[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	(4) + REMOVAL OF FUEL RODS FROM FUEL POOL IN REACTOR-4
Title	Replace Water in Fuel Pools and Reactors with Sodium Thiosulfate
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1. Overview of Technologies (features, specification, functions, owners, etc.)

Given the fact that the coolant water works also as moderator, the removal of fuel rods from the pool in reactor 4 is expected to become extremely challenging. The problem with the partially burned rods is, that they are hot AND contain still enough fissible material to risk prompt criticality or at least delayed criticality when disintegrated and surrounded by water. The decay heat might have caused fuel rod damage due to water shortage during the accident. Thus an attempt to lift the bundles could lead to rod fragments falling to the ground of the pool risking to create a critical configuration.

To avoid this, the proposal is to replace the water by a liquid which moderates neutrons much less then water. Sure some research has to be done especially for the possible chemical reactions, but Sodium Thiosulfate $Na_2S_2O_3$ might be a solution.

It melts at 48°C / 52°C (pentahydrate / anhydrous) and could (if chemically stabile) work up to 100°C / 300°C (pentahydrate / anhydrous).

It can be effectively cooled just by adding solid Sodium Thiosulfate or water in case of emergency.

Liquid Sodium Thiosulfate is transparent so fuel rack handling is still possible.

It can bind iodine: $I_2 + 2\,Na_2S_2O_3 \rightarrow 2\,NaI + Na_2S_4O_6$

There should be no chemical contamination issue (WGK 1 slightly water endangering, LD50 rat > 5000 mg/kg), however some chemical reaction products could be more dangerous.

The (compared to water) high melting point allows for sealing leakages automatically where the temperature drops below 48°C.

This approach could also be considered for the coolant in the reactors and if the leaks are not too deep in the ground where running groundwater might take away too much Sodium Thiosulfate by dissolving, it could even seal the leaks and separate groundwater from the core cooling circuit. However this would require an enormous amount of Sodium Thiosulfate.

2. **Notes (Please provide following information if possible.)**

- **Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)**

As far as I know this has never been tried before.

Therefore the technology has to be developed. I expect that the research could be done within one month. The topics are:

- Chemistry of Sodium Thiosulfate in the environment of the fuel pool.
- Mixing of water with Sodium Thiosulfate under the conditions in the pool.
- Shielding capacity against radioactivity.
- The heat-exchanger and a pump technology.
- Kinematic and heat transport studies of Sodium Thiosulfate in the fuel pool

- **Challenges**

- Chemical reactions with substances present in the fuel pool
- Supply of ~1200 m^3 Sodium Thiosulfate for each fuel pool
- Transition process from Water to Sodium Thiosulfate
- Development of corrosion inhibitors if necessary
- Transition from the coolant Water to Sodium Thiosulfate (pH needs to be controlled)
- Flow control more difficult due to higher viscosity and smaller temperature window (local crystallization could create ho spots)
- Engineering on heat exchanger and pump required
- Research on radiation shielding required

- **Others (referential information on patent if any)**

As far as I know there are no patent issues.

【Areas of Technologies Requested】

(1) Accumulation of contaminated water (Storage Tanks, etc.)
(2) Treatment of contaminated water (Tritium, etc.)
(3) Removal of radioactive materials from the seawater in the harbor
(4) Management of contaminated water inside the buildings
(5) Management measures to block groundwater from flowing into the site
(6) Understanding the groundwater flow