[NEWS :
Focus on chemistry and environment

OPTIMIZING STEAM GENERATOR LAYUP AT TIHANGE NUCLEAR POWER PLANT

Under its new environmental permit, Belgium's Tihange Nuclear Power Plant must limit its discharge of N_2H_4 (hydrazine) to 10 ppm. Laborelec conducted an international investigation to advise the power plant on how to comply with this strict requirement.

The layup treatment of a steam generator generally uses a high concentration of N_2H_4 to reduce the secondary water's oxygen level, minimizing the risk of carbon steel corrosion. Laborelec developed a solution to limit the use and discharge of N_2H_4. This advice is based on a study of nuclear power plants in the USA, France, Sweden, Belgium, and Finland.

[Removing oxygen from steam generator auxiliary feed water

A high concentration of N_2H_4 is not a good solution for removing oxygen at steam generator layup temperatures (20-40°C). At such low temperatures, reaction between both substances is slow. 'We advised the plant operator to minimize the use of N_2H_4 and use degasified auxiliary feed water,' explains Raphaël Lecocq.

Tihange 2 and 3 are equipped with a degasifier. 'They can use this equipment to degasify auxiliary feed water in the storage tank,' observes Lecocq. 'Moreover, both reservoirs have a floating cover, preventing oxygen from continuously penetrating the water.'

At Tihange 1, the auxiliary feed water cannot be degasified. The unit has no degasifier and its water reservoir has no floating cover. The sole solution is the use of another oxygen scavenger. 'At low temperatures, DEHA (diethylhydroxylamine) reacts faster with oxygen than N_2H_4,' points out Lecocq. 'We advised to inject DEHA in the auxiliary feed water before it enters the steam generator to remove as much oxygen as possible.'

[Nitrogen blanket limits contamination inside steam generator

Regardless of the auxiliary feed water's oxygen level, oxygen can still enter the steam generator. A nitrogen blanket avoids this. In this case, nitrogen covers the empty area above the water level, leaving no room for oxygen. This practice, however, implies strict safety measures for the maintenance workers during outages.

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OPTIMIZING PROCEDURES FOR REDUCED ECOLOGICAL FOOTPRINT

Ever stricter environmental legislation forces power plants to continuously optimize their operating procedures. The past year, for instance, our chemical experts have helped the nuclear power plants in Tihange and Doel optimize their water conditioning techniques. In addition, our partnership with Profish Technology was able to safeguard aquatic life surrounding the water intakes of the Tihange plant. You will find out more in this edition of Laborelec News.

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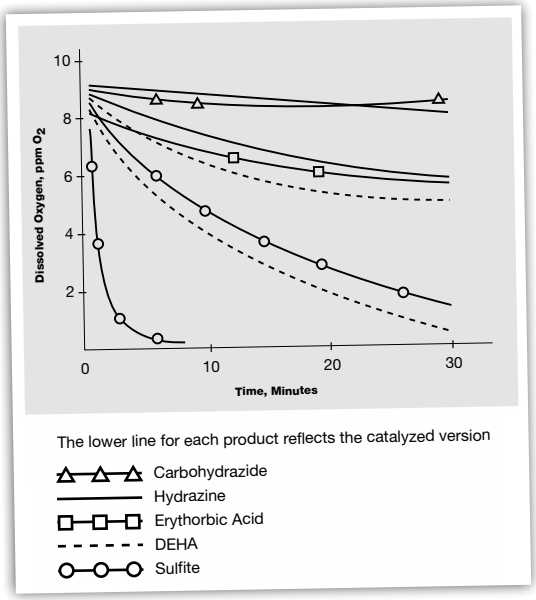

DEHA reacts more quickly than N_2H_4 and removes most of the oxygen from the auxiliary feed water before it enters the steam generator.

[In short

- The Tihange Nuclear Power Plant has to limit the discharge of N_2H_4 to 10 ppm
- Laborelec advised to degasify the auxiliary feed water (where possible) or use DEHA as an alternative to N_2H_4
- A nitrogen blanket keeps oxygen outside the steam generator, but implies some risks for workers

PREVENTING DENTING FROM CAUSING FURTHER DEGRADATION

Thorough investigation and advice at Doel Nuclear Power Plant

During an outage, inspection probes detected denting in the steam generator's tubes at Unit 3 of Belgium's Doel Nuclear Power Plant. Such denting could cause cracks, as occurred at the Almaraz Nuclear Power Plant in Spain. To prevent this, Doel asked Laborelec to study the problem and prevent similar degradation at other tubes.

Laborelec discovered that the denting phenomenon at Doel 3 is related to the gradual buildup of sludge. 'The iron oxides in the secondary water precipitate in the steam generator. They accumulate on the tube sheet and modify the chemistry in the small cavities between the steam generator's tubes and tube sheet,' explains Charles Laire. 'The increased deposit of iron oxides obstructs heat transfer, creating local superheat. This enables aggressive substances such as chlorine to penetrate the iron oxide deposits and oxidize the steel surface. The growing oxidation layer causes denting — plastic deformations — of the steam generator tubes.'

[Optimizing water chemistry during operation

Analysis of the plant's secondary water treatment revealed several events and practices that could be linked to the buildup of sludge and the denting occurrence. For instance, the gradual removal of ammonia during transients. 'At lower ammonia concentrations, the reduced pH level will stimulate the dissolution of iron oxides,' points out Laire. 'The operator needs to maintain the high pH levels and look for other ways to minimize the ammonia discharge.'

Laborelec also advised the Doel Nuclear Power Plant to completely remove the sludge piles and to advance steam generator inspection from 2012 to 2010.

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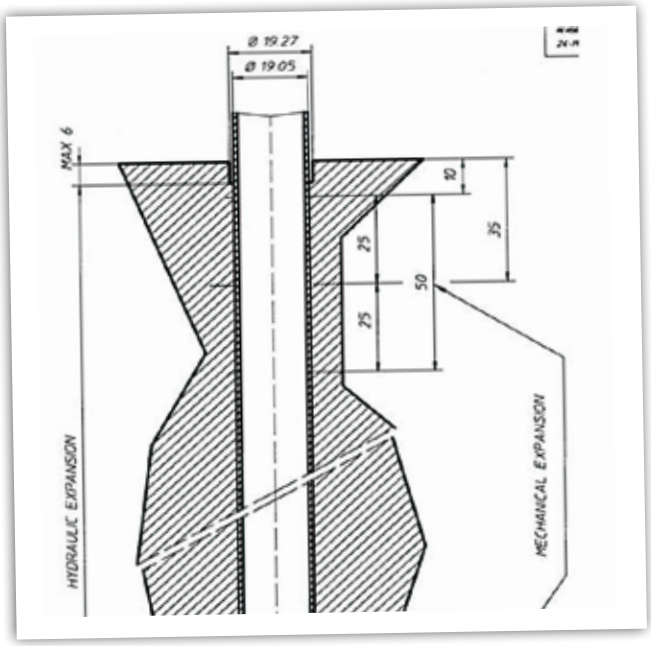

The iron oxides in the secondary water precipitate, form sludge piles, and stimulate the concentration of impurities in the small cavities between the steam generator's tubes and tube sheet. This is the primordial condition for denting to occur.

[Prioritizing denting causes and remedies

Laborelec has put together a list of probable causes and influences for denting during normal operations, during an outage, and during transients. Charles Laire: 'We have ranked several events and practices that may contribute to the buildup of sludge and the denting occurrence. This assessment will help our experts advise remedial actions that will prevent further denting occurrence and tube degradation.'

[In short

- Precipitation of iron oxides plays a crucial role in the denting occurrence at the Doel Nuclear Power Plant
- Laborelec advised to revise management of ammonia levels in the secondary water during transients
- Our experts also advised to advance the inspection of the steam generator

MINIMIZING POWER PLANT IMPACT ON FISH POPULATIONS

Fish repulsion systems for hydroelectric and cooling water intakes

Laborelec partners with the Belgian company Profish Technology to spread fish repulsion systems throughout the GDF SUEZ Group. The initial implementation at the Tihange Nuclear Power Plant has proven to be very successful.

The production of 1,000 MW of electricity kills on average five tons of fish per year at power plant cooling water intakes worldwide. It poses a serious threat to migrating fish like Atlantic salmon and European eel populations. Legislators throughout Europe, North America, and other parts of the world are forcing industries to mitigate fish mortality at water intakes.

[Infrasound guides fish safely past Tihange

The Tihange Nuclear Power Plant has successfully implemented an ingenious fish repulsion system. Developed by Profish Technology, the system uses infrasounds to keep fish safely away from the cooling water intake. 'After a year in operation, tests have revealed the efficiency of the infrasound fish fence. More than 80% of the fish population avoid the cooling water intake and migrate safely along the river Meuse. A significant improvement compared to the near 100% mortality rate before,' explains Damien Sonny.

[Testing fish repulsion systems at hydroelectric water intakes

Along with thermal power plants, hydroelectric plants also have a significant impact on aquatic wildlife. 'Hydroelectric water intakes can kill up to 30% of all migrating fish populations per site,' states Sonny. 'We are currently testing a new repulsion system at the water intake of one of the Compagnie Nationale du Rhône hydroelectric plants. The system is still in development and will establish another important step in minimizing the ecological impact of electricity generation.'

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Thanks to the infrasound fence, 80% of the fish population safely pass the water intakes at the Tihange Nuclear Power Plant.

[WANO auditors propose Tihange's fish repulsion system as a best practice

The Tihange Nuclear Power Plant underwent a WANO Peer Review in October 2009. Twenty members of the World Association of Nuclear Operators (WANO) audited the plant's nuclear safety performance and operation practices. The WANO auditors were very impressed by the plant's fish repulsion system. They valued the infrasound fence as a best practice and recommend its use to power plant operators worldwide.

[In short

- The production of 1,000 MW of electricity kills on average five tons of fish per year at thermal power plants worldwide; hydroelectric plants kill up to 30% of migratory fish species
- The infrasound fence guides 80% of all migrating fish safely past the cooling water intakes at the Tihange Nuclear Power Plant
- Profish Technology is currently adapting its new fish repulsion systems for hydroelectric plants

PCR QUICKLY INDICATES PATHOGEN RISKS

Searching for correlation with culture tests

In the summer, Laborelec regularly performs culture and Polymerase Chain Reaction (PCR) tests on cooling water samples from Belgium's Tihange Nuclear Power Plant. PCR provides a rapid indication of pathogen concentrations, enabling timely remedial action. Our experts are currently fine-tuning the PCR technique so that it better coincides with the legally obliged culture tests.

The Tihange plant must limit the concentration of pathogens in its cooling water before emission. This requires a rigorous disinfection programme, especially during summer when warm temperatures increase concentrations of Naegleria fowleri (Nf), Legionella species (Lspp), and Legionella pneumophila (Lp).

[PCR triggers timely action

The PCR technique determines the concentration of pathogens within 36 hours of the samples being taken. 'This means we can quickly take preventive actions,' explains Lieve Verelst. 'Cultures deliver their results only after seven (Naegleria) and ten (Legionella) days.'

[Cultures are a legal requirement

Laborelec is currently investigating how to make PCR results better coincide with cultures. 'Cultures are presently the only accepted method of proving compliance with environmental legislation,' states Verelst. The permit allows a maximum of 1,000 colony forming units of Lspp per litre of water. Determining the exact number of these types of cells is only possible via culture tests since the PCR technique also takes into account dead cells and cells that cannot be cultured.

[Simultaneous sampling for PCR and culture tests

Laborelec and the Tihange plant have adjusted the sampling protocol. 'We take culture and PRC samples simultaneously,' says Verelst. 'This way we can verify results based on the same data and optimize our correlation studies.'

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[State-of-the-art pathogen lab

Laborelec operates its own pathogen lab. It has state-of-the-art equipment to analyze pathogen concentrations in cooling water, sludge, and environmental water. 'We have filtration and centrifugation equipment, we can prepare specific cultures on concentrates, and we can perform DNA extractions. In the specific case of Nf, we are also able to run flagellation tests and analyze antibody/antigen reactions,' says Lieve Verelst. 'In other words, we have everything in place to efficiently carry out pathogen analyses.'

Laborelec is able to calculate the concentration of pathogens in water using its in-house lab.

[In short

- Our experts regularly analyze cooling water samples to determine the concentration of Nf, Lspp, and Lp
- PCR quickly indicates when additional water treatment is necessary; pathogen cultures are required to prove legislative compliance
- When taking samples for pathogen cultures, Laborelec will simultaneously take samples for PCR tests to compare the two test methods

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