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. 3
December 2021

Contents

Accreditation No.: 30/E/KPT/2018

EDITORIAL

Dear reader,

It is a great pleasure to provide you the third issue of Atom Indonesia in 2021, namely Vol. 47 No. 3 (2021). Since SCOPUS and Web of Science (WOS) indexed Atom Indonesia, the number of articles submitted to Atom Indonesia has significantly increased. 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. 3 (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.

"Characterization of The Heat Transfer on Spray Quenching for Different Material Properties" was explored by Sabariman from Dept. of Electrical Engineering, Industrial Technology Faculty, Universitas Internasional Batam, Indonesia under collaboration with E. Specht from Institute of Fluid Dynamics and Thermodynamics, Faculty of Process and System Engineering, University of Magdeburg, Magdeburg, Germany. A broad range of water spray applications as a means of two-phase cooling scheme has encouraged research in the thermal management system to support safety and process efficiency in industries. The objective of the research was to characterize the boiling parameters on different materials in the regime of film boiling, transition boiling, and nucleate boiling as the basis for its boiling curve construction. To explain the influence of material properties, this work is featuring, firstly, the calculated vapor film thickness in film boiling regime by promoting self-developed analytical model of single droplet and, secondly, the calculated boiling width which indicates a strong combination of surface temperature and heat flux observed as the boiling phenomena. This is obtained by calculating the propagation of wetting front and 100 ^{0}C points. This experimental work employed a volumetric spray flux of 4.2, 10 and 13.7 kg/m^{2}s to cool a hot metal sample of aluminium alloy AA6082 and nickel heated up to 560 ^{0}C. An infrared camera was used to record the temperature drop over time. Heat flux calculation follows the numerical procedure according to 1D energy balance model. Calculated vapor film thickness explains why the HTC tends to increase with the decrease of the surface temperature. Leidenfrost and Departure from Nucleate Boiling (DNB) temperatures are found to be inversely proportional to the heat penetration coefficient of the metal while maximum heat flux and boiling width increase with it.

"Theoretical Inspecting of ^{211}At Radionuclide via Coupled-Channel Model for Fusion Reaction of Stable Nuclei" was written by Z. M. Cinan, T. Başkan, and A. H. Yılmaz from Department of Physics, Faculty of Science, Karadeniz Technical University, Trabzon, Turkey under collaboration with B. Erol from Department of Physics, Faculty of Arts and Science, Recep Tayyip Erdoğan University, Zihni Derin Campus, Turkey. This work has been carried out to obtain and inspect the ^{211}At radionuclide through fusion reaction. Cross-sections for fusion reaction have been calculated with different interaction combinations and excitations for ^{19}F + ^{192}Os and ^{18}O + ^{193}Ir reactions. All calculations have been performed on NRV Knowledge Base, CCFULL code, and Wong's Formula. Firstly, we assigned reaction parameter values taking into account the compatibility with the experimental data ^{19}F + ^{192}Os reaction. Afterward, to enrich studies on ^{211}At radionuclide, we proposed ^{18}O + ^{193}Ir reaction which did not have experimental data in the literature with the method and parameter values we determined. We examined the effects of phonon excitations in projectile and target nuclei on fusion cross sections and barrier distributions. With our research, we showed that the coupled channel model and the calculation codes used to explain the fusion cross-section data and barrier distributions well. This research sheds light on the importance of analysing important medical radionuclides such as ^{211}At by heavy-ion fusion reactions and encourages new researches.

"Gamma Radiation Shielding Properties of Slag and Fly Ash-based Geopolymers" was explored by M. W. Hassan and S. Astutiningsih from Department of Metallurgical and Materials Engineering, Faculty of

Engineering, Universitas Indonesia, Depok, Indonesia under collaboration with Sugiharto from the Center for Isotopes and Radiation Application, National Nuclear Energy Agency (BATAN), Lebak Bulus Raya, Jakarta, Indonesia. Industrial waste-based geopolymer cement is a greener alternative to Ordinary Portland Cement (OPC) for radiation shielding with comparable mechanical properties without the production of CO_2 during synthesis. In this paper, the linear attenuation coefficient of slag and fly ash-based geopolymers, unmodified by aggregates, is measured and used to calculate the mass attenuation coefficients, half-value layer (HVL), and tenth-value layer (TVL) of the geopolymers. Narrow Beam Gamma Spectrometry with gamma energy of 0.662 MeV, 1.173 MeV, and 1.332 MeV was used to irradiate a series of slag and fly ash-based geopolymer paste of cylindrical shape with a diameter of 7.5 cm and height of 9.5 cm. Slag geopolymer has linear attenuation coefficient of 0.1642/cm, 0.1237/cm, 0.1150/cm, mass attenuation coefficient of 0.0782 cm^2/g, 0.0589 cm^2/g, 0.0548 cm^2/g, the HVL of 4.222 cm, 5.609 cm, 6.056 cm, and TVL of 14.025 cm, 18.633 cm, 20.118 cm, respectively.

"Implementation of Beam Matching Concept for the New Installed Elekta Precise Treatment System Medical LINACs in Indonesia" was studied by O. A. Firmansyah, A. F. Firmansyah, and S. I. Sunaryati from the Center for Radiation Safety Technology and Metrology, National Nuclear Energy Agency (BATAN), Lebak Bulus Raya, Jakarta, Indonesia under collaboration with M. M. Putri, A. R. Setiadi, O. A. Akbar and V. Arif from PT. Besindo Medi Prima, The Belleza Permata Hijau, Jakarta, Indonesia, and C. Amelia from Sanglah General Hospital, Jl. Diponegoro Dauh Puri Klod, Bali, Indonesia. A concept of radiation beam matching of some medical linear accelerators (LINACs) that have identical characteristics of the models, radiation quality, and multileaf collimator features may be implemented as long as the manufacturer provides complete specifications so that a Treatment Planning System (TPS) can be used for many beam-matched LINACs. This paper describes a preliminary study on the implementation of the beam matching concept for five units Elekta Precise Treatment System LINACs that have recently been installed in Indonesia. The beam matching criteria were based on the percentage depth dose (PDD) and beam profile for photon and electron beams. Dosimetry measurements were carried out by using an SNC 125 ionization chamber of 0.125 cm3 in volume, PTW Pinpoint 3D of 0.016 cm3 in volume, and PTW Farmer Chamber of 0.6 cm3 in volume.

"Model Comparison of Passive Compact-Molten Salt Reactor Neutronic Design Using MCNP6 and Serpent-2" was explored by R. A. P. Dwijayanto from the Center for Nuclear Reactor Technology and Safety, National Nuclear Energy Agency (BATAN), Puspiptek Area Serpong, South Tangerang, Indonesia under collaboration with M. Y. A. Putra, and A. W. Harto from Department of Nuclear Engineering and Physics Engineering, Faculty of Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia and M. R. Oktavian, from School of Nuclear Engineering, Purdue University, West Lafayette, Indiana, United States. Passive Compact Molten Salt Reactor (PCMSR) is a thermal breeder molten salt reactor (MSR) developed in Universitas Gadjah Mada, Indonesia, run in thorium fuel cycle. Its design was initially developed using deterministic code SRAC2006 but has never been compared with other codes. This paper attempts to compare PCMSR neutronic design using Monte Carlo codes MCNP6 and Serpent-2 with ENDF B/VII.0 continuous neutron cross-section library. The reactor was run in a pure thorium fuel cycle with lithium fluoride as its carrier salt. The analyzed parameters were effective multiplication factor (keff), temperature coefficient of reactivity (TCR), void coefficient of reactivity (VCR), and conversion ratio (CR). The result shows that there are several important discrepancies between the original calculation and this research. The Monte Carlo calculations implied that PCMSR core was able to be critical using lower fissile concentration than previously designed but failed to reach CR above unity. While the TCR value was found to be negative, the VCR value was positive up until the 10 % void fraction. The PCMSR core suffered from ineffective neutron moderation and high neutron leakage. These findings imply that the previous PCMSR neutronic design is inaccurate. For PCMSR to be able to operate as a thermal breeder MSR, geometrical modifications must be performed to improve neutron moderation and reduce neutron leakage.

"Monte Carlo Simulation-Based BEAMnrc Code of a 6 MV Photon Beam Produced" by a Linear Accelerator (LINAC)" was written by R. Sapundani and K. M. Wibowo from Department of Electromedical Engineering, Universitas Muhammadiyah Purwokerto, Kembaran Banyumas, Purwokerto, Indonesia under collaboration with R. Ekawati from Faculty of Information Science and Engineering, Jakarta Global University (JGU), Jatiwaringin, Pondokgede, Bekasi, Indonesia. In radiotherapy, high energy ionizing radiation, such as X-rays, gamma rays and electron beams, is used. The dose in the tissue is often approached

with the dose in the medium of the body, which is 80 % of human soft tissue. It is often difficult to determine the dose because the interaction of materials in a medium is very random. Measurement is also quite difficult because there are almost no detectors that are tissue equivalent. Measurement using an ion chamber requires a lot of correction to obtain a dose in the tissue, which is done using phantom and not directly in humans. This research aimed to compare the absorbed dose between modelling using Monte Carlo simulation and experiments. The simulation of dose distribution produced by a 6 MV medical linear accelerator has been performed using BEAMnrc code running on Linux-based 2-processor system arranged in parallel. BEAMnrc was used to model and simulate the linac head with an SSD of 100 cm and Field size of10x10 cm2. A phase-space file is obtained as input to a DOSXYnrc code to produce Percent Depth Dose (PDD) in water and polymethyl methacrylate (PMMA) phantoms. New particles formed (electrons: 0.2 %, photon: 0.17 %; and positron: 0.08 %) were far from the contamination threshold of 2 %. The range of the correction factor of the depth of a maximum dose compared to the experimental data was 0.04-0.15.

"The Dose Distribution from Iridium-192 Source on Cervical Cancer Brachytherapy by Manchester System Using Monte Carlo Simulation" was written by F. Kurniati, F. P. Krisna and F. Haryanto from Faculty of Mathematics and Natural Sciences, Institut Teknologi Bandung, Bandung, West Java Indonesia under collaboration with Junios from Institut Kesehatan Prima Nusantara Bukittinggi, Gulai Bancah Bukittinggi, West Sumatera. Indonesia. One treatment for cervical cancer is to use radioactive sources that directly target the cancer cell called brachytherapy. This study is aimed to determine dose distribution at phantom pelvis using the DOSXYZnrc Monte Carlo code. The phantom was derived from a CT scan image of the DICOM-type pelvis with a size of 50 × 50 × 28.8 cm obtained from Santosa Kopo Hospital. The source used was Ir-192, which makes an asymmetrical beam with a size of 0.45 × 0.09 × 0.09 cm. Monte Carlo simulation was performed to determine the dose distribution of the Ir-192 source on cervical cancer CT images based on the Manchester system. The Monte Carlo simulation was divided into two models with distance variations on the applicator. Model A used TPS data with a distance between sources of 0.9 cm, while model B had a distance between sources of 0.5 cm. The distribution of dose resulting from the Monte Carlo simulation was analyzed and compared with TPS data. The results showed that at the range of 50 %, dose distribution in model A reaches the end of 3.9 cm. When compared to the range of 50 % dose distribution at the TPS results that reaches the point of 4 cm, it produces a deviation value of 2.5 %, which is still within the tolerance range. Model A and Model B provide different dose distribution. In model B, it reaches 3.86 cm, resulting in a deviation of 1.02 %, which is still within the tolerance range. The resulting γ-index value for the 50 % dose distribution was 2.26, while the whole area's GPR value was 94.13 %. This indicates a difference in dose distribution between the two models. Therefore, the smaller the distance between the sources, the shorter the dose distribution range with relatively more uniform dose distribution.

"Dosimetric Assessment of Routine X-Ray Examination at Selected Health Clinics in Perak Using Commercialized Optically-Stimulated Luminescence Dosimeter (OSLD) was explored by M. T. Saidin from School of Physics, Universiti Sains Malaysia Main Campus, Penang, Malaysia and A. A. Rahman, and Y. M. Radzi from Perak State Department, Ministry of Health Malaysia, Jalan Panglima Bukit Gantang Wahab, Perak, Malaysia under collaboration with H. H. Harun from Department of Physics, Faculty of Science, Universiti Putra Malaysia, Selangor, Malaysia, C. Anam from Department of Physics, Universitas Diponegoro, Jl. Prof. Soedarto, SH., Tembalang, Semarang, Indonesia and Medical Radiation Surveillance Division, Ministry of Health Malaysia, Wilayah Persekutuan Putrajaya, Malaysia. This study aims to compare entrance surface dose (ESD) values measured with nanoDot Al_2O_3:C optically-stimulated luminescence dosimeter (OSLD) and guidance level set under the second national dose survey which utilized old-version LiF:Mg,Ti thermoluminescence dosimeter (TLD). In this study, we conducted a dosimetric assessment for posteroanterior chest X-ray (PA-CXR) examinations performed at various community clinics in Perak, Malaysia. These clinics were selected as they were excluded from the first and second national dose survey conducted in Malaysia in 1993-1995 and 2005-2009, respectively. The ESD is obtained by mounting the OSLD on the surface of polymethyl methacrylate (PMMA) slabs. The PMMA slabs were then exposed to X-ray based on the current practice of respective clinics. The results show that the 3rd quartile of ESDs ranged from 0.180 mGy to 0.229 mGy, which is less than the recommended guidance level of the second national dose survey by 77 %. ESD measured using OSLD was found to be lower than the guidance values recommended from the second national dose survey. The finding showed a good competency of the radiographer to optimize radiological practice specifically in routine X-ray examination.

"Analysis of ^{137}Cs Radionuclide Content in Sediment in Musi Watershed using Gamma Spectrometer and its Affecting Factors" was written by T. A. Jaya and A. Mara from Department of Chemistry, Faculty of Mathematics and Natural Sciences, Sriwijaya University, Prabumulih Indralaya, Sumatra Selatan, Indonesia under collaboration with G. F. Amri from the Center for Safety Technology and Radiation Metrology, National Nuclear Energy Agency (BATAN), Lebak Bulus Raya, Jakarta, Indonesia. The concentration of the radionuclide ^{137}Cs on sediment in watershed in Palembang has been analyzed. This study aims to determine the influence of sampling location and the water quality indicators of water pH, sediment pH, conductivity, turbidity, and sediment type on the concentration of ^{137}Cs and to determine the distribution pattern of ^{137}Cs in sediments. Sampling was conducted at seven stations spaced approximately 5 km apart, placed from the western end to the eastern end of the Musi river segment located within Palembang City. Sediment samples were prepared and their ^{137}Cs contents were measured with gamma spectrometry. The results showed that their ^{137}Cs concentrations ranged from below MDC (minimum detectable concentration) to 1.51 Bq/kg. This was within the 1×10^3 Bq/kg limit set by the quality stan.

"Natural Radioactivity and the Evaluation of Related Radiological Risks in Concrete Used in Prizren District, Kosovo" was explored by M. Qafleshi, D. Kryeziu and D. Qafleshi from University for Business and Technology, Kalabria, Kosovo under collaboration M. K. Xhixha from University Aleksandër Moisiu Durrës, Faculty of Professional Studies, Durrës, Albania and G. Nafezi from University of Prishtina "Hasan Prishtina", Faculty of Mathematical and Natural Sciences, Str. "Nëna Terezë", Prishtina, Kosovo. This study aims to investigate the natural radioactivity levels in concrete made of Portland cement and used in Prizren district, Republic of Kosovo. The activity concentrations of 40K, 226Ra and 232Th were determined by gamma-ray spectroscopy technique with High Purity Germanium (HPGe) detector. The activity concentrations of 40K, 226Ra, and 232Th were found to be 15.4-28.4 Bq kg-1, 4.3-5.9 Bq kg-1 and 2.0-4.1 Bq kg-1, respectively. These results were used to calculate the activity concentration index as recommended by the Basic Safety Standard of Council Directive 2013/59/EURATOM for the safe use of building material. Kosovo must comply with this recommendation in the framework of legislative harmonization with the European Union. The activity concentration index was found to be lower than the reference level of unity (I=0.05), corresponding to an annual effective dose rate of AED=0.05 mSv y-1. The concentration of radionuclides and radiological hazard parameters for concrete investigated in this study were compared with respective results found in literature from different countries. These results show very low activity concentrations, indicating that concrete used in Prizren, Kosovo, does not pose any significant risk due to its use as building material.

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