The Choice of Fuel Design

Presentation to the US DOE

Dieter Matzner

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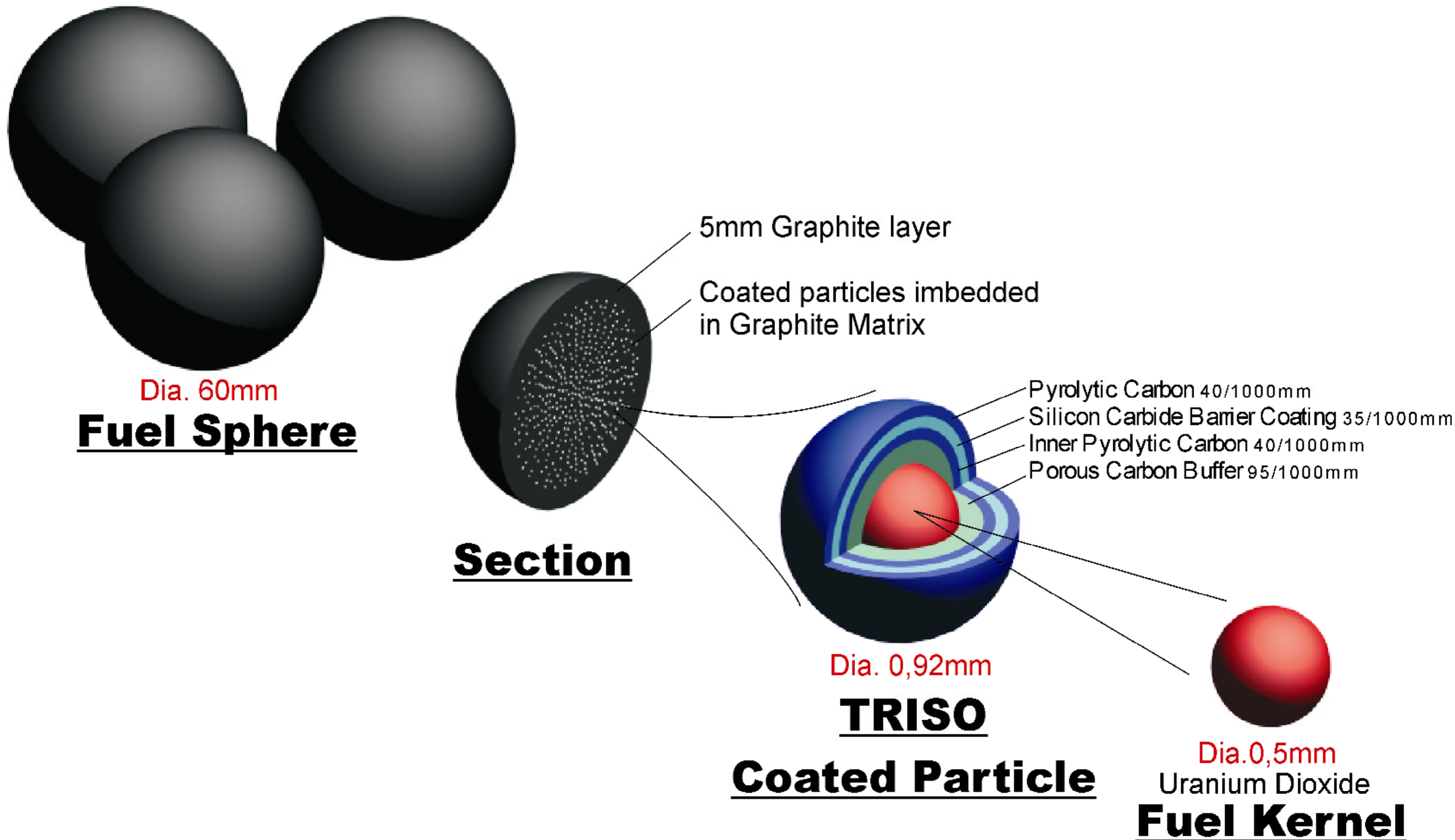
Fuel Sphere



Dia. 60mm
Fuel Sphere
5mm Graphite layer
Coated particles imbedded in Graphite Matrix
Section
Pyrolytic Carbon 40/1000mm
Silicon Carbide Barrier Coating 35/1000mm
Inner Pyrolytic Carbon 40/1000mm
Porous Carbon Buffer 95/1000mm
Dia. 0,92mm
TRISO
Coated Particle
Dia.0,5mm
Uranium Dioxide
Fuel Kernel

Pebble advantages

- Continuous fuelling
- Constant core conditions
- Burnup improvement
- Flexibility in core design
- Cycle operating temperature
- Mass fuel production costs
- Spent fuel handling and storage

Continuous fuelling

- Planned unavailability lower because of continuous fuelling
  - THTR and AVR experience support PBMR estimates
  - Enables 6 years between outages
- Design only needs small excess reactivity for load following purposes
  - PBMR excess needed is 1.3% Δk for 40 to 100% control
  - Block reactors need 3.5% Δk excess and burnable poison

Core conditions are constant

- Equilibrium core is constant for plant life
  - Equilibrium core conditions exist for > 90% of plant life
- No need to redesign core at every outage
  - After defuelling outage equilibrium core conditions are restored in a few months
- Small top to bottom fuel mixture difference
  - Average burnup difference between top & bottom is less then 10 000 MWd/tU

Fuel burnup

PBMR

- Equal fuel burnup for all discharged fuel
- For same enrichment pebble fuel reaches higher burnups than block fuel as no neutron poisons are needed
  - PBMR 19.6% = 208 GWd/tU
  - Block at 19.75% (14% av) = 120 GWd/tU
- Average core fission product inventory lower

Flexibility in core design

PBMR

- Higher enrichment for higher burnup can be introduced in standard plant design
- Excess reactivity is constantly adjustable by regulating feeding rate of fuel

Cycle operating temperature

P B M R

- Direct cooling of spheres gives substantially lower fuel temperatures than block type fuel (~ 100 to 150°C)
- Ag and Cs releases are 100 to 1000 times lower
- PBMR outlet temperature can be higher for similar Ag and Cs releases from core of block fuel
  - Potential to increase outlet temperature to >950 ºC for process heat applications (hydrogen production) and improved efficiency

Fuel costs

P B M R

- Standardized single-enrichment fuel reduces manufacturing costs
- No burnable poisons
- Single component fuel element

Spent fuel handling and storage

P B M R

- Continuous removal of spent fuel completely automated
- All subsequent fuel handling via automated pneumatic system
- Future higher burnup will reduce future spent fuel volumes