NEWS: focus on nuclear power technologies

Benchmarking chemical and radiochemical data from the Belgian nuclear power fleet

Laborelec analyzes the chemical and radiochemical data from the reactor coolant systems of the Belgian nuclear fleet. We benchmark the data and provide recommendations in the pursuit of operational excellence.

The Belgian nuclear power stations in Doel and Tihange gather a large amount of chemical and radiochemical data. Laborelec analyzes and compares these data over time and within the Belgian fleet to benchmark values and trends.

Analyzing data from reactor coolant systems

First, we analyze various chemical parameters, such as the treatment of the reactor coolant system, lithium hydroxide, boric acid, hydrogen, and impurities. This enables us to assess the applied chemistry program and identify deviations.

In the second phase, we analyze the corrosion products, such as iron and nickel, but also corrosion products that are activated by the neutron field in the reactor core. Our analysis provides information on the degree of corrosion in the primary circuit and on the corrosion product behaviour during a normal reactor cycle.

Identifying shutdown releases

During a shutdown process, the chemistry is changed from alkaline reducing conditions to acid oxidizing conditions. As a result, a certain amount of the precipitated corrosion products will dissolve into the primary circuit. The calculated total shutdown release of the different species (Co-58, Ni, Sb-124, etc.) provides additional information on the corrosion in the primary circuit, the behaviour of corrosion products, and the relation with the applied chemistry.

Linking chemistry to radioactive doses

Laborelec tries to link the chemical and radiochemical data with the dose rates measured around the primary circuit, the activated corrosion products deposited on the inside surfaces of the primary circuit. By detecting and explaining differences, and linking the chemistry with the behaviour of (activated) corrosion products, we can provide recommendations on how to improve the applied chemistry to lower the dose rates around the primary circuit.

Kim Schildermans

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Fostering continuous improvement in nuclear power plants

For many years now, Laborelec has been providing operational support to nuclear power plant operators. Our services include analysis and testing, as well as research and development, based on issues that arise on site. We help operators continuously improve existing practices or develop new ones within a wide range of domains, including chemistry, automation, instrumentation and control, materials, alarm management, and environmental matters. This edition presents a sample of our interventions that contribute to the operational excellence of nuclear power plants.

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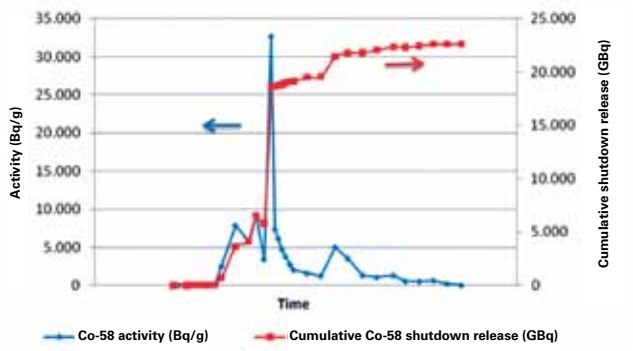

Calculating the total shutdown release of different (activated) corrosion products enables us to benchmark different nuclear power units applying different shutdown procedures.

In short

> Analyzing the chemical and radiochemical data from the units in the Belgian nuclear power fleet
> Identifying the relation between the applied chemistry and the dose rates around the primary circuit
> Providing recommendations to improve the chemistry program in order to decrease corrosion in the primary circuit and reduce the dose rates around it

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Assessing gamma cameras for characterizing radioactive material

How can radioactive material best be characterized in order to ensure accurate classification? Laborelec is assessing various gamma camera models to help plant operators achieve greater precision and efficiency in characterizing large quantities of radioactive material.

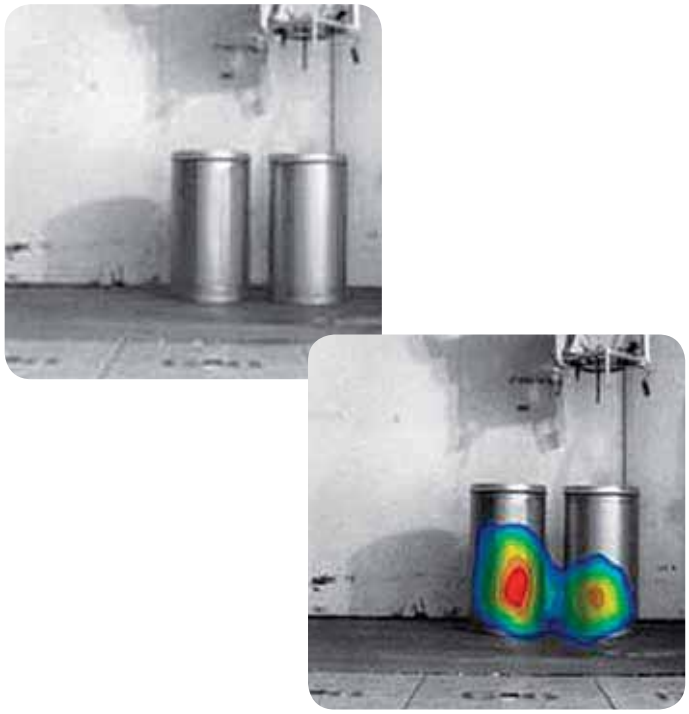
Nuclear power plants have to classify and store the radioactive material that they generate according to its radiation level. However, within a package, one specific item may have a radiation level that is higher than that of the other items in that package. Each package must therefore be thoroughly checked for 'hot spots' in order to manage the material correctly.

Visualizing radiation hot spots

A gamma camera enables the accurate identification of 'hot spots'. The camera generates photographs with coloured patches—similar to the images generated by an infrared camera—that indicate where radiation levels are higher.

The camera models currently available on the market vary according to their weight, precision, ease-of-use, and detector cooling technology. Some also provide 3D views. Laborelec is assessing which types are most suitable for the characterization of radioactive material. Once the most appropriate type of camera is selected, practical tests with this camera can be carried out on site.

Pascale Absil



Laborelec helps nuclear power plants select the most appropriate gamma camera for the characterization of radioactive material.

Characterizing dust in nuclear reactor buildings

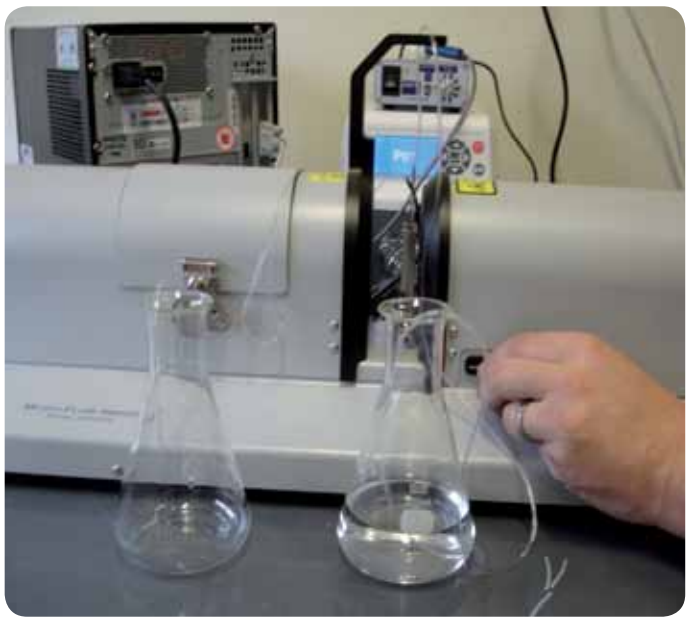
Flexibility and nuclear expertise ensured quick results

Electrabel is assessing how the presence of dust particles affects the proper functioning of filters in nuclear reactor buildings. Laborelec has contributed to this study by carrying out a detailed characterization of the dust particles found in two nuclear reactor buildings in Belgium. Our flexibility and nuclear expertise enabled us to rapidly fulfil Electrabel's request.

Although this is not a standard type of analysis for Laborelec, we were able to rapidly deploy an adequate experimental set-up, respecting all stringent safety requirements. Our experts analyzed samples of the types of dust found in the reactor buildings, primarily using a flow microscope. This enabled us to classify the particles according to their size, shape, and chemical composition. These characterizations were carried out in our hot laboratory, located at the Doel Nuclear Power Plant. They highlight Laborelec's ability to quickly respond to specific and uncommon requests.

The first conclusions of the characterization have been sent to Electrabel, presenting the types of dust in the reactor buildings. These initial results will enable the review of the first assumptions and hypotheses that were taken into account when modelling the actual situation. The studies are performed by Tractebel Engineering.

Steven Goedseels



Our flexibility and nuclear expertise proved to be essential to rapidly characterize dust in nuclear reactor buildings.

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How do oxygen scavengers behave during the wet lay-up of steam generators?

Which hydrazine concentration can be injected initially during the wet lay-up of a steam generator in order to comply with discharge limitations? Can less toxic alternatives be used as oxygen scavengers? What is their behaviour in the wet lay-up solution? Laborelec carried out a series of tests to answer these questions, which concern the Tihange 1 Nuclear Power Plant more specifically.

Oxygen removal from steam generators is necessary to obtain reducing conditions and to reduce the stress corrosion cracking risks of tubes. In most nuclear power plants, hydrazine hydrate is the current oxygen scavenger. In Tihange, hydrazine hydrate releases are limited to 10 ppm, including during a wet lay-up. Moreover, the water used in Tihange 1 for this treatment is not degassed, which means that a greater hydrazine hydrate concentration is required.

Wet lay-up simulation in laboratory

Through laboratory tests, we measured how hydrazine hydrate reacts with oxygen over time in a close-to-reality steam generator wet lay-up. Based on the test results, we were able to recommend the appropriate quantity of hydrazine hydrate to use in order to maintain reducing conditions during the entire wet lay-up and to comply with release limits.

DEHA proves to be a potential alternative

We also started looking for an alternative oxygen scavenger, as hydrazine is suspected to be carcinogenic. Diethylhydroxylamine (DEHA) is one such promising alternative because it does not present any health risk. Results have shown that DEHA actually eliminates low-temperature oxygen in the wet lay-up conditions. However, it needs to be used in larger quantities to be effective and its reducing power is lower.

The tests enabled to identify a new procedure for the wet lay-up treatment based on hydrazine, as well as the potential use of DEHA as an alternative to hydrazine hydrate for a steam generator wet lay-up.

Raphaël Lecocq

A wet lay-up environment was created in Laborelec's laboratory in order to test the reaction rate between oxygen scavengers and oxygen.

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Reducing steam generator fouling

Fouling inside the steam generator tube bundle impacts the heat exchange capacity and increases the risk of corrosion and clogging of tube to tube-plate interstices. Laborelec is investigating an organic product that acts as a dispersant to prevent the formation of deposits. The results are promising so far.

Maintenance works are very difficult to carry out on the steam generator tube bundle, which forms a large heat exchange surface between the primary and the secondary circuits. Therefore, the formation of deposits on the external tube walls must be prevented as much as possible. Fouling issues, however, may occur after several years of operation.

Laborelec investigates organic product

Laborelec is investigating the use of a dispersant in the feedwater as an iron oxide vehicle so that it can be evacuated via blowdown purification. The method was also assessed in collaboration with the Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA) regarding the innocuity for the tube material and the impact of the water treatment downstream of the steam generator. CEA and Laborelec concluded that the dispersant does not increase the risk of tube material degradation and that the thermal decomposition products do not present a concern for the water-steam circuit.

Additional work is ongoing to prepare practical implementation and to monitor the efficiency of the modified water treatment.

Charles Laire

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Rationalizing alarms during nuclear power plant revision

During the revision of a nuclear power plant, some processes remain active and need to be monitored from the control room. However, the tests performed during the revision increase the number of alarms, potentially overloading the control room operator. Therefore, Laborelec was asked to analyze and rationalize the alarm behaviour during plant revisions.

Identifying a reference for alarms during shutdowns

Laborelec used its Intelligent Alarm Management Tool to analyze the alarm data collected during shutdowns at unit 2 of the Doel Nuclear Power Plant and unit 1 of the Tihange Nuclear Power Plant. We studied the behaviour of the alarm system, as well as its priority levels. We then compared this information against the EEMUA 191 guideline for alarm management and determined the maximum manageable alarm load for the operator.

Recommendations for prioritizing and minimizing alarms

Based on our analysis, we provided a detailed report, containing a list of the most polluting alarms and recommendations on how to optimize the alarm system. The nuclear stations can use this information to rationalize or suppress certain alarms during revision.

Jos Menting

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Assessing the quality of coatings inside reactor buildings

The Belgian nuclear power plants chose Laborelec to characterize the quality of the coatings inside their reactor buildings. Laborelec tested the coatings for possible loss of adhesion in order to qualify or disqualify them.

Testing coating adhesion

A loss of adhesion of a coating can clog the recirculation filters and reduce the filters' efficiency. Laborelec has worked out a qualification procedure in order to evaluate the condition of the coating systems inside the primary containments of the nuclear power plants in Belgium.

Our experts performed inspections inside the reactor buildings. We also conducted laboratory tests by exposing coatings to varying temperature, radiation, and pressure conditions. Based on these results, we established one acceptance criterion for all coatings. Comparing the results of the on-site tests with the established criterion will enable the final qualification of the coating systems.

Anne-Francoise Vaessen

Laborelec submitted the coatings to laboratory tests by simulating the environment of a reactor building.

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Monitoring 75 electric vehicles in the Netherlands

Laborelec has been chosen to monitor the electric vehicle fleet of a Dutch consortium, comprised of the city of Rotterdam, the Rotterdam grid operator Stedin, and energy company Eneco. The consortium selected Laborelec because of its expertise and experience in electric vehicle research and monitoring.

Monitoring and analyzing electric vehicle characteristics

Laborelec is monitoring a fleet of 75 electric cars and small vans, as well as a group of conventional cars. The monitored data will enable us to investigate various characteristics, such as the impact of battery charging on the net, the overall safety of the cars and the charging points, carbon emissions, and the total cost of ownership. We will also question the drivers regularly on the cars' driving experience.

Experience and expertise lead to partnership

Laborelec's experience with electric vehicles was a major contributor to being selected for this job. Our experts are, for instance, carrying out extended measuring campaigns on electric vehicles as part of a GDF SUEZ Group research project.

Hans Bastings

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