Very High Temperature Gas Reactor

VHTR Cooperative Agreement

Program Review Meeting

February 25, 2009

Very High Temperature Gas Reactor

- The Next Generation Nuclear Plant (NGNP) is slated to be a VHTR design.
  - Many specific design decisions which have yet to be made.
    - Core configuration.
      - Prismatic block core.
      - Pebble bed core.
      - There is potential for license applications for both a prismatic block and a pebble bed core design type reactor.
      - HTTF will be designed to model both the prismatic block core and the pebble bed core designs
    - Outlet temperature.
      - Higher outlet temperatures allow for a more efficient hydrogen production operation.
      - Higher outlet temperature may present a challenge to existing vessel and structural materials.

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Prototypical VHTR Design Data

Thermal Fluid Data for the Full Scale VHTR Base Case

Thermal Fluid Parameters		
Coolant	Helium	
Core Thermal Power	600	MW
Power Density	4	MW/m^3
Coolant Pressure	7	MPa
Core Outlet Temperature	1000	C
Core Inlet Temperature	490	C
Mass Flow Rate	320	kg/s
Maximum Fuel Temperature (Normal Operation)		
LEU-PyC/SiC	1250	C
LEU-PyC/ZrC	1400	C
Maximum Fuel Temperature (Emergency Conditions)		
LEU-PyC/SiC	1600	C
Core Pressure Drop		
0.2 bypass flow	55847.5	Pa
0.15 bypass flow	62052.8	Pa
0.1 bypass flow	68947.6	Pa

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Prototypical VHTR Design Data

VHTR Full-Scale Pressure Vessel Data

Pressure Vessel Data		
Material	9Cr-1Mo-VNb ferritic steel	
Inside Diameter	7.23	m
Outside Diameter	7.66	m
Cylindrical Section Length	15.98	m
Lower Head Geometry (Radius)	3.61	m
Upper Head Geometry (Radius)	3.61	m
Inlet Duct Flow Area	8.35	m^2
Outlet Duct Flow Area	6.42	m^2
Number of graphite core support columns	186	
Outside diameter of each core support column	0.2261	m
Length of core support column	1.8481	m
Geometry of core support columns	cylindrical	

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Prototypical VHTR Design Data

VHTR Full-Scale Core Data

Reactor Core Data		
Core geometry and dimensions		
Inner reflector, effective diameter	2.96	m
Core, effective diameter	4.82	m
Outer reflector, effective diameter	6.66	m
Active Core Height	7.93	m
Number of fuel columns	102	
Number of fuel blocks per column	10	
Length of individual assembly	0.793	m
Core geometry	Annular	
Core total flow area (control rods inserted)	2.06	m^2
Core total flow area (control rods withdrawn)	2.15	m^2
Flow area, core through upper plenum shroud	1.33	m^2
Reflector Above Active Core	1.19	m
Reflector Below Active Core	1.58	m
Number of Guide Tubes	48	
Control Rod Guide Tube Diameter	0.1016	m
Flow area, core exit to hot gas plenum	0.8216	m^2
Geometry, core exit to hot gas plenum	Rectangular	
Assembly geometry and dimensions		
Number of active fuel elements per assembly	210	
Outside diameter of each fuel element	0.0127	M
Edge to Edge length, hexagonal fuel assembly	0.3600	M
Total Coolant Flow Area per channel	0.02095	m^2
Number of coolant channels per fuel assembly		
Small Channels	6	
Large Channels	102	
Inside diameter of each coolant channel		
Small Channels	0.0127	m
Large Channels	0.0159	m

Data for prismatic block core design.

For purposes of HTTF design, the same vessel and core dimensions will be used for the pebble bed design with the difference being that the core is fueled with 6 cm diameter fuel spheres instead of the fueled graphite blocks.

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Questions?

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