Accreditation No.: 30/E/KPT/2018

atom indonesia

Exist for publishing the results of research and development in nuclear science and technology

Publisher : Center for Informatics and Nuclear Strategic Zone Utilization
Mailing Address : National Nuclear Energy Agency
Puspiptek Serpong, Tangerang 15314, Indonesia
Phone (+62 21) 7560575, 7562860 ext. 9017, Fax (021) 7560895
Web: http://aij.batan.go.id, E-mail : atomindonesia@batan.go.id

Licences : SIT No. 078/Khs/Dit.PP/II. 1a & 75; 24.5.75,
SIC No. B/289-PK/VI/75; 3.6.75

Accreditation No.: 30/E/KPT/2018

atom indonesia
vol. 47 no. 1
April 2021

Contents

Accreditation No.: 30/E/KPT/2018

EDITORIAL

Dear reader,

It is a great pleasure to provide you the first issue of Atom Indonesia in 2021, namely Vol. 47 No. 1 (2021). Since SCOPUS and Web of Science (WOS) indexed Atom Indonesia, the number of articles submitted to Atom Indonesia has significantly increased. Starting from this issue, the number of published articles in Atom Indonesia will be increased from eight articles to ten articles. To retain the quality of the publications, all articles published in Atom Indonesia have been peer reviewed by qualified editors and reviewers. In addition, the publishing process is supported by a professional administration team.

The Atom Indonesia Vol. 47 No. 1 (2021) 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.

"Radon Concentrations in Canned Liquid Juice" was written by A. A. Abojassim from the University of Kufa, Faculty of Science, Physics Department, Kufa, Najaf Governarate, Iraq. This study was performed at University of Kufa, Iraq, using canned liquid juice samples found in Iraqi markets due to the absence of environmental contamination from radionuclides emitting ^{222}Rn concentrations using RAD-7 detectors. The annual effective dose (AED) of ^{222}Rn was estimated for children and adults from the ingestion of canned liquid juice samples. All estimated results of ^{222}Rn concentrations for juice samples were lower than the natural limits provided by the WHO and the European Union Commission to the public (0.5 and 1 Bq/L, respectively). Therefore, there are no health hazards from drinking juice sold in Iraq markets.

"Study of Dried and Calcinated Ceria Stabilized Zirconia Microspheres Morphology by Small-Angle X-Ray Scattering and Optical Microscopy" was explored by A. Patriati, A. Insani, N. Suparno, E. Hutamaningtyas and Mujamilah from the Center for Science and Technology of Advanced Materials, National Nuclear Energy Agency (BATAN), Puspiptek Area, Serpong, Indonesia under collaboration with S. Soontaranoon from Synchrotron Light Research Institute, 111 University Avenue, Muang District, Nakhon Ratchasima 30000, Thailand. The knowledge of how to avoid crack at high temperature is crucial in fuel fabrication for Experimental Power Reactor or Reaktor Daya Eksperimental (RDE). This knowledge should be established and well-mastered by BATAN. RDE uses uranium dioxide as its nuclear fuel. However, uranium utilization for research purposes is heavily restricted. Therefore, the fabrication of ceria-stabilized zirconia (CSZ) microspheres as nuclear fuel surrogate was studied. In this work, the CSZ was prepared by external gelation with two different washing solutions, i.e. isopropyl alcohol (IPA) and propylene glycol methyl ether (PGME). The morphology in nano- and micro-scale of each CSZ microspheres from both variations was evaluated by small-angle x-ray scattering (SAXS) and optical microscopy. The morphology of the CSZ microsphere after drying at 80 °C and calcination at 200 °C were observed to understand the structural change in those steps and to see the potential crack based on its morphology. There are two parameters that can prevent microspheres from cracking at high temperatures for the next process, i.e., porosity and gel texture. It was observed that IPA solution has a benefit as a washing solution as it can trigger more porosities in the microspheres, but less in gel texture.

"Measurements of Natural Radionuclides and ^{137}Cs in Airborne Particulate Samples Collected from Bali and Lombok Islands (Indonesia)" was explored by Syarbaini from the Center for Radioisotopes and Radiopharmaceuticals Technology, National Nuclear Energy Agency (BATAN) Puspiptek Area Serpong, Indonesia, under collaboration with Wahyudi and G. Suhariyono from the Center for Radiation Safety Technology and Metrology, National Nuclear Energy Agency (BATAN), Jakarta Indonesia and D. Gunawan and E. Suharguniyawan from the Center for Climate Change and Air Quality, Meteorology Climatology and Geophyisics Agency, Kemayoran Jakarta, Indonesia. Bali and Lombok islands are popular resorts and

tourist destinations in the world because of their culture and beautiful natural view. The natural and anthropogenic radionuclides content in surface air of Bali and Lombok islands such as ^{226}Ra, ^{232}Th, 40K and ^{137}Cs were measured at 3 monitoring stations in a period from January to December 2016. Aerosol samples were collected using a high volume total suspended particles (TSP) sampler. The activity concentrations of those radionuclides in the airborne particulate matter were measured using gamma-ray spectrometry. The results show that the activity concentrations of natural radionuclides ^{226}Ra, ^{232}Th, and ^{40}K ranged from 1.0 to 3.04 μBq/m^3, not detected to 1.78 μBq/m^3, and 0.03 to 0.49 mBq/m^3, respectively. All the airborne particulate matter filter samples were found to be lower than the minimum detectable activity for ^{137}Cs, which means that none of ^{137}Cs is originated from atmospheric nuclear weapon tests and other sources in the surface air of Bali and Lombok islands. Variations of monthly activity concentrations of natural radionuclides were influenced by rainfall during the study period. Furthermore, the peak concentrations of radionuclides also occur due to volcanic ash coming from the Mount Rinjani eruption.

"Calculated Electronic Energy Loss of Heavy Ions at Low Energies in LR-115, Kapton, SiO_2, and Al_2O_3 Amorphous Materials" was written by J. El Asri1 and A. Chetaine from the Nuclear Reactor, Nuclear security and Environment, Faculty of Sciences, Mohammed V University in Rabat, Rabat, Morocco under collaboration with O. El Bounagui from the EPHE-SM, Faculty of Sciences, Mohammed V University in Rabat, Rabat, Morocco, N. Tahiri from the LaMCScl, Faculty of Sciences, Mohammed V University in Rabat, Rabat, Morocco and H. Erramli from the Faculty of Science Semlalia, University Cadi Ayyad Marrakech, Morocco. The electronic stopping powers of LR-115 and Kapton polymeric foils have been estimated, using Monte Carlo simulations, for ^{9}Be, ^{11}B, ^{12}C, ^{14}N, ^{16}O, and ^{35}Cl ions covering the energy range ~0.1-1.0 MeV/n. Comparison of stopping power based on Lindhard, Scharff, and Schiott (LSS) theory with the corresponding values obtained by SRIM and MSTAR codes in LR-115 and Kapton polymeric foils illustrate a significantly large deviation. However, a semiempirical equation has been proposed here and tested for better stopping power calculations at low-energy regime in the domain of LSS theory for Z = 4-8 ions across materials. Furthermore, the electronic energy losses for ^{9}Be and ^{16}O ions in SiO_2 and Al_2O_3, respectively, have been calculated in the energy range of ~0.1-1.0 MeV/n. The calculated stopping powers exhibit up to 10 % deviation from the experimental values and MSTAR data.

"Investigation on the Background Radiation of Abakaliki Rice Mill in Ebonyi State, Nigeria" was explored by A.N. Nwachukwu from the Centre for Climate Change and Development, Alex Ekwueme Federal University, Nigeria under collaboration with C.F. Ikeagwuani and A.O. Adeboje from the Physics Department, Alex Ekwueme Federal University, Nigeria. This study investigated the background ionizing radiation of Abakaliki rice mills. The requirement to monitor this site is because the prevalent activities in the site suggest that it is a source of ionizing radiation. The activities include fuel stations and excavation sites. Other sources are various chemicals and agrochemicals (like Phosphate, Uranium, Thorium, and Radium) used during the planting of the different rice species. There is, therefore, an urgent need to investigate the radiation level of Abakaliki rice mills in Ebonyi state, Nigeria to ascertain if it has passed the safety standards. The investigation was carried out using the Radalert 100 radiation monitor and a geographical positioning system (Garmin GPSMAP 765). The studied site was split into different points with each representing a mill that houses different grinding plants. This study included all the sections of the mill. The mean background radiation exposure rate ranges from 0.014 mRhr^{-1} to 0.0204 mRhr^{-1}. The obtained values are higher than the world standard limit of 0.013 mRhr^{-1} recommended by ICRP except point 7 which corresponds to the top of the rice husk dumpsite. The calculated absorbed dose rates for the various sections of the mill ranged from 99.18 nGh^{-1} to 177.48 nGyh^{-1}. These values of absorbed dose rates were observed to be far higher than the world permissible value of 89 nGyh^{-1}. The annual effective dose equivalent (AEDE) for the exposure values ranged from 0.122 mSvy^{-1} to 0.218 mSvy^{-1} which are far lower than the ICRP permissible limits of 1.00 mSvlyr for the public and therefore implies absence of any immediate radiological risk. The excess lifetime cancer risk for the mill users were all above the 0.29×10^{-3} world recommended value. This suggests a possibility of the rice mill workers developing radiation-related illnesses over time.

"Safety Investigation of Hazardous Materials Released from the Combined High Temperature Gas Cooled Reactor – Hydrogen Production Plant Using ALOHA Software" was written by D. Priambodo and Sunarko from the Center for Nuclear Energy System Assessment, National Nuclear Energy Agency (BATAN), Jakarta, Indonesia under collaboration with W.W. Purwanto from the Sustainable Energy Systems and Policy Research Cluster, Department of Chemical Engineering, University of Indonesia, Kampus UI Depok, Jawa Barat, Indonesia. Safety Investigation of Hazardous Materials Released from The Combined High Temperature Gas Cooled Reactor (HTGR) – Hydrogen Production Plant Using ALOHA software has been carried out. Currently, most of studies for HTGR – hydrogen plant are focused only on the impact of hydrogen presence to the HTGR plant safety. Therefore, the objective of this study was to investigate the effect of the presence of natural gas and synthetic gas from Steam Methane Reforming hydrogen plant on the combine HTGR-Hydrogen production system using ALOHA software. Three selected hazardous materials: CH_4, CO and H_2 were analyzed. The selected potential hazards of the hazardous materials after leaking from the pipe were downwind suffocation/toxication, flammable area and blast area from vapor cloud explosion. Two types of parameter, i.e., meteorological dispersion (including wind speed, temperature, humidity, nuclear building air changes for day and night) and source release parameters (including pipeline length, and distance from the reactor building to the hydrogen plant), were selected for this study. The effects of the parameters on the hazard distance were then analyzed. The study shows that hydrogen detector needs to be installed at the plant to ensure safety of field operator. Furthermore, CO adsorber and H_2 recombiner should be installed at the Reactor HVAC system for CO poisoning and H_2 fire protection. Provision of a separation distance of more than 250 meters or construction of a blast barrier between the reactor building and the hydrogen plant is also recommended to protect the reactor from H_2 explosion hazard.

"Conceptual Design of Experimental Facility for Large-Diameter NTD-Si at the IRT-T Reactor" was explored by I.I. Lebedev, D.E. Zolotykh, A.G. Naymushin, N.V. Smolnikov, M.N. Anikin, and V.A. Varlachev from the National Research Tomsk Polytechnic University, Lenin ave. 30, Russia. The IRT-T reactor has been conducting research in the field of irradiation of ingots of single-crystal semiconductor materials since 1987. The article describes the existing silicon doping facility. The results of studies on the possibility of creating an additional irradiation channel for neutron-transmutation doping of silicon are presented. It is shown that the use of a graphite reflector and a thermal neutron filter based on boron makes it possible to achieve non-uniformity of irradiation up to 5%. The principal possibility of irradiating single-crystal silicon ingots with a diameter of up to 203 mm and a length of up to 500 mm is shown. The questions of optimizing the configuration of the core and the regime of reactors operation for increasing the neutron flux in the irradiation channels are discussed. In addition, applying the facility to produce base materials for neutron dosimeter in neutron capture therapy studies is proposed.

"Synthesis and Characterization of Ordered and Disordered Mesoporous Alumina as High-Performance Molybdenum-99 Adsorbents" was written by I. Saptiama, F. Rindiyantono and A. Aries from the Center for Radioisotope and Radiopharmaceutical Technology, National Nuclear Energy Agency (BATAN), Puspiptek Area Serpong, Tangerang Selatan, Indonesia under collaboration with Y. V. Kaneti from the International Center for Materials Nanoarchitectonics (WPI-MANA)-NIMS, Tsukuba, Ibaraki, Japan and M. Iqbal from the Engineering Physics Department and Research Centre for Nanoscience and Nanotechnolog, Institut Teknologi Bandung, Indonesia. Molybdenum-99 (^{99}Mo) is the parent radioisotope of technetium-99m (^{99m}Tc), an essential medical radioisotope for diagnostic agents in nuclear medicine. In ^{99}Mo/^{99m}Tc generator, a chromatography column system with ^{99}Mo adsorbent as a filler is usually used to produce ^{99m}Tc in hospitals. However, it is still challenging to find high-performance adsorbents for Mo adsorption. We have synthesized both ordered and disordered mesoporous alumina and compared their performance as ^{99}Mo adsorbents. These materials were prepared via a soft-templated method using a triblock copolymer as the template, followed by air calcination at 400°C. The experimental results show that the ordered mesoporous alumina has a higher ^{99}Mo adsorption capacity of 72.06 mg (Mo) g^{-1} than the disordered mesoporous alumina (50.12 mg (Mo) g^{-1}). The results indicate the excellent potential of ordered mesoporous alumina as an adsorbent for the ^{99}Mo/^{99m}Tc generator column.

"Reactivity Effects in a Very-High-Temperature Pebble-Bed Reactor" was explored by D. M. Pérez, L. H. Pardo, D. M. Pérez, D. E. M. Lorenzo from the Higher Institute of Technologies and Applied Sciences (InSTEC), University of Havana (UH), Avenida Salvador Allende y Luaces, Havana, Cuba under collaboration with L. P. R. Garcia from the Universidade Federal de Pernambuco (UFPE), Cidade Universitária, Avenida Professor Luiz Freire, Brasil and C. A. B.de Oliveira Lira from the Centro Regional de Ciências Nucleares (CRCN-NE), Cidade Universitária, Avenida Professor Luiz Freire, Brasil. The very-high-temperature reactor (VHTR) is one of the most promising and innovative designs selected by the Generation IV International Forum. Although previous papers have focused on the study and optimization of several parameter of a VHTR conceptual design, there is still much work needed to achieve the commercial introduction of this technology. The primary aim of this study is to obtain the reactivity effects of such parameters as the temperature of the fuel, moderator, and reflector, and the poisoning by 135Xe and 149Sm in the VHTR critically. To reach this goal, the widely-used MCNP6 code was employed in order to simulate the neutronics of the VHTR. The viability of the utilization of the MCNP6 code and the developed model for the study of the physics of the VHTR core was confirmed through the calculation and comparison with benchmarks provided by the IAEA. Based on the results of the temperature coefficients of reactivity obtained, a negative reactivity effect on the system of about -12 pcm/K was found, as is expected in all the nuclear fission reactors, while the combined effect of fission products 135Xe and 149Sm implies a negative reactivity of -3475 pcm.

"Proposed Managements of ^{137}Cs Contaminated Soil: Case Study in South Tangerang City was explored by B. Setiawan, D. Iskandar, G. Nurliati, H. Sriwahyuni, Mirawaty, P. A. Artiani, K. Heriyanto, N. E. Ekaningrum, Y. Purwanto, and Sumarbagiono from the Center for Radioactive Waste Technology, National Nuclear Energy Agency (BATAN), Puspiptek Area, Serpong, Tangerang Selatan, Indonesia. Recently, BAPETEN found contamination of ^{137}Cs while testing environmental radiation monitoring equipment in an area in South Tangerang City. The area, therefore, needs to be cleaned up by performing decontamination followed by the activity of treating the contaminated soil. The decontamination works were carried out by excavating the contaminated soil on the surface to a depth of more than 1.5 m, and then the soils were put into the 100L drum. Decontamination work resulted in a significant reduction dose exposure in the area to 0.3-0.75 μSv/h. The drums containing contaminated soil were then sent to the interim storage facility in BATAN Serpong facility for further treatment. To resolve the ^{137}Cs contaminant, some alternatives in the decontamination and management of the contaminated soils were studied. Some techniques and strategies for decontamination and managing ^{137}Cs are presented in this paper. Management that involves wet and dry methods will be proposed in this paper. By comparing and evaluating various alternative management methods, an appropriate method for treating the contaminated soil in South Tangerang City can be obtained. The objective of the study was to find a suitable management method for the contaminated soil based on the proposed alternative management methods. In the present case, the compaction method seems promising for use soon.

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 for 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