Coolant fluids for fast neutron reactors, Scientific and technical issues: Elements for a discussion

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Fluid coolants: Feedbacks

Type of coolant	Feedback from previous experience
Sodium	RAPSODIE, Phenix, EBR I et EBR II, Beloïarsk, FFMT JOYU, Monju, Dounreay, China, India
Lead	Russian Nuclear submarines, ELSY
Molten Salt	Oak Ridge National Lab
Helium	DRAGON

Fluid coolants: a comparison?

	Sodium	Lead	Molten Salt	Helium
Better use of fuel resources (U, Pu, Th…)	+++			
Better efficiency of heat conversion (higher T)				+++
Better interaction fluid structure (corrosion)	++	--	---	+++
Easier operation condition and maintenance	--	--		

Scientific Challenges

- **Materials** Find Materials appropriate for the required mechanical loadings , operating temperatures, chemical environment

- **Fluid:** Combine a Neutron transparent fluid , chemically inert, physically stable (the gaz would be ideal , but what are the possible materials?

Required research equipments

- Thermal loops with the choosen coolant
- Materials testing devices
- Pilot units for the hydraulic machinery (pumps, valves…)
- Pilot units for non destructive testing and maintenance operations

Scientific issues to be adressed

- Liquid metal interaction with the structures: possible conditions of grooving, of GB embrittlement
- Interation fluid / surface / fluid transport to understand the conditions and kinetics of phase transformation
- Thermohydraulics and turbulence in confined geometries. What is the physical foundation of the phenomenological rules?
- Interaction between the structural materials and a chemically agressive environment: what is the influence of the metallurgical structure?

Technical issues to be addressed

- Size/power of the « energy production system » as function of the coolant
- Fluid of the converting system (gaz or vapour)and thermodynamic cycle: pro's and con's
- Etancheity of pumping devices and alternative to mechanical pumps
- Chemistry of the fluid and chemistry control, globally, locally and in leaking situations
- Materials and materials implementations (especially welding)
- Non destructive testing during operation and maintenance
- Cleaning of the componants, cleaning of the coolant fluid
- Confinement? Protection agains radioactive leaks and cooling: what are the alternatives?
- Availability of the industrial tool to make things
- Availability of people. Training?

Coolant fluid	Na	Pb	He	MS
Size/power vs Coolant fluid				
Converting system				
Pumping devices				
Chemistery control				
Materials and welds				
Non destructive testing				
Cleaning of the coolant				
Confinement				
Availability of the industrial tool				
Availability of the competences training				
Liquid metal grooving and embrittlement				
Metallurgical structure and corrosion				
Thermohydraulics and boiling in confined media				