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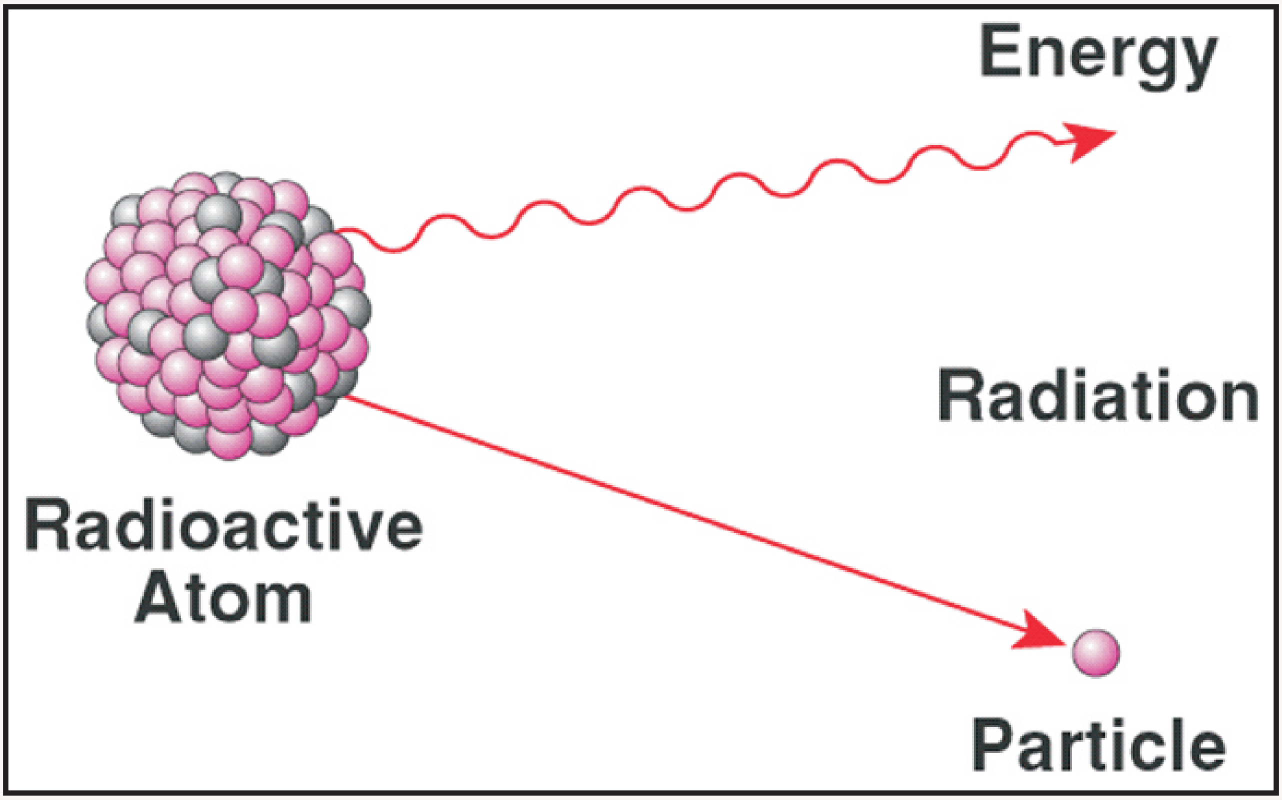

CSIR-INDIA

Indian Institute of Toxicology Research

IN THIS ISSUE

EDITORIAL

Radioactivity was first discovered in 1896 by the french scientist Henri Becquerel for which he received the nobel prize. Further research by Marie Curie, Pierre Curie, Ernest Rutherford and others led to discovery of several functions of radioactive compounds. Studies done on survivors and offsprings of Hiroshima and Nagasaki nuclear attack during World War-II conclusively revealed genetic changes and malformations in their DNA. The main concern is that genetic damage from the nuclear exposure may be transmitted to several generations. In 1986 worst reactor disaster (Chernobyl) took place whose effects were widespread. The World Health Organization (WHO) found that the radiation released due to Chernobyl accident was 200 times more than that of the Hiroshima and Nagasaki nuclear bombs combined.

Radioactivity is the process whereby unstable atomic nuclei release energetic subatomic particles. Radioactive substances are used to study living organisms, to diagnose and treat diseases, to sterilize medical instruments and food, to produce energy for heat and electric power, and to monitor various steps in all types of industrial processes. About 3% of India's electricity is generated by sixteen nuclear reactors and seven more are under construction. Nuclear waste generated during use of radioactive elements needs to be safely managed because it is potentially hazardous to human health and the environment. Inadequate management of waste of radioactive material has been reported to result into radiation exposure to people or extensive contamination of equipment, buildings or land. By using good practices during production & use of radionuclides, the amount of waste can be considerably reduced but not fully eliminated.

The radioactivity of all nuclear waste diminishes with time. All radioisotopes contained in the waste have a half-life (the time it takes for any radionuclide to lose half of its radioactivity). Eventually all radioactive waste decays into non-radioactive elements for example, after 40 years 99.9% of radiation in spent nuclear fuel disappears. This property of radioactivity indicates that proper management & disposal of waste can be helpful for protecting people and the environment. The main approaches to managing radioactive waste to date have been segregation and storage for short-lived wastes, near-surface disposal for low and some intermediate level wastes, and deep and secure burial for the long-lived high-level wastes. Spent fuel is processed at facilities in Trombay & Tarapur near Mumbai & Kalpakkam near chennai. It is important that safe waste management, in full compliance with all relevant regulations is considered and planned at the beginning of projects involving radioactive materials.

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Distributed Information Centre on Toxic Chemicals

Environmental Information System (ENVIS)

at IITR, Lucknow

ODDS & ENDS

Removal of radioactive caesium from low level radioactive waste streams using cobalt ferrocyanide impregnated organic anion exchanger

The volumes of low level waste (LLW) generated during the operation of nuclear reactor are very high and require a concentration step before suitable matrix fixation. The volume reduction (concentration) is achieved either by co-precipitating technique or by the use of highly selective sorbents and ion exchange materials. This study deals with the preparation of cobalt ferrocyanide impregnated on anion exchange resin and its evaluation with respect to removal of caesium (Cs) in LLW streams both in column mode and batch mode operations. The Kd values (is a measure of how readily one species sorbs to a surface) of the prepared exchanger materials were found to be very good in actual reactor LLW solutions also. It was observed that the exchanger performed very well in the pH range of 3-9. A batch size of 6 g L^{-1} of the exchanger was enough to give satisfactory decontamination for Cs in actual reactor LLW streams. The lab scale and pilot plant scale performance of the exchanger material in both batch mode and column mode operations was very good.

Journal of Hazardous Materials 2009, 166/2-3, 1148-53.

Improved performance of a biomaterial-based cation exchanger for the adsorption of uranium (VI) from water and nuclear industry wastewater

The amine-modified polyhydroxyethylmethacrylate (poly(HEMA))-grafted biomaterial (tamarind fruit shell, TFS) carrying carboxyl functional groups at the chain end (PGTFS-COOH) was prepared and used as an adsorbent for the removal of uranium (VI) from water and nuclear industry wastewater. Fourier Transform Infrared spectral analysis revealed that uranium (VI) ions and PGTFS-COOH formed a chelate complex. The adsorption process was relatively fast, requiring only 120 min to attain equilibrium. The adsorption kinetic data were best described by the pseudo-second-order equation. The equilibrium adsorption data were correlated with the Sips isotherm model. The maximum uranium (VI) ions uptake with PGTFS-COOH was estimated to be 100.79 mg/g. The complete removal of 10 mg/L uranium (VI) from simulated nuclear industry waste-water was achieved by 3.5 g/L PGTFS-COOH. The reusability of the adsorbent was demonstrated over 4 cycles using NaCl (1.0M)+HCl (0.5M) solution mixture to de-extract the uranium (VI). The results show that the PGTFS-COOH tested is very promising for the recovery of uranium (VI) from water and wastewater.

Journal of Environmental Radioactivity 2009, 100/3, 250-257.

Synthesis and characterization of imprinted polymers for radioactive waste reduction

A cobalt (II) imprinted polymer that could lead to significant reduction in radioactive waste volume generated during decontamination of nuclear reactors, was synthesized using [*N*-(4-vinylbenzyl) imino] diacetic acid as the functional monomer through two different methods. The imprinted polymer was found to selectively trap cobalt (II) ions even when present in ppb levels from strong complexing medium against excess ferrous ions. It showed no uptake of ferrous ions under the conditions tested. Cobalt sorption and desorption were found to be rapid. The cobalt selectivity of the polymer was also demonstrated with radioactive cobaltous ions wherein it showed 55% reduction in cobalt activity from a complexing solution containing 2 μCi of radio-active cobalt along with excess ferrous ions. The selectivity of the polymer was compared to that of a commercial resin containing similar functional ligand.

Industrial & Engineering Chemistry Research 2009, 48/8, 3730–3737.

Removal of uranium (VI) from aqueous solutions and nuclear industry effluents using humic acid-immobilized zirconium-pillared clay

Removal of uranium (VI) from aqueous solutions with humic acid-immobilized zirconium-pillared clay (HA-Zr-PILC) was investigated using a batch adsorption technique. The adsorbent was characterized using x-ray diffraction, fourier transform infrared, scanning electron micro-copy, thermogravimetry, surface area analyzer and potentiometric titration. The effects of pH, contact time, initial concentration, adsorbent dose, and adsorption isotherm on the removal process were evaluated. A maximum removal of 97.6±2.1 and 94.7±3.3% was observed for an initial concentration of 50 and 100 mg L^{-1}, respectively at pH 6.0 and an adsorbent dose of 2.0g L^{-1}. Equilibrium was achieved in approximately 180 min. The mechanism for the removal of uranium (VI) ions by HA-Zr-PILC was based on an ion exchange reaction. The experimental kinetic and isotherm data were analyzed using a second-order kinetic equation and Langmuir isotherm model, respectively. The monolayer adsorption capacity for uranium (VI) removal was found to be 132.68±5.04 mg g^{-1}. An increase of temperature of the medium caused an increase in metal adsorption. Complete removal (congruent with 100%) of uranium (VI) from 1.0 L of a simulated nuclear industry effluent sample containing 10.0 mg uranium (VI) ions was possible with 1.5 g of HA-Zr-PILC. The adsorbent was suitable for repeated use (over 4 cycles) without any noticeable loss of capacity.

Journal of Environmental Radio-activity, doi:10.1016/j.jenvrad.2009.12.001

Geological disposal of high-level nuclear waste feasible

There is a scientific consensus that safe geological disposal of high-level nuclear waste is technically feasible. The European Commission's Joint Research Centre (JRC) has analysed the state of the art of science, technology and procedures needed across the European Union (EU) for implementation. It has identified no major conceptual or research gap for the host rocks and repository systems envisaged, namely those in clays, hard rocks and salt.

The new research from the JRC, conducted by Institute for Energy (IE), concludes that the critical step in implementing this waste management solution is regulatory approval, coupled with public acceptance. The approval requires an adequate set of regulations and criteria for evaluation as well as enabling of regulators. The report, entitled "Geological disposal of radioactive waste: moving towards implementation", summarises these requirements.

There are numerous difficulties behind implementation of geological disposal. While final responsibility rests with the national regulators and although a harmonised European regulatory framework could be of some advantage, the report concedes that "broad consensus" might be the most realistic approach, with individual countries retaining their own regulatory mechanisms. In addition, enabling and resourcing national regulators is likely to become an important task in the near future in some countries, thus ensuring that they are capable of performing the required tasks.

Regarding geological disposal, the situation is different across Europe. Some countries, such as Sweden and Finland, have defined road-maps with specific dates for implementation. Others, such as Germany and the UK, are also technically advanced and have identified suitable host rock formations, but the development of disposal facilities at specific sites continues to be held back due to local opposition. In most of the countries that have more recently joined the EU, funding and knowledge acquisition are additional barriers to implementation.

In this line, the report calls for continuing scientific co-operation to ensure a harmonised level of understanding throughout the EU. It suggests as well that mechanisms to demonstrate equivalence between member states' regulations might be a more efficient approach as opposed to harmonised or unified regulations and adds that supporting more advanced countries in their implementation is likely to create synergies in other member states. Finally, it analyses the possible benefits of sharing radioactive waste management facilities between countries.

Research perspective

On a technical level, the JRC report examines the various elements of a deep geological repository system: waste forms, containers, buffers, backfills and host rocks. Research in these areas appears to be mature enough to proceed with step-wise implementation that provides options for review and reverting decisions after each step. Continuing R&D activities in these topics are not a sign of immaturity or lack of confidence, but an effort to demonstrate that decisions are still valid or to further increase safety margins. However, other areas have been identified where further research could be conducted. They relate to:

- Certain processes affecting radionuclide behaviour in the repository and the surrounding rock, such as the microbiological activity during repository development and after closure, and physico-chemical surface processes affecting long-lived radionuclides as well as their colloid-mediated migration.

- Gas generation and multi-phase flow processes as there is a limited number of conceptual and numerical modelling tools available.

- The interaction between the repository components, such as the interaction of host rocks with steel corrosion products and other feedback and coupling mechanisms into the geomechanical properties.

Science Daily Oct. 18, 2009

Is it safe to store US nuclear waste above ground?

If leading United States (US) energy experts have their way, the US will be storing tens of thousands of tonnes of nuclear waste above ground for decades to come. But are dry casks, originally intended as a short-term fix for nuclear waste, a safe bet?

Researchers from Massachusetts Institute of Technology and Harvard University fielded questions from US Senator Tom Carper yesterday in Cambridge, Massachusetts on what the US should do with its nuclear waste now that plans for Yucca Mountain, a national underground repository, have been put on hold by the Obama administration. Surprisingly, the assembled scientists unanimously told Carper not to worry, saying existing aboveground storage would be perfectly save for another 60 to 70 years. Instead, they pressed the senator to spend time and money developing better waste reprocessing technology, rather than rush to develop the same reprocessing technology now used by Japan and other countries. Existing reprocessing technology is "costly, prone to sabotage, offers very little waste reduction, and very little additional energy," said Harvard's Matthew Bunn of a process that can yield weapon-grade plutonium.

So, which is better? Storing spent fuel for decades on end in less than ideal storage conditions while working on developing safer, more efficient reprocessing technology, or reprocessing the waste today into plutonium rich fuel? The US Nuclear Regulatory Commission says that, based in part on an unblemished 20-year track record, dry cask storage is perfectly safe. But similar casks in the UK have corroded in the past, exposing radioactive waste to the elements. Whatever decision Carper and his fellow congressmen decide to pursue could have far reaching implications.

Ernest Moniz of MIT closed the discussion saying that to reduce greenhouse gas emissions, building new nuclear plants as soon as possible should be our number-one priority.

New Scientist May 19, 2009

Glass matrices for vitrification of radioactive waste – An update on R & D efforts

Majority of radioactivity in the entire nuclear fuel cycle is concentrated in high level radioactive liquid waste (HLW), which is generated during reprocessing of spent nuclear fuels. A three-step strategy for management of HLW has been adopted in India. This involves:

(a) Immobilization of waste oxides in stable and inert solid matrices

(b) Interim retrievable storage of the conditioned waste under continuous cooling

(c) Disposal in deep geological formations.

Radioactive waste gets generated at different stages of nuclear fuel cycle like mining/milling, fuel fabrication, reactor operation, reprocessing of spent fuel and the production & application of radioisotopes for various industrial, medical and research purposes. High Level radioactive Waste (HLW) is generated during reprocessing of spent nuclear fuel and it contains most of the radioactivity present in entire fuel cycle. Vitrification of HLW in borosilicate matrix is being practiced using induction heated metallic melters at industrial scale plants at Tarapur and Trombay. The nature of HLW largely depends on off – reactor cooling of spent nuclear fuel, its type and burn – up, and reprocessing flow sheet. In view of varying characteristics, processing of HLW at Tarapur and Trombay has offered a wide spectrum of challenges in terms of development of matrices and characterization to accommodate compositional changes in waste. The present paper summarizes details of extensive R and D efforts made in the Department of Atomic Energy towards development and characterization of glass formulations for immobilization of HLW.

IOP Conf. Series: Materials Science and Engineering 2 (2009) 012002 (doi:10.1088/1757-899X/2/1/012002)

Spent fuel management in India

The Indian nuclear story is different from the rest of the nuclear power producing countries largely due to the unique nuclear energy path the country has chosen. The issues regarding the resultant spent nuclear fuel are also accordingly different. Based on the ideology of self-dependence, India adopted a three-stage nuclear energy program which envisages reprocessing spent fuel aimed at the final utilization of the vast amount of thorium reserves in the country. The nuclear test of 1974 and the country's subsequent nuclear isolation furthered this technology innovation. At present, nuclear energy contributes a merely 3% (approximately) of the total energy produced in the country. Since the program is very small, high level waste (HLW) after reprocessing is very minimal and its management at present does not pose any major concerns. But with India's rapid economic growth, access to electricity is becoming crucial and nuclear energy is viewed as a promising source to meet future demand. The government is envisaging substantial raising of nuclear power production in the next couple of decades. With the objective of expanding nuclear energy production, India in 2008 came out of nuclear isolation through a special agreement with the International Atomic Energy Agency (IAEA), the USA, and Nuclear Suppliers Group (NSG) countries that allows members of the nuclear club to undertake nuclear trade with India. While we are not certain what shape India's nuclear energy program will take, it is certain that the proposed expansion plan will lead to HLW becoming a concern in the future.

Journal of Risk Research 2009, 12/7-8, 955 – 967.

Activity limit for earth trench disposal of radioactive solid waste based on radionuclide leaching and well groundwater yield

Low and intermediate level radioactive solid waste generated from nuclear power plants, is generally disposed in near surface solid waste disposal facilities (NSDF) such as earth trenches, reinforced concrete trenches (R.C.T) and tile holes. The important radionuclides present in these wastes include 137Cs, 134Cs, 90Sr, 60Co, 54Mn and 3H. The wastes with very low concentration of radionuclide content are disposed off in earth trenches due to economic reason. The radionuclides disposed off in the earth trenches may migrate from the disposal system to the groundwater while interacting with the rainwater and may also reach the groundwater utilization point of the public during the transportation process. Intake of water containing radionuclides concentration above certain levels results in radiation dose to the public. A public dose limit of 0.05 mSv/y is apportioned to the near surface solid waste disposal facilities through the terrestrial route including groundwater pathways. In this investigation acceptable/benchmark concentration of the important radionuclides in groundwater based on the terrestrial dose limits was derived. This benchmark concentration can be used to monitor the regulatory compliance and assess the quality of groundwater with respect to radiation safety. This study also discusses the acceptable distance of the groundwater utilization points of the public from the waste disposal facilities based on easily mobile radionuclides. Efforts are also made to derive the permissible activity limit for the earth trench disposal of radioactive solid waste based on terrestrial dose apportionment, permissible ground-water radionuclide concentration, well groundwater yield and ingestion toxicity index.

Proceedings of the 12th IACMAG: Geomechanics in the Emerging Social & Technological Age, 1-6 October 2008, 2248-2253.

Radioactive waste management plan for the PBMR (Pty) Ltd fuel plant

The Pebble Bed Modular Reactor (Pty) Ltd Fuel Plant (PFP) radioactive waste management plan caters for waste from generation, processing through storage and possible disposal. Generally, the amount of waste that will be generated from the PFP is low and intermediate level waste. The waste management plan outlines all waste streams and the management options for each stream. It also discusses how the Plant has been designed to ensure radioactive waste minimisation through recycling, recovery, reuse, treatment before considering disposal. Compliance to the proposed plan will ensure compliance with national legislative requirements and international good practice.

The national and the overall waste management objective is to ensure that all PFP wastes are managed appropriately by utilising processes that minimize, reduce, recover and recycle without exposing employees, the public and the environment to unacceptable impacts. Both International Atomic Energy Agency (IAEA) and Department of Minerals and Energy (DME) principles act as a guide in the development of the strategy in order to ensure international best practice, legal compliance and ensuring that the impact of waste on employees, environment and the public is as low as reasonably achievable. The radioactive waste classification system stipulated in the Radioactive Waste Management Policy and Strategy 2005 will play an important role in classifying radioactive waste and ensuring that effective management is implemented for all waste streams, for example gaseous, liquid or solid wastes.

Nuclear Engineering & Design 2009, 239/10, 2196-2200.

THE PRINCIPLES OF RADIOACTIVE WASTE MANAGEMENT

Since the beginning of the twentieth century, research and development in the field of nuclear science and technology have led to wide scale applications in research, medicine, industry and in the generation of electricity by nuclear fission. In common with certain other human activities, these practices generate waste that requires management to ensure the protection of human health and the environment now and in the future, without imposing undue burdens on future generations. Radioactive waste may also result from the processing of raw materials that contain naturally occurring radionuclides. To achieve the objective of safe radioactive waste management requires an effective and systematic approach within a legal framework within each country in which the roles and responsibilities of all relevant parties are defined.

Radioactive waste occurs in a variety of forms with very different physical and chemical characteristics, such as the concentrations and half-lives of the radionuclides.

This waste may occur:

- In gaseous form, such as ventilation exhausts from facilities handling radioactive materials.
- In liquid form, ranging from scintillation liquids from research facilities to high level liquid waste from the reprocessing of spent fuel.
- In solid form, ranging from contaminated trash and glassware from hospitals, medical research facilities and radiopharmaceutical laboratories to vitrified reprocessing waste or spent fuel from nuclear power plants when it is considered a waste.

Such wastes may range from the slightly radioactive, such as in those generated in medical diagnostic procedures, to the highly radioactive, such as those in vitrified reprocessing waste or in spent radiation sources used in radiography, radiotherapy or other applications. Radioactive waste may be very small in volume, such as a spent sealed radiation source, or very large and diffuse, such as tailings from the mining and milling of uranium ores and waste from environmental restoration. Basic principles for radioactive waste management have been developed even though there are large differences in the origin and characteristics of radioactive waste, for example, concentration, volume, half-life and radiotoxicity. Although the principles are generally applicable their implementation will vary depending on the types of radioactive waste and their associated facilities.

Radioactive waste, as a source of ionizing radiation, has long been recognized as a potential hazard to human health. National regulations and internationally recommended standards and guidelines dealing with radiation protection and radioactive waste management have been developed, based on a substantial body of scientific knowledge. It has been a feature of radioactive waste management that special attention has been given to the protection of future generations. Considerations related to future generations may include potential radiation exposure, economic consequences and the possible need for surveillance or maintenance. Radioactive waste may also contain chemically or biologically hazardous substances and it is important that hazards associated with these substances are adequately considered in radioactive waste management.

Fundamental safety approaches for

the management of radioactive waste are based on international experience. In its Radioactive Waste Safety Standards (RADWASS) series of publications, the IAEA integrates this experience into a coherent set of fundamental principles, standards, guides and practices for achieving safe radioactive waste management.

Principle 1: Protection of human health

Radioactive waste shall be managed in such a way as to secure an acceptable level of protection for human health.

Principle 2: Protection of the environment

Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment.

Principle 3: Protection beyond national borders

Radioactive waste shall be managed in such a way as to assure that possible effects on human health and the environment beyond national borders will be taken into account.

Principle 4: Protection of future generations

Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today.

Principle 5: Burdens on future generations

Radioactive waste shall be managed in such a way that will not impose undue burdens on future generations.

Principle 6: National legal framework

Radioactive waste shall be managed within an appropriate national legal framework including clear allocation of responsibilities and provision for independent regulatory functions.

Principle 7: Control of radioactive waste generation

Generation of radioactive waste shall be kept to the minimum practicable.

Principle 8: Radioactive waste generation and management interdependencies

Interdependencies among all steps in radioactive waste generation and management shall be appropriately taken into account.

Principle 9: Safety of facilities

The safety of facilities for radioactive waste management shall be appropriately assured during their lifetime.

AEA Safety Series no. 111-F. The Principles of Radioactive Waste Management, International Atomic Energy Agency, Vienna, 1995.

DID YOU KNOW ?

- Seven Near Surface Disposal Facilites have been operating within the country for disposal of low and intermediate level solid wastes.
- A typical 1000 MWe reactor produces 25 tonnes of spent fuel a year.
- India is known to be the only country in the world, planning multiple plutonium recycling schemes.
- Sources of radioactive waste: Uranium mining and milling, electricity generation. decommissioning nuclear reactors, reprocessing of spent fuel, military wastes, medical and industrial applications.

Table-1 : Half-Life of some radioactive isotopes produced during nuclear reactions

Sl. No.	Isotope	Half-life	Isotope	Half-life	Isotope	Half-life
1. Shorter half-life	Strontium-89	54 days	Zirconium-95	65 days	Niobium-95	39 days
	Ruthenium- 103	40 days	Rhodium-103	57 minutes	Rhodium-106	30 seconds
	Lanthanum-140	40 h	Iodine-131	8 days	Tellurium-134	42 minutes
	Cerium-141	32 days	Barium-140	13 days	Xenon-133	8 days
2. Medium half-life	Hydrogen-3	12 years	Krypton-85	10 years	Strontium-90	29 years
	Ruthenium-106	1 year	Cesium-137	30 years	Cerium-144	1.3 years
	Promethium-147	2.3 years	Plutonium-238	85.3 years		
3. Longer half-life	Technecium -992'	106 years	Iodine-129 1.7´	107 years	Americium-241	440 years
	Plutonium-240	6500 years	Americium-243	7300 years	Plutonium-239	24000 years

Current Science 2001, 81/12 1535-1546.

Table-2 : Radioactive Hazard Symbols

Sign of ionizing radiation

Sign of radioactive materials

Table-3 : Nobel Prizes Awarded in the Field of Radioactivity

Sl. No.	Year	Discover	Country	Field	Achievement
1.	1903	Antoine Henri Becquerel	France	Physics	Discovery of spontaneous radioactivity.
		Pierre Curie Marie Curie	France	Physics	Extraordinary services rendered by research on the radiation phenomena discovered by professor Henri Becquerel.
2.	1904	Sir William Ramsay	Great Britain	Chemistry	Services in the discovery of the inert gaseous elements in air, and his determination of their place in the periodic system.
3.	1908	Ernest Rutherfod	Great Britain	Chemistry	Investigations into the disintegration of the elements, and the chemistry of radioactive substances.
4.	1911	Marie Curie	France	Chemistry	Services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element.
5.	1921	Frederick Soddy	Great Britain	Chemistry	Investigations into the origin and nature of isotopes.
6.	1934	Harold Clayton Urey	USA	Chemistry	Discovery of heavy hydrogen.
7.	1935	Frdric Joliot Irne Joliot-Curie	France	Chemistry	Synthesis of new radioactive elements.
8.	1938	Enrico Fermi	Italy	Physics	Demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons.
9.	1939	Ernest Orlando Lawrence	USA	Physics	Invention and development of the cyclotron and for results obtained with it, especially with regard to artificial radioactive elements.
10.	1943	George de Hevesy	Hungary	Chemistry	Use of isotopes as tracers in the study of chemical processes.
11.	1944	Otto Hahn	Germany	Chemistry	Discovery of the fission of heavy nuclei.
12.	1951	Sir John Douglas Cockcroft Ernest Thomas Sinton Walton	Ireland Great Britain	Physics	For their pioneer work on the transmutation of atomic nuclei by artificially accelerated atomic particles.

		Edwin Mattison McMillan Glenn Theodore Seaborg	USA USA	Chemistry	Discoveries in the chemistry of the transuranium elements.
13.	1960	Willard Frank Libby	USA	Chemistry	Method to use Carbon-14 for age determination in archaeology, geology, geophysics, and other branches of science.
14.	1977	Rosalyn S. Yalow	USA	Physiology or Medicine	Development of radioimmunoassays of peptide hormones.

http://www.vigyanprasar.gov.in/scientists/AntoineHenriBecquerel.htm

CURRENT CONCERNS

Radioactive waste generates either from civilian nuclear activities or from defence-related nuclear-weapon activities poses a difficult problem for handling & it requires proper management. It is a cause for concern as it causes a number of health hazards for anybody who comes into contact with the radiation emitted from waste because it does not decompose naturally in environment if disposed off improperly. Harmful radioactive emissions can cause skin cancer and genetically alter the DNA of people coming into contact with them, the effects of which will be passed to offspring of victims for many generations to come. By proper management, living being & environment can be protected by its adverse effects because radioactivity of all nuclear waste diminishes with time.

REGULATORY TRENDS

The International Atomic Energy Agency (IAEA) is promoting acceptance of some basic tenets by all countries for radioactive waste management. These include:

(i) Securing acceptable level of protection of human health

(ii) Provision of an acceptable level of protection of environment

(iii) While envisaging (i) and (ii), assurance of negligible effects beyond national boundaries;

(iv) Acceptable impact on future generations and

(v) No undue burden on future generations

Disposal of radioactive wastes and protection from radiation generated by radioactive waste have been followed by following regulations:

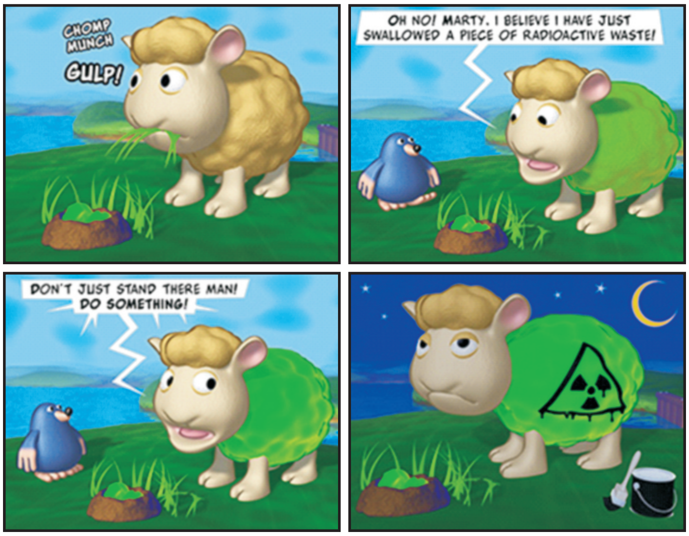
(i) The Atomic Energy Act, 1962 (33 of 1962)

(ii) The Radiation Protection Rules, 1971 and

(iii) The Atomic Energy (Safe disposal of Radioactive Wastes) Rules 1987

The Atomic Energy Regulatory Board (AERB) issued comprehensive guidelines in March 2004, on waste management for nuclear power plants using pressurized heavy water reactors, which were the mainstay of India's programme. The guidelines cover all aspects of waste manage - ment, including transport, storage and disposal facilities. Each plant is to set up its waste management organisation, plant, and related facilities before commissioning. However, in the Indian context, implementation of guidelines and codes needs to be carefully monitored, especially by citizen's groups.

ON THE LIGHTER SIDE



Source: www.seamoursheep.com/ comics.php?id=61

ON THE WEB

http://www.aerb.gov.in/T/actsrules/atomicenergyact_amendment1987.htm
This link provides information on various features of Atomic Energy Act.

http://www-ns.iaea.org/conventions/waste-jointconvention.htm
This website link to International Atomic Energy Agency Convention entitled "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management," entered into force on 18 June 2001.

http://www-pub.iaea.org/MTCD/publications/PDF/rwmp-3/FOREWORD.pdf
Waste Management Database developed by International Atomic Energy Agency contains information on national waste management programmes, activities, plans, policies, relevant regulations and waste inventories.

http://alsos.wlu.edu/qsearch.aspx?browse=science/Nuclear+Waste
Provides an annotated bibliography of over 2,700 books, articles, films, CDs, and websites about a broad range of nuclear issues.

CONFERENCES

Nuclear waste management: Research challenges for the future (2010)
28-29 September 2010
E-Mail: ian.farnan@esc.cam.ac.uk
Website: http://www.geolsoc.org.uk/gsl/op/preview/views/nwm

Waste management 2010
12- 14 July 2010
E-Mail: ajones@wessex.ac.uk
Website: http://www.wessex.ac.uk/10-conferences/waste-management-2010.html

Water and wastewater treatment plants in towns and communities of the xxi century: Technologies, design and operation
2-4 June 2010
Email: iwaconference@sibico.com
Website: http://www.iwaconference.ru

The International conference on Environmental Pollution and Public Health (EPPH2010)
21-23 June 2010
Email: epph@icbbe.org
Website: http://www.icbbe.org/epph 2010/

BOOK STOP

Stability and buffering capacity of the geosphere for long-term isolation of radioactive waste: Application to crystalline rock
Authors: OECD Publishing
Publisher: OECD Publishing, 2009
ISBN: 9264060561, 9789264060562

Cleaning up sites contaminated with radioactive materials: International workshop proceedings
Authors: National Research Council (U.S.). Committee on Cleaning Up of Radioactive Contamination: Russian Challenges and U.S. Experience, Office for Central Europe and Eurasia, Russian Academy of Sciences, National Research Council
Publisher: National Academies Press, 2009
ISBN: 0309127610, 9780309127615

The reporter's handbook on nuclear materials, energy, and waste management
Authors: Michael R. Greenberg, Bernadette M. West, Karen W. Lowrie, Henry J. Mayer
Publisher: Vanderbilt University Press, 2009
ISBN: 0826516602, 9780826516602

Nuclear energy: an introduction to the concepts, systems, and applications of nuclear processes
Author: Raymond L. Murray
Publisher: Butterworth-Heinemann, 2009
ISBN: 0123705479, 9780123705471

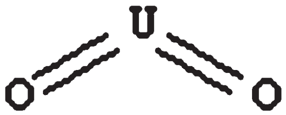
MINI PROFILE OF URANIUM DIOXIDE

SYNONYMS: C.I. 77915, dioxido de uranio, dioxyde d'uranium, urandioxid, urania, uranium dioxide, uranium oxide, uranium (4+) dioxide, uranium (iv) oxide, γ-uranium dioxide.

CAS RN: 1344-59-8

MOLECULAR FORMULA: UO_2

MOLECULAR STRUCTURE:



MOLECULAR WEIGHT: 270.03 g/mol

PROPERTIES: Black, radioactive & crystalline powder. Density: 10.97 g/cm^3, Melting point: 2865 °C, insoluble in water

USES: It is used in nuclear fuel rods in nuclear reactors. A mixture of uranium and plutonium dioxides is used as mixed fuel. Prior to 1960 it was used as yellow and black color in ceramic glazes and glass.

TOXICITY DATA:
orl-rat LD :>4 gm/kg
ihl-rat LC :>110 mg/m^3/1H
ipr-rat LD_{50}: 120 mg/kg
orl-mus LD :>2 gm/kg
ihl-mus LC :>110 mg/m^3/1H
ipr-mus LD_{50}: 140 mg/kg

PERSONAL PROTECTION: Wear protective clothing, rubber gloves, chemical goggles & high efficiency particle respirator.

STORAGE: Keep container dry. Store away from excessive heat. Keep container closed to prevent contamination.

Route	Symptoms	First Aid	Target Organ
Inhalation/ Ingestion	May cause kidney damage and acute necrotic arterial lesions. May also affect liver function. Causes lung irritation.	Wash out mouth with water but never give liquids to an unconscious person.	Lung, Kidney & Liver
Contact	May irritate eyes and cause dermatitis.	Wash eyes with copious amounts of water for minimum of 15 minutes. Remove contaminated clothing, then rinse skin thoroughly with large amounts of soap and water to remove all traces of the substance. If irritation persists, contact qualified medical practitioner.	Skin & Eyes.

Scientist In-Charge

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