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Efficiency and harmlessness of film-forming amines (FFA) used as alternative lay-up method in secondary circuit for corrosion protection

Context

Maintenance of secondary circuit in nuclear power plant during shutdown

Conventional – Dry / Wet methods

⇒ Time-consuming / Using hydrazine(CMR)

Alternative – Lay-up method

(since 1980s) Film-Forming Amines (FFA)
Octadecylamine (ODA)

Secondary circuit

- Conversion thermal energy to electrical energy
- Mainly composed of carbon steel
- Native magnetite layer on the pipes

Film-Forming Amines (FFA) - ODA

Since 1980s – Used for corrosion inhibitor in thermal & nuclear power plant (China, Spain, USA...)

2019 – Understanding the behavior & the efficiency of ODA in the 2nd circuit of PWR plants

Methods and tools

Choice of magnetite support on carbon steel sample

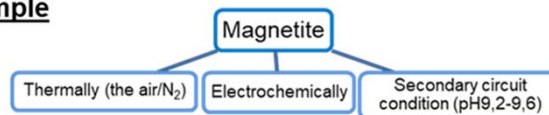


Fig 1. Magnetite formed by different technology

Adsorption of FFA on magnetite support



Fig 2. Simplified schema of FFA support

Interface study (Physi- /Chemi-sorption and surface energy)

Caracterisation of FFA

- *In-situ* study in autoclave Parr at high temperature and pressure (up to 275°C and 60 bar) and hydrodynamic condition
- Morphology study – roughness, porosity, hydrophobic effect and film composition

Effect of FFA as a corrosion inhibitor during shutdown and restart of system

- Aging study of material in secondary circuit condition and safety on the entire system (erosion-corrosion)

Analytical methods

Interface study	Morphology and surface study	Aging & Hydrodynamic study
<ul style="list-style-type: none"> • DRX, ATR-IR • Raman spectroscopy • Zetametrie potential • EIS 	<ul style="list-style-type: none"> • SEM/SEM-EDS • Optic profilometer 3D • Contact angle 	<ul style="list-style-type: none"> • EIS with rotating cylinder • FLUENT (logiciel mécanique des fluides)

Goals

- Have a better comprehension of the behavior of FFA (Octadecylamine) in secondary circuit conditions

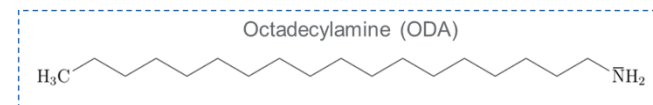
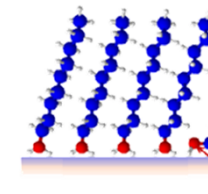


Fig 3. Structure of Octadecylamine

- Develop a method to characterize the formed films under different conditions (site monitoring if it is possible)



Monoamine

Fig 4. Example of an adsorption of ODA on the surface

- Validation of efficiency of FFA formed at different temperatures and phases (liquid/ vapor)
- Verify the harmlessness of FFA in the circuit when restarting nuclear power station