were performed to optimize the labeling efficiency by changing reaction conditions, including the ratio of starting material and chloramine-T, pH, solvent, temperature, and reaction time. Overall, labeling at acidic conditions in dimethyl sulfoxide (DMSO) resulted in considerable low radiochemical yields (RCYs) (< 4.0 %), and therefore the focus was shifted to exploit the alkaline reaction conditions. The optimized reaction condition: pH (10.5-11.0), xanthine:chloramine-T ratio (1:2), reaction temperature (27 ºC), and reaction time (30 min), provided [^{131}I]-xanthine with a RCY of 65.8 ± 0.1 %. After purification with extraction using chloroform (CHCl2), the radiochemical purity (RCP) of 95.1 % was achieved, as indicated by radio-thin layer chromatography (radio-TLC) analysis. In addition, the labeling of hypoxanthine was accomplished in a maximum 60.3 ± 0.2 % RCY, and after purification a RCP of 94.2 % was obtained. The present results provide an efficient and practical labeling method for xanthine and hypoxanthine with iodine-131, suggesting that these radiolabeled compounds can be further investigated in in vitro and in vivo studies for their theranostics potential.

"Inter-Code Comparison of Computational VERA Depletion Benchmark Using OpenMC, OpenMC-ONIX and DRAGON" was explored by A. Islam, T. A. Rahim, and A. S. Mollah from Department of Nuclear Science and Engineering, Military Institute of Science and Technology (MIST), Dhaka, Bangladesh. This research focuses on the comparative analysis of the PWR fuel assembly based on VERA depletion benchmark problems using community-developed opensource Monte Carlo code OpenMC, pythonbased burnup code system ONIX (a coupling interface for Monte Carlo code OpenMC), and deterministic DRAGON code. The depletion analysis was performed using OpenMC and ONIX with ENDF/B-VII.1 nuclear data library, and DRAGON with SHEM-361 based DRAGLIB format library (ENDF/B-VII.1). The code-to-code analysis on the evolution of, atom number density, and power distribution as a function of burnup has been performed and the result shows a good agreement with the maximum difference within 200 pcm at EOC. However small discrepancy around 90 pcm has been observed in calculated by DRAGON compared to OpenMC in the presence of integral fuel burnable absorbers (IFBA). The above-mentioned codes have been validated successfully for the first time against PWR fuel assembly based on VERA depletion benchmark problems. It can be concluded that initial implementation of these codes at the Department of Nuclear Science and Engineering under Military Institute of Science and Technology, Dhaka, was successful and that further research works are to be performed to utilize these codes for depletion/neutronics calculation of existing 3MW TRIGA Mark-II research reactor and VVER-type power reactor that is to be commissioned in Bangladesh.

"Scanning Horn Simulation Code for Electron Beam Machine Based on Boris Algorithm" was written by A. H. Shali, S Saminto, S. R. Adabiah, and Taufik from Center for Accelerator Science and Technology, National Nuclear Energy Agency (BATAN), Yogyakarta, Indonesia under collaboration with F. Lucyana from Center for Nuclear Facility Engineering, National Nuclear Energy Agency (BATAN), Puspiptek Area Serpong, Tangerang Selatan, Indonesia. A numerical particle simulation code package to estimate the irradiation distribution of an electron beam machine is presented. Particle-to-particle interactions are calculated using particle-in-cell method, while the equation of motion is solved using Boris algorithm. The amplitude of oscillating magnetic field distribution from the scanning horn is obtained using CST

magnetic field solver. The code was run using Intel's i7-10700 processor without multithreading. For cases where particle-to-particle interactions are negligible, the simulation requires about 10000 seconds to finish. The results show that different shapes of signals will result in different irradiation distributions. For a relatively low magnetic oscillation frequency, it is shown that a triangular signal will result in a more evenly distributed irradiation compared to a sinusoidal signal.

"Dose Distribution of Radioxenon Due to a Hypothetical Accident of TRIGA Research Reactor in Bangladesh" was explored by K. M. Z. Zihan, M. M. Rahman and M. S. Islam from Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh under collaboration with M. A. Hoq, M. A. Khaer, M. T. Chowdhury and M. M. Rahman from Institute of Energy Science, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh. Radiological dose distribution owing to the deposition of ^{131m}Xe, ^{133m}Xe, ^{133}Xe, ^{135m}Xe, ^{135}Xe, and ^{138}Xe on ground and immersion considering a postulated accident of TRIGA Mark-II research reactor has been assessed. The radiological dose distribution has been carried out in various directions with the help of Gaussian Diffusion Model. Local meteorological data such as average wind speed, frequency, etc. has been collected and evaluated for various directions around the reactor site. For all the dominant directions, the maximum dose values due to 131mXe, ^{133m}Xe, ^{133}Xe, ^{135m}Xe, 1^{35}Xe, ^{138}Xe and the total (^{131}mXe + ^{133}mXe + ^{133}Xe + ^{135m}Xe + ^{135}Xe + ^{138}Xe) were observed within the limit 3.03E-7–1.23E-4 µSv/h, 1.01E-5–4.09E-3 µSv/h, 0.0003–0.14 µSv/h, 2.29E-5–9.26E-3 µSv/h, 0.002 –1.111 µSv/h, 1.11E-5–4.55E-3 µSv/h, and 0.003–1.269 µSv/h, respectively. Dose distribution was found to be dominant due to immersion and the contribution was 87.55 %. There is shortage of data regarding the release of radioxenon in the atmosphere during nuclear accident especially in the case of TRIGA type research reactor. This paper is the first such detailed study on atmospheric release of radioxenon and its dose distribution for a full power- reactor and the consequences towards the environment and public health. The result can be applied to develop the radiological protective measures and to prepare an emergency response plan for the TRIGA reactor site.

"Detection of Radon Exhalation from Various Building Materials Using CR-39, RAD7, and Biosensors" was written by B. J. Albazoni and H. J. Almayahi from Department of Physics, Faculty of Science, University of Kufa, Najaf, Iraq. Study aimed to design and manufacture two biosensors, namely BIOS-I and BIOS-II, for ^{222}Rn and Pb+2 measurements in building materials and soil samples. For comparison, the conventional detectors of RAD7 and CR-39 were used. The biosensor material used was based on ssDNA rich guanine or primer. The two biosensors have a difference in the sequence of the nitrogenous bases. The measurement revealed that the average of 222Rn exhalation by the BIOS-I was 373.30 Bqm-3, while the BIOS-II was 342.29 Bqm-3. The average ^{222}Rn exhalation measured by the CR-39 detector was 326.17 Bqm-3, whereas by the RAD7 detector it was 319.95 Bqm-3. This study found that 222Rn exhalation in the Indian and Chinese granites, soil, and Iraqi mosaic samples was higher than the limits recommended by WHO, while the rest of the samples were within the permissible limits. It is also known that there is a very weak positive correlation between BIOS-I or BIOS-II and humidity, while a very weak negative correlation was found between them and temperature. There is a very strong positive correlation between radon exhalation recorded by RAD7 and humidity. On the other hand, there are no statistically significant differences between BIOS-I and BIOS-II at (level 0.01), while there are statistically significant differences between BIOS-I and CR-39 or RAD7 at level 0.01. It was concluded that the manufactured biosensors have better detection for radon than RAD 7 and CR-39 detectors.

"Simulation of Dispersion Modeling of 137Cs for the Possible Leakage of Malaysia's Nuclear Power Plant Operation" was explored by M Muslim, F. I. Maulana, and S. Y. Wulandari from Department of Oceanography, Diponegoro University,Jalan Prof. Soedarto, SH Tembalang Semarang, Indonesia under collaboration with H. Suseno from Research and Technology Center for Safety and Metrology Radiation. Research Organization for Nuclear Energy - National Research and Innovation Agency (BRIN), Jakarta, Indonesia. The world's energy needs increase in line with population growth. One alternative to overcome this problem is the construction of a nuclear power plant, a source of energy that is cheap, clean, and safe. Malaysia has a plan to construct nuclear power plants by 2025, which is located close to Indonesian waters. This study aimed to determine the distribution model of ^{137}Cs radionuclide released by the nuclear power

plant in the event of a leak in east coast of Peninsular Malaysia and its impact on the presence of ^{137}Cs in Indonesian waters. A quantitative method was used in this study with a scenario 2D modeling using hydrodynamics module and transport module in MIKE software. The results showed that the highest concentration of ^{137}Cs would be found in the area around the nuclear power plant with a value of 10^{11} PBq/m^3, then it would decrease through diffusion and advection processes. On the 15^{th} day, the spread of ^{137}Cs would reach Indonesian waters with a distance of up to 76 km and would expand on the 30^{th} day with a distance of up to 130 km from the released source. The movement of ^{137}Cs follows the dominant current pattern due to its nature. The presence of ^{137}Cs in Indonesian waters after the 15^{th} and 30^{th} days would reach a value of 1 Bq/m^3 due to advection and diffusion processes.

"The Investigation of Lead Borate Glass Composites for Boron Neutron Capture Therapy Shielding" was explored by M. S. Ali from African Institute for Mathematical Sciences, Mbour, Thies Region, Senegal and Physics Department, Faculty of Science, New Valley University, Egypt under collaboration with A. M. Abdelmonema dnd S. K. Elshamndy from University of Jouf, Faculty of Science and Art, Department of Physics, Al-Jouf, KSA, G. M. Shoraiet and T. M. Mustafa from Physics Department, Faculty of Science, New Valley University, Egypt and Hassan from Physics Department, Faculty of Science, Assiut University, Egypt. In this work, we studied the lead borate glass composites to optimize its shielding properties of thermal neutrons and gamma-rays for Boron Neutron Capture Therapy (BNCT) applications. Attenuation coefficients, half-value layer (HVL), and tenth-value layer (TVL) were measured for a broad range of gamma-ray energies, i.e., 356, 511, 662, 1173, 1274, and 1332 keV experimentally. Theoretical results using XCOM software show an agreement with the NaI(Tl) detector-based experimental measurements. The attenuation of collimated thermal neutrons, from Cf-252 source, was simulated using Monte Carlo-based code and compared experimentally with measurements by BF3 detector. A reasonable agreement between simulations and experiments was observed, suggesting that the shielding properties of lead borate glass (LBG) composites are monotonically increasing with the increasing of the lead and boron additives.

"Response Surface Optimization of Gamma Irradiation Synthesis of Alginate-Stabilized Silver Nanoparticles Without Addition of a Hydroxyl Radical Scavenger" was explored by D. P. Perkasa from Doctoral Program in Biomedical Science, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia and Research Center for Radiation Process Technology, Research Organization for Nuclear Energy – National Research and Innovation Agency, Jakarta, Indonesia under collaboration with W. Arozal from Doctoral Program in Biomedical Science, Faculty of Medicine, Universitas Indonesia, Jakarta and Dept. of Pharmacology and Therapeutics, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia, Kusmardi from from Doctoral Program in Biomedical Science, Faculty of Medicine, Universitas Indonesia and Dept. of Pathological Anatomy, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia, and M. Syaifudin from Research Center for Radioisotope, Radiopharmaceutical, and Biodosimetry Technology, Research Organization for Nuclear Energy - National Research and Innovation Agency, Jakarta, Indonesia. The use of isopropanol as a hydroxyl radical scavenger on the radiosynthesis of alginate-stabilized silver nanoparticles (AgNPs) can limit its application in nanomedicine. Meanwhile, optimum condition for gamma irradiation synthesis of alginate-stabilized AgNPs without addition of a hydroxyl radical scavenger has not been reported yet. In this study, the optimization of this process was carried out using response surface methodology (RSM) combined with Central Composite Design (CCD). The three processing conditions, i.e. radiation dose, precursor silver ion concentration, and alginate concentration were selected as decision variables to maximize two responses in terms of the conversion yield and AgNP concentration responses. The results indicated that the regression model of conversion yield and AgNP concentration fit linearly with the two-factor interaction and the linear model, respectively. The significant effect of the alginate factor on the conversion yield indicates the dual stabilizing–scavenging role of the alginate. The optimum conditions derived from CCD-RSM were obtained at a 20 kGy radiation dose, 7.78 mM precursor silver ion concentration, and 1.2 % (w/v) alginate concentration with the desirability of 0.731. The actual experimental results were 65.43% conversion yield and 480.91 ppm AgNP concentration, which were within the prediction interval at confidence of 95 %. The AgNPs under the

optimum condition had a spherical shape, 97.4 % volume of size distribution at 6.50-28.21 nm, and zeta potential of -28.3 mV.

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