gFHR Project Updates

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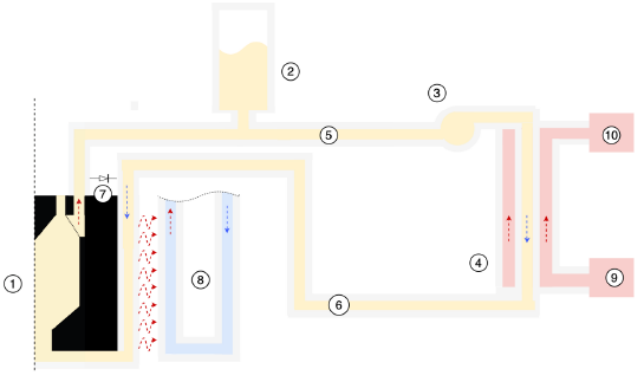
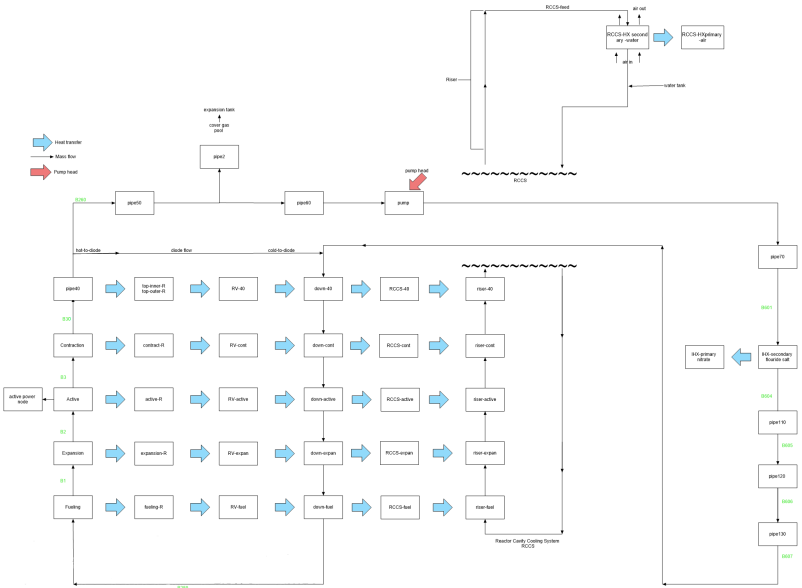
- In this SAM model, the core is divided into four regions axially from the bottom: fueling, expansion, active and contraction region
- The reflector, reactor vessel and the downcomer are also divided axially the same way but with additional region to include the first part of the hot-leg (pipe40)
- This model has two heat exchangers: intermediate heat exchanger (IHX) and the reactor cavity cooling system heat exchanger



gFHR graph


RCCS-feed
air-out
RCCS-HX secondary -water
RCCS-HXprimary -air
air-in
Riser
water tank
RCCS
expansion tank
cover gas purpl
pipe2
Heat transfer
Mass flow
Pump head
pump head
pipe50
pipe60
pump
hot-to-diode
diode flow
cold-to-diode
pipe70
pipe40
top-inner-R top-outer-R
RV-40
down-40
RCCS-40
riser-40
B401
B30
Contractors
contract-R
RV-cont
down-cont
RCCS-cont
riser-cont
RXI-primary nitrate
RXI-secondary flinaxite salt
B3
active power node
Active
active-R
RV-active
down-active
RCCS-active
riser-active
B404
pipe110
B2
Expansion
expansion-R
RV-expan
down-expan
RCCS-expan
riser-expan
B405
pipe120
B1
Fueling
fueling-R
RV-fuel
down-fuel
RCCS-fuel
riser-fuel
B406
pipe130
B407
Reactor Cavity Cooling System RCCS
B200

- This graph includes the reactivity cavity cooling system which is a passive safety system that removes the decay heat.
- The graph shows the connections between the components. B represents the branches connecting fluid components.
- The expansion tank (number 2 from the first figure) has a pool and cover gas region. These two regions outputs are : pool level, volume, pressure, rho, temperature and velocity and cover gas pressure.
- The simulation outputs for each component are listed in the next few slides. However, some of the RCCS heat exchangers's outputs are not included as well as the reactivity related outputs.

Important simulation outputs

	Output	Description
Primary Loop	HX_energy	Heat removal rate by IHX
	pressure_outlet	Expansion tank pressure (pipe2)
	secondary-flow	Nitrate flow out
	IHX-in	Secondary side (fluoride salt) inlet temperature
	IHX-out	Secondary side (fluoride salt) outlet temperature
Core	core_in_T	Core inlet temperature (fueling outlet temp.)
	core_out_T	Core outlet temperature (pipe40 outlet temp.)
	core_in_V	Core inlet velocity (fueling outlet velocity)
	core_out_v	Core outlet velocity (pipe40 outlet velocity)
	core_in_P	Core inlet pressure (fueling outlet pressure)
	core_out_p	Core outlet pressure (pipe40 outlet pressure)
	core_energy	Energy balance between fueling(in) and contraction(out) core regions (components)
	core_flow	Flow entering the fueling region of the core
	DeltaP	Pressure difference in the core
	MaxFuel	Maximum fuel temperature (in the second layer of the pebble)

Components and outputs

Component	Name in SAM	Description	Outputs	Output in csv
Core	Output based on the fueling, contraction regions of the core and on pipe-40(hot leg)		Core inlet temp| core inlet velocity| core outlet temp| core outlet velocity| core flow |core inlet and outlet pressure| core energy | pressure difference| maximum fuel temp.	core_in_T| core_in_V| core_out_T| core_out_v| Core_flow| core_in_p| core_out_p | Core_energy| DeltaP | MaxFuel
Reactor	reactor		Power and decay heat	reactor:power | reactor:decay_heat
Fueling	fueling	First region from the bottom of the core	Avg pressure| avg temp |avg solid core/fuel temp.| avg velocity |	fueling-CPbar| fueling-CTbar| fueling-CTsolidbar |fueling-CVbar
Expansion	expansion	Second region from the bottom of the core	Avg velocity| avg temp | avg pressure |avg solid core/fuel temp	expansion-CVbar| expansion-CTbar| expansion-CPbar| expansion-CTsolidbar
Active	active	Third region from the bottom of the core	Avg velocity| avg temp | avg pressure |avg solid core/fuel temp	active-CVbar| active-CTbar| active-CPbar| active-CTsolidbar
Contraction	contraction	Fourth region from the bottom of the core	Avg velocity| avg temp | avg pressure |avg solid core/fuel temp	contraction-CVbar| contraction-CVbar| contraction-CPbar| contraction-CTsolidbar

Component	Name in SAM	Description	Outputs	Output in csv
Pipe-40	pipe040	Hot leg- first part connecting with the core	Avg velocity | avg temp avg pressure	pipe040-Vbar| pipe040-Tbar| pipe040-Pbar
Pipe-50	pipe050	Hot leg – between pipe40 and expansion tank	Avg velocity | avg temp avg pressure	pipe050-Vbar| pipe050-Tbar| pipe050-Pbar
Pipe-060	pipe060	Hot leg- between expansion tank and the pump	Avg velocity | avg temp avg pressure	pipe060-Vbar| pipe060-Tbar| pipe060-Pbar
Pipe-2	pipe2	Pipe from hot leg to expansion tank	Avg velocity | avg temp avg pressure	pipe2-Vbar| pipe2-Tbar| pipe2-Pbar
Pipe-070	pipe070	Pipe between pump and IHX	Avg velocity | avg temp avg pressure	pipe070-Vbar| pipe070-Tbar| pipe070-Pbar
Pipe-110	pipe110	Cold leg -pipe between pipe70 and pipe 120	Avg velocity | avg temp avg pressure	pipe110-Vbar| pipe110-Tbar| pipe110-Pbar
Pipe-120	pipe120	Cold leg -pipe between pipe 110 and pipe 130	Avg velocity | avg temp avg pressure	pipe120-Vbar| pipe120-Tbar| pipe120-Pbar
Pipe-130	pipe130	Cold leg connected with the core - downcomer	Avg velocity | avg temp avg pressure	pipe130-Vbar| pipe130-Tbar| pipe130-Pbar

Component	Name in SAM	Description	Outputs	Output in csv
fueling-R	fueling-R	Reflector axial regions based on the core 4 regions	Reflector temperature	fueling-R-HSbar
expansion-R	expansion-R		Reflector temperature	expansion-R-HSbar
active-R	active-R		Reflector temperature	active-R-HSbar
contract-R	contract-R		Reflector temperature	contract-R-HSbar
Flow diode	flow_diode	Flow from the hot leg to the cold leg	Diode flow	diode-flow
Hot to diode	hot_to_diode	Connecting the hot leg with the check valve	Flow average velocity, temperature, and pressure	hot_to_diode-Vbar| hot_to_diode-Tbar| hot_to_diode-Pbar
Cold to diode	cold_to_diode	Connecting the cold leg with the check valve	Flow average velocity, temperature, and pressure	cold_to_diode-Vbar| cold_to_diode-Tbar| cold_to_diode-Pbar
Down-40	down-40	downcomer consists of 5 axial regions, the same 4 core regions and a region on the same level with pipe40	Flow average velocity, temperature, and pressure	down-40-Vbar| down-40-Tbar| down-40-Pbar
Down-cont	down-cont		Flow average velocity, temperature, and pressure	down-cont-Vbar| down-cont-Tbar| down-cont-Pbar
Down-active	down-active		Flow average velocity, temperature, and pressure	down-active-Vbar| down-active-Tbar| down-active-Pbar
Down-expan	down-expan		Flow average velocity, temperature, and pressure	down-expan-Vbar| down-expan-Tbar| down-expan-Pbar
Down-fuel	down-fuel		Flow average velocity, temperature, and pressure	down-fuel-Vbar| down-fuel-Tbar| down-fuel-Pbar

Component	Name in SAM	Description	Outputs	Output in csv
RV-40	RV-40	Reactor vessel consists of 5 axial regions, the same 4 core regions and a region on the same level with pipe40	RV average temperature	RV-40-HSbar
RV-cont	RV-cont		RV average temperature	RV-cont-HSbar
RV-active	RV-active		RV average temperature	RV-active-HSbar
RV-expan	RV-expan		RV average temperature	RV-expan-HSbar
RV-fuel	RV-fuel		RV average temperature	RV-fuel-HSbar
Output based on the 5 reactor vessel components			Energy balance, conduction heat removal by the RV | RV surface temperature	RV-EnergyBalance| RV-surface
Riser	riser	Riser 6 axial regions from the top to the bottom	Avg velocity, temperature, and pressure	riser-Vbar| riser-Tbar| riser-Pbar
Riser-40	riser-40			riser-40-Vbar| riser-40-Tbar| riser-40-Pbar
Riser-cont	riser-cont			riser-cont-Vbar| riser-cont-Tbar| riser-cont-Pbar
Riser-active	riser-active			riser-active-Vbar| riser-active-Tbar| riser-active-Pbar
Riser-expan	riser-expan			riser-expan-Vbar| riser-expan-Tbar| riser-expan-Pbar
Riser-fuel	riser-fuel			riser-fuel-Vbar| riser-fuel-Tbar| riser-fuel-Pbar

Component	Name in SAM	Description	Outputs	Output in csv
RCCS-40	RCCS-40	RCCS consists of 5 axial regions, the same 4 core regions and a region on the same level with pipe40	RCCS wall average temperature	RCCS-40-HSbar
RCCS-cont	RCCS-cont		RCCS wall average temperature	RCCS-cont-HSbar
RCCS-active	RCCS-active		RCCS wall average temperature	RCCS-active-HSbar
RCCS-expan	RCCS-expan		RCCS wall average temperature	RCCS-expan-HSbar
RCCS-fuel	RCCS-fuel		RCCS wall average temperature	RCCS-fuel-HSbar
RCCS	Outputs based on the 4 riser regions		Energy balance between riser-fuel and riser-40 |The temperature entering from riser-fuel | The temperature leaving riser-40	RCCS-EnergyBalance| RCCS-InletTemp| RCCS-OutletTemp
Pump	Pump		Pressure, pump head , rho , temperature, velocity	Pump:pressure| Pump:pump_head| Pump:rho| Pump:temperature| Pump:velocity
IHX	HX	Intermediate heat exchanger	Energy removed by heat exchanger| The mass flow rate for the primary side(nitrate) | Secondary side (fluoride salt) inlet temperature| Secondary side (fluoride salt) outlet temperature	HX_energy| secondary-flow| IHX-in | IHX-out

Component	Name in SAM	Description	Outputs	Output in csv
B1	Branch1	These branches connect fluid components. The position for each of these branches are on the gFHR graph	Pressure, density, temperature and velocity of the flow	Branch1:pressure| Branch1:rho| Branch1:temperature| Branch1:velocity
B2	Branch2			Branch(#):pressure| Branch(#):rho| Branch(#):temperature| Branch(#):velocity
B3	Branch3			
B30	Branch030			
B260	Branch260			
B501	Branch501			
B601	Branch601			
B604	Branch604			
B605	Branch605			
B606	Branch606			
B607	Branch607			
B280	Branch280			

- Three more post-processors were added to the code in order to get the maximum fuel surface temperature, inlet and outlet temperature of the primary side (nitrate) intermediate heat exchanger.

Output	Description
IHXPN-in	IHX primary side (Nitrate) inlet temperature
IHXPN-out	IHX primary side (Nitrate) outlet temperature
MaxSurface	Maximum fuel surface temperature

- Simplified gFHR graph was created by removing the RCCS and some of the pipes.

Simplified gFHR graph without RCCS