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Editorial

Special Issue: "The Future of Nuclear Power for Clean Energy Systems"

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Currently, many countries are considering the construction of nuclear power plants as a result of rapidly changing global political and economic conditions. Research and development in the field of nuclear energy focus on a number of aspects related to the operation of nuclear power plants in the power system, nuclear security and safety, new reactor technologies, nuclear fuel cycles, spent nuclear fuel treatments, decommissioning and dismantling, etc. These issues undoubtedly constitute research topics for many scientific groups all over the world. This Special Issue, "The Future of Nuclear Power for Clean Energy Systems", contains four scientific papers related to significant topics in nuclear energy.

The paper by Mah and Kim, "Application of an Independent Temporary Spent Fuel Storage Pool Cooling System for Decommissioning of Pressurized Water Reactor Kori units 3 and 4", presents a study on the application of an independent temporary spent fuel storage pool cooling system in Kori nuclear power plant, units 3 and 4 [1]. The decommissioning of both units demands the removal of the radioactive spent nuclear fuel to a dedicated facility for its safe storage. However, such a facility is currently unavailable in Korea. The case study shows that the concept of temporary spent fuel storage can be implemented, and it is technically mature. Furthermore, based on an equivalent estimate of costs, the total installation cost per unit is USD 9.51 million. Compared with dry cask spent fuel storage options, it is much more economical. The selection of three cooling methods for the removal of decay heat are made by assessing the installation of an indirect air-cooled system. New heat exchangers, cooling pumps and chillers are included in this design. The ORIGEN decay heat calculations show that the peak heat generation of unit 4 is expected to be 1.67 megawatts. The cooling capacity as well as the contingency plan for potential single failure scenarios are main system requirements of the temporary spent nuclear fuel cooling system at Kori nuclear power plant.

The paper by Ayodele, Luta and Khan, "A Micro-Nuclear Power Generator for Space Missions", focuses on the modelling of a hybrid multi-mission radioisotope thermoelectric generator (MMRTG)—with an lithium-ion (Li-ion) battery [2]. Ensuring a continuous power supply and extended mission durations are critical functions of dependable energy storage systems, which makes them indispensable for spacecraft applications. Finding a power unit that overcomes the drawbacks of MMRTG and Li-ion batteries to create a highly dependable and efficient power source for autonomous systems, like spacecraft, was the primary challenge of this study. The proposed design of the hybrid system includes a 110 W/32 V RTG and a 3.6 V/43 Ah Li-ion battery coupled to a DC motor through power converters. The hybrid energy system's evaluation under various load scenarios reveals that a load resistance of 1 Ω allows for the achievement of the maximum power peak of 3500 W. Additionally, the findings demonstrate that the output voltage of the hybrid energy system is roughly identical at 253 °K and 293 °K. It was proven that the power cycle at

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the maximum hybrid voltage was longer and needed more time to decrease. Moreover, compared with those at low temperatures, there were fewer charge–discharge cycles at high temperatures. The adopted hybrid energy system has the potential to increase spacecraft mission duration, reliability, and efficiency, as evidenced by the presented results.

The paper by Sokólski et al., "Event-Triggered Communication in Cooperative, Adaptive Model Predictive Control of a Nuclear Power Plant's Turbo–Generator Set", investigates the problem of ensuring optimal communication between the components of a cooperating control system formed by two MPC controllers for nuclear power plant turbines using online least recursive squares identification [3]. The main goal of this paper was to propose a change in the method of information exchange in the case of asynchronous communication between control system components as well as prove its appropriateness for the chosen solutions. In contrast to the standard approach where communication is triggered by time, the authors propose using event-triggered communication, i.e., the transmission of information only at specified time instants. Since the recursive least squares method is used to estimate the parameters of an online model, there is a need to reduce discrepancies in real signals and those which are determined by identification systems as much as possible. Therefore, it is important to communicate even the smallest changes in signals that enable an RLS algorithm to keep better track of model parameters. Accordingly, a communication strategy is adopted which leads to the sending of updates when information on minimal signal changes results in an output threshold being exceeded. In order to reduce the load on the network by approximately 90% while maintaining the quality of control, it is possible to withdraw from continuous communication in favour of sending information only at certain moments, which was proved in the paper.

The paper by Kang and Kim, "The Impact of Full-System Decontamination of Kori unit 1 on the Radioactive Waste Classification of Steam Generator Tubes", shows the prediction of the radioactive inventory of steam generator tubes from Kori nuclear power plant, unit 1 [4]. Kori unit 1 was permanently shut down on 18 June 2017 and is planned to undergo full-system decontamination prior to major decommissioning activities. The reduction in the radioactive waste classification level is one of the benefits of implementing a full-system decontamination. Thus, the analysis was carried out to assess the effect on the steam generator tubes which account for a substantial part of the overall surface area during full-system decontamination operations. The radioactivity inventory of the Kori unit 1 steam generator tubes was estimated using the CRUDTRAN code. The total radioactive inventory of the steam generator tubes was calculated to be 5.17×10^{12} Bq. The values of the decontamination factors in the steam generator tube section from overseas cases were selected and applied for the estimation of radioactivity in the tubes after full-system decontamination. At that point, the regulations on radioactive waste in Korea were reviewed and specific activities calculated by accounting for the steam generator tubes' mass. Finally, it was confirmed that the steam generator tubes will be classified as low-level radioactive waste, and it will take more than 50 years for their clearance.

The presented scientific papers are an important contribution to the efforts towards the implementation of nuclear energy for clean energy systems. Other studies introducing new topics and enhancing the topics presented in this Special Issue by authors and editors are also available [5–8].

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