



Waste management

Prevention and Minimization of Waste Production

THE SOUND MANAGEMENT of both radioactive and conventional waste and of the environment starts by reducing the waste production in all three phases of the life cycle of nuclear installations: design, operation, and decommissioning. SCK•CEN develops new processes and technologies to reduce the production of radioactive waste.

Objectives The general objective of the programme Prevention and Minimization of Waste Production is to contribute to reducing the volumes and costs of nuclear waste. It also aims to provide reliable data and models to the design engineers with a view to determining the final plant characteristics. In the long term, these objectives will be extended to other nuclear applications. Medium-term objectives are

- to demonstrate a process for the removal of boron from PWR waste and to purify boric acid for recycling;
- to define and assess adequate treatment and conditioning techniques for exotic materials such as aluminium, beryllium, lead, tritium, radium, and other isotopes if necessary;
- to define and assess an effective deactivation process to be applied to activated metals;
- to demonstrate and apply existing technology and technology developed in house to the recycling of contaminated materials;
- to define and assess new soil-restoration techniques.

Boron recovery from reactor effluents At most PWRs, evaporation of the Low-Level Liquid Waste (LLW) guarantees high decontamination factors and thus low releases of radioactivity. However, the boron concentration in these effluents limits the volume-reduction factor; the boron-containing evaporator concentrates thus represent an important fraction of the nuclear waste.

SCK•CEN therefore developed a process involving the separation of boric acid from evaporator concentrates. This process separates and purifies solid boric acid by volatilization with

superheated, followed by desublimation at a temperature slightly above the dew point of the steam.

In 1997, SCK•CEN and Královopolská-RIA (Czech Republic) collaborated to develop and propose a boron-recycling installation for the nuclear power plant of Mochovce.

Treatment of metallic sodium Although processes for the treatment of contaminated sodium coming from liquid-metal fast-breeder reactors and R&D programmes already exist, they are not optimized in terms of safety and waste conditioning.

SCK•CEN therefore developed and patented a dedicated, safe treatment process, fully compatible with acceptable immobilization techniques. It has signed a contract with EdF, which sponsors the research since there is a lack of safe techniques on the market. The first version of the design of the fluidized-bed reactor has been finished and the reactor has been ordered. Further efforts have been made to finalize the flow sheet and to prepare the process control and the preliminary safety report. Qualification tests are going on with both the liquid-metal spray nozzle and the gas-injector system. The pilot plant is being constructed in the Technology building. We intend to perform the cold feasibility demonstration test in the first semester of 1998 and the hot demonstration in 1999.

Electrodestruction of organic waste Organic waste represents a problem in terms of conditioning and safety under disposal conditions. It can be destroyed by Ag^{2+} . In the past, we successfully elaborated a theoretical model describing the selectivity of the anode and designed an adequate electrochemical cell.

In 1997, we managed to solve the difficult question of the analytical speciation of the electrochemical mediator. For this purpose, we compared extensively the determinations obtained by three methods and carried out a successful statistical analysis of the results, which appeared to be coherent. We conceived a statistical experimental design to finalize the modelling of the process. Furthermore, we used a

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pilot loop to assess the electrodestruction of methanol and observed that its efficiency increases at lower temperatures. We interpret this result through the difference in activation energy for the reactions of the mediator with water and with the organic species, respectively.

Decontamination of metallic pieces The cerium process, based on the use of Ce^{4+} as strong oxidant, was selected as chemical decontamination process for the stainless steel coming from the dismantling of the BR3 reactor. Electrodialysis experiments carried out at pilot scale have confirmed that up to 95% of the sulphuric acid present in the effluents of the cerium process can be recycled. This approach proved economical, but only in the case of an adequate on-site conditioning of the effluents by separation of the contaminated metals from the aqueous phase, for instance by precipitation.

Recycling of contaminated material Reuse and recycling are more and more recognized as very good methods to reduce waste and costs safely during decommissioning activities. Thirty-six tons of scrap metals coming from SCK•CEN were recycled in the SEG melting facility in Oak Ridge (Tennessee, USA), into shielding blocks for other nuclear programmes.

An easy way to reduce waste production is to sort scrap material as a function of the available reuse, recycle, and decontamination processes. A building, called the Central Buffer Zone, was specially designed to perform these activities at SCK•CEN. It will become operational in early 1998. By sorting the remaining waste, we intend also to enhance the filling factor of the waste drums.

Based on the results obtained with the decommissioning of hot cell #10 in the Laboratory for High- and Medium-level Activity (LHMA), we are convinced that on-site decommissioning of glove boxes and cells after a first decontamination is very promising in terms of safety and of waste and costs minimization. Up to now, we have only carried out the first decontamination of three glove boxes and two hot cells. We in-

tend to dismantle them in the Central Buffer Zone. Then, scrap metal will be decontaminated and/or recycled according to its radiological and geometrical characteristics.

Partners, sponsors, and customers

Sponsor Electricité de France (EdF)

Scientific output

Publication in 1997

A. BRUGGEMAN, J. BRAET, F. SMAERS, P. DE REGGE, "Separation of Boric Acid from PWR Waste by Volatilization during Evaporation," *Separation Science and Technology* 32:1-4, 737-757 (1997).

V. FEDERICI, A. BRUGGEMAN, C.P. JONES, A. SEVERO, R. ROOFTHOFT, "Advanced Processes for the Treatment of Low-Level-Liquid Waste," Proc. of the fourth conf. of the EC on the Management and Disposal of Radioactive Waste, Luxembourg, Grand Duchy of Luxembourg, March 25-29, 1996, EUR 17543 EN, 149-164 (1997).

Presentations delivered in 1997

S. HARNIE, L. NOYNAERT, "Decommissioning a Hot Cell Used for Post Irradiation Research," European working group on Hot Laboratories and Remote Handling: Nyköping, Sweden, June 5-6, 1997.

L. NOYNAERT, V. VAN ALSENOY, R. CORNELISSEN, "Decommissioning Plan of a Nuclear Research Centre: Practical Experience," Fifth Int. Conf. On Nuclear Engineering (ICONE 5): Nice, France, May 26-30, 1997. Proc., 2252.

A. RAHIER, M. KLEIN, M. PONNET, "Theoretical and Experimental Study of the Selective Oxidation of the Cerous Ion on a Pt-Ti Anode in Sulphuric Acid Solutions," Symp. on Electrochemical Processing (ICT): Barcelona, Spain, April 14-18, 1997.

A. RAHIER, M. KLEIN, M. PONNET, "Régénération de l'ion cérique en milieu sulfurique," Journées d'Electrochimie 1997: Polytechnic Institute of Montreal, Montreal, Quebec, Canada, July 2-5, 1997. Proc., H3C 3A7, C04-3.

Theses published in 1997

V. BARBU, "Mise au point d'une méthode de dosage de l'aluminium en milieu aqueux par polarographie," final-year thesis (Ecole Nationale Supérieure de Chimie de Rennes), August 1997.

L. BOSSART, "Mesure polarographique du cobalt dans les aciers inoxydables," final-year project, Industrial Engineering (Institut Supérieur Industriel de Bruxelles), June 1997.

A. CAMPSTEYN, "Dosage de l'aluminium par polarographie," final-year project, Laboratory Assistant (ISET), June 1997.

S. DRIESEN, "De veilige behandeling van tritiumhoudende methanol," final-year project, Industrial Engineering in Chemistry (Katholieke Hogeschool Limburg, Hasselt), June 1997.

G. GRAMS, "Détermination analytique de l'espèce AgONO_2^- et étude cinétique de l'oxydation contrôlée du méthanol, du graphite et des résines," final-year project, Laboratory Assistant (ISET), June 1997.

S. MARQUES, "Conception et étude du système d'injection des réactifs gazeux utilisés pour oxyder le sodium métallique contaminé," final-year thesis (Ecole Nationale Supérieure de Chimie de Rennes), August 1997.

S. SAUVAGE, "Récupération de l'acide sulfurique issu de la décontamination des pièces métalliques par électro-électrodialyse," final-year project, Industrial Engineering (Institut Supérieur Industriel de Bruxelles), June 1997.

F. VAN PETEGEM, "Ontmanteling van de BR2-reactorkuip," final-year project, Industrial Engineering in Nuclear Sciences (Katholieke Hogeschool Limburg, Hasselt), June 1997.

Lecture taught in 1997

A. RAHIER, "La gestion d'un projet de recherche en technologie nucléaire," Course given at the Institut des Hautes Etudes Commerciales: Liège, Belgium, April 24, 1997.

Reports published in 1997

J. BRAET, A. BRUGGEMAN, J. VANWILDEMEERSCH, "Boron Recovery from PWR Waste by Volatilisation during Evaporation in the Mochovce NPP, Slovak Republic," contract KNT 9096 852 (June 1997). R-3187.

M. BRUGGEMAN, S. BODEN, R. HARNIE, "Afval-karakteriserings-methoden voor de afvalstromen SCHXXX-N van het SCK•CEN," SCK•CEN report (1997). R-3108.

A. BRUGGEMAN, C. JONES, R. ROOFTHOFT, A. SEVERO, "Advanced Processes for the Treatment of Low-Level-Liquid Wastes at a Pilot Plant Scale" (1997). EUR 17446 EN.

S. CATTOIR, "De recuperatie van zwavelzuur uit gecontamineerde oplossingen door elektro-elektrodialyse," SCK•CEN report (May 1997). BLG-744.

M. LECLERCQ, "Dosage du médiateur argentique en milieu nitrique par voltamétrie cyclique," trainee report, Université de Liège (September 1997).

B. PETITFOUR, "Déconvolution de pics polarographiques par régression multiparamétrique," Ecole Nationale Supérieure de Chimie de Rennes (August 1996). BLG-742.

B. PETITFOUR, "Etude des conditions idéales de vitrification de déchets sodés après oxydation sur lit fluidisé," Ecole Nationale Supérieure de Chimie de Rennes (August 1997). BLG-759.

V. VAN ALSENOY, "Analytical Determination of Ag^{++} ," SCK•CEN report (January 1997). BLG-730.

Patent applied for in 1997

A. RAHIER, V. VAN ALSENOY, "Procédé d'oxydation d'au moins un métal alcalin," Belgian patent application #9700039 of January 15, 1997, in the name of SCK•CEN.