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Spent Fuel from Nuclear Power Reactors

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International Conference on the Management of Spent Fuel from Nuclear Power Reactors: *Meeting the Moment*

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Resources

1 [Comprehensive nuclear materials]

Editors-in-chief, Rudy J.M. Konings, Roger E. Stoller, (2020)

Abstract

Materials in a nuclear environment are exposed to extreme conditions of radiation, temperature and/or corrosion, and in many cases the combination of these makes the material behavior very different from conventional materials. This is evident for the four major technological challenges the nuclear technology domain is facing currently: (i) long-term operation of existing Generation II nuclear power plants, (ii) the design of the next generation reactors (Generation IV), (iii) the construction of the ITER fusion reactor in Cadarache (France), (iv) and the intermediate and final disposal of nuclear waste. In order to address these challenges, engineers and designers need to know the properties of a wide variety of materials under these conditions and to understand the underlying processes affecting changes in their behavior, in order to assess their performance and to determine the limits of operation. Comprehensive Nuclear Materials 2e provides broad ranging, validated summaries of all the major topics in the field of nuclear material research for fission as well as fusion reactor systems. Attention is given to the fundamental scientific aspects of nuclear materials: fuel and structural materials for fission reactors, waste materials, and materials for fusion reactors. The articles are written at a level that allows undergraduate students to understand the material, while providing active researchers with a ready reference resource of information. Most of the chapters from the first Edition have been revised and updated and a significant number of new topics are covered in completely new material. During the ten years between the two editions, the challenge for applications of nuclear materials has been significantly impacted by world events, public awareness, and technological innovation. Materials play a key role as enablers of new technologies, and we trust that this new edition of Comprehensive Nuclear Materials has captured the key recent developments.

2 [Thermal and reliability criteria for nuclear fuel safety]

Maksymov, Maksym (2021)

Abstract

The book covers basic approaches to the nuclear fuel state of energy reactors in the last stages of the nuclear fuel cycle, these have been developed by the authors based on Ukrainian Nuclear Power Plant (NPP) operational experience. The book is essential reading for anyone concerned with NPP maintenance and safety.

ISBN 9788770224017

3 [Radioactive waste management in the 21st century]

William R. Roy (2021)

Abstract

The safe management of radioactive wastes is of paramount importance in gaining both governmental and societal support for nuclear energy. The scope of this new textbook is to provide a comprehensive perspective on all types of radioactive wastes as to how they are created, classified, characterized, and disposed. Written to emphasize how geology and radionuclide chemistry impact waste management, this book is primarily designed for engineers who have little background in geology with low-level wastes, decommissioning wastes, high-level wastes and spent nuclear fuel. This textbook provides the most up-to-date information available on waste management in several countries. The content of this work includes transporting radioactive materials to disposal facilities. The textbook cites numerous case studies to illustrate past practices, current methodologies and to provide insights on how radioactive wastes may be managed in the future. An international perspective on waste management is also provided to help the readers better understand the diversity in approaches while highlighting what many countries have in common. Review questions for classroom use are provided at the end of each chapter.

4 **Review of spent nuclear fuel management in different developed countries**
Shi, L; Wang, YH; Ma,N; Liu,HJ, 2024.

Abstract

Spent nuclear fuel (spent fuel), which is used nuclear fuel that has been exposed to radiation usually produced by nuclear reactors in nuclear power plants, is an inevitable product from the development of nuclear energy. Almost all of the fuel content is radioactive, and long systematic process are required for the safety management, which has always been an important global issue. In order to make sure that spent nuclear fuel should be safely managed, different countries developing nuclear power have established a complete policy and legislative system, so as to ensure that the whole process of spent fuel management is systematic, standardized and effective. In developed countries such as France, Russia and Japan, closed -cycle strategy is implemented with industrial -scale reprocessing plant under construction or in operation. At present, China has become the country with the largest scale of nuclear power under construction in the world. There will be a large number of spent nuclear fuel requiring properly and safely managed. The lessons -learning of how developed countries managing spent nuclear fuel arising is important for China. The authors suggest that it is necessary to combine the top-level design to the legal practice, so that there are laws to respect during all steps of spent fuel management, and responsibilities of all parties are clear.

5 **National inventories and management strategies for spent nuclear fuel and radioactive waste : final methodology**
OECD Nuclear Energy Agency, OECD NEA, 2020 Report No.7424

Abstract

Radioactive waste inventory data are an essential element in the development of a national radioactive waste management programme since these data affect the design and selection of the ultimate disposal methods. Inventory data are generally presented as an amount of radioactive waste under various waste classes, according to the waste classification scheme developed and adopted by the country or national programme in question. Various waste classification schemes have thus evolved in most countries, and these schemes classify radioactive waste according to its origin, to criteria related to the protection of workers or the physical, chemical and radiological properties of the waste and the planned disposal method(s). The diversity in classification schemes across countries has restricted the possibility of comparing waste inventories and led to difficulties in interpreting waste management practices, both nationally and internationally. To help improve this situation, the OECD Nuclear Energy Agency (NEA) developed a methodology that ensures consistency of national radioactive waste and inventory data by presenting them in a common scheme in direct connection with accepted management strategy and disposal routes. This report provides the final version of the methodology and presenting scheme for nuclear and the radioactive waste of all existing types. Additionally, there are recommendations in the report on how to enhance the comparability of national inventory data using the NEA methodology. The NEA support for joint efforts of the International Atomic Energy Agency and the European Commission on harmonization of the reporting process by member countries to the Joint Convention and European Council Directive 2011/70 EURATOM is also presented in the report.

6 **Assessing the release, transport, and retention of radioactive aerosols from hypothetical breaches in spent fuel storage canisters**
Sasikumar, Y ; Chatzidakis, S ; Dahm, Z ; Durbin, SG ; Montgomery, R. Frontiers in Energy Research. Vol. 12 Article No. 1229025, 2024.

Abstract

Interim dry storage of spent nuclear fuel involves storing the fuel in welded stainless-steel canisters. Under certain conditions, the canisters could be subjected to environments that may promote stress corrosion cracking leading to a risk of breach and release of aerosol-sized particulate from the interior of the canister to the external environment through the crack. Research is currently under way by several laboratories to better understand the formation and propagation of stress corrosion cracks, however little work has been done to quantitatively assess the potential aerosol release. The purpose of the present work is to introduce a reliable generic numerical model for prediction of aerosol transport, deposition, and plugging in leak paths similar to stress corrosion cracks, while accounting for potential plugging from particle deposition. The model is dynamic (changing leak path geometry due to plugging) and it relies on the numerical solution of the aerosol transport equation in one dimension using finite differences. The model's capabilities were also incorporated into Graphical User Interface (GUI) that was developed to enhance user accessibility. Modealidation efforts presented in this paper compare the model's predictions with recent experimental data from Sandia National Laboratories (SNL) and results available in literature. We expect this model to improve the accuracy of consequence assessments and reduce the uncertainty of radiological consequence estimations in the remote event of a through-wall breach in dry cask storage systems.

7 [Determination of the 144Ce/238U atomic ratio in spent nuclear fuel using double spike isotope dilution mass spectrometry]

Aurélien Beaumais, Anthony Nonell, Céline Caussignac, Sébastien Mialle, Guillaume Stadelmann, Myriam Janin, Hélène Isnard, Michel Aubert, Thomas Vercouter and Frédéric Chartier, J. Anal. At. Spectrom., **2022,** 37**, 1288-1297**

Abstract

The low abundance cerium-144 radionuclide is one of the significant contributors to the decay heat from spent nuclear fuel for cooling times of less than ten years after nuclear reactor discharge. The accurate quantification of the 144Ce content (or 144Ce/238U) in irradiated nuclear fuel is necessary to validate and extend the neutronic calculation codes as well as to improve the short-term nuclear waste management strategies. In order to quantify the 144Ce/238U atomic ratios at low uncertainty, we developed a new analytical technique based on double spike isotope dilution associated with mass spectrometry. This includes (1) the chemical elimination of the major neodymium-144 isobaric interference by two steps of liquid chromatography prior to isotope analysis by Thermal Ionization Mass Spectrometry (TIMS) using both total evaporation and sequential methods, and (2) the preparation and use of an in-house double spike solution, using a mixture of a natural Ce solution with a 233U-enriched solution. This new approach was applied for the first time on two Mixed Oxide (MOx) spent nuclear fuel samples and allowed the determination of 144Ce/238U atomic ratios ranging from 35 × 10−6 to 59 × 10−6 with a relative expanded uncertainty of measurement of around 1% at a 95% confidence level.

8 [Guidebook on Spent Fuel Storage Options and Systems, Third Edition]

Technical Reports Series No. 240, IAEA, Vienna (2024)

Abstract

This publication is a new edition of Technical Reports Series No. 240, Guidebook on Spent Fuel Storage (1991). It aims to provide guidance on spent fuel storage options, describing the history and observed trends of spent fuel storage technologies, gathering operational experiences and lessons learned. The evolving aspects related to higher burnup and mixed oxide (MOX) spent fuel, and the extension of storage timeframes are detailed. It also includes information on the distribution of the current global inventory of spent fuel by storage systems, a description of (and terminology relating to) available spent fuel storage technologies and different storage facility locations.

9 [Practices for interim storage of Research reactor spent nuclear fuel, IAEA Nuclear Energy Series No. NF-T-3.10, IAEA, Vienna (2020)]

Abstract

This publication provides an introduction to the management of research reactor spent nuclear fuel (RRSNF). Five key areas are discussed: types of RRSNF, characterization data, wet storage considerations, dry storage considerations, and lessons learned and current practices. Information on internationally accepted standards as well as information on aspects such as drying treatment and surveillance programmes are presented, as well as suggestions for further optimization of effective and safe storage of RRSNF through the application of new approaches. The intended users of this publication include industry professionals at operating research reactors and at RRSNF storage facilities who need to identify the most suitable approach for interim storage of spent fuel.