Small Modular Reactor, Natural Circulation mode

Introduction to Nuclear Engineering, December 2021 - Simplified Modeling exercise

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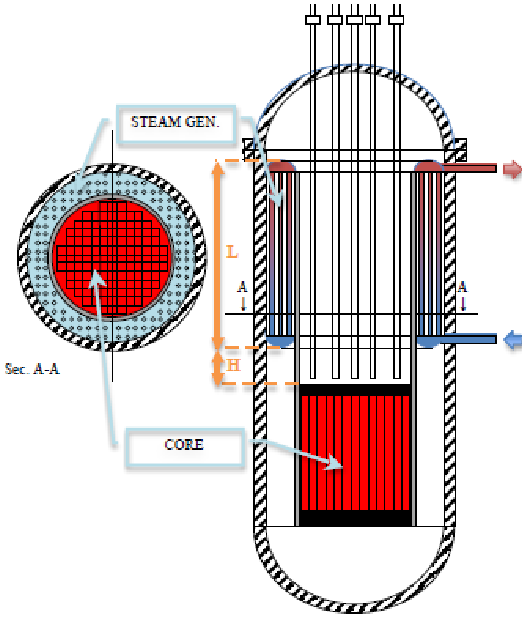

Natural Circulation SMR		
Reactor Thermal Power	300 MWth	W
Tcore in	292 degC	Tin
enthalpy-in	1300 kJ/kg	hin
density-in	727.6 kg/m³	ρin
Tcore out	329 degC	Tout
enthalpy-out	1520 kJ/kg	hout
density-out	643.5 kg/m³	ρout
Primary pressure	155 bar	Pc
# Fuel assemblies	121	Nfa
Fuel assembly (fuel rods)	(17 x 17)	
Fuel rod diam.	9.5 mm	Dfr
Fuel rod pitch	12.67 mm	Pfr
Fuel rod length	3 m	Lfr
Once-Through Steam Generator		
SG Tube outer diam.	10 mm	OD
SG Tube inner diam.	8.5 mm	ID
SG Tube pitch	15 mm	Psg
SG pressure	65 bar	Ps
Tsat (@65 bar)	280.82 degC	Tsg
Tube thermal conductivity	30 W/m K	Ksg
RPV inner diam.	3.75 m	
Barrel outer diam.	2.75 m	
Global heat transfer coeff.	5100 W/m² K	α
Form pressure loss coeff.		
Core support plate	4	K1
Core upper plate	4	K2
SG area - inlet	3.5	K3
SG area - outlet	3.5	K4
Fuel rod, SG tube roughness	4×10^{-6} m	e
Fluid viscosity	8.284×10^{-5} kg/m s	μ

- **First goal:** code a steady-state model for the Small Modular Reactor, to dimensioning:
  - the tube-bundle average length of the Steam Generator modules
  - the clearance between the Core and the Steam Generators, to sustain the Natural Circulation mode
- **Second goal:** code a model able to perform parametric analysis of the SMR configuration, by changing:
  - core thermal power
  - secondary pressure
  - steam generator tube pitch or tube outer diameter

The output files in the repository include a function to compute the height of the SG (compute L), a function to compute the clearance value (compute H), a main script to do parametric studies (i.e. study how L and H change with core power).