

Ch 15 Equipment

Pumps
HX
Piping
Aux. eqp.

Expansion Tanks
Storage Vessels
Valves
Sensors

Pumps

containment → exclude oxidants
→ prevent escape of salt & gases
motor → minimize heating
→ minimize irradiation

HX

minimize salt volume ARF: 384g/L ^{235}U in fuel salt
↑ important design goal* core volume: 38.8L → 149g ^{235}U in core
significant fuel inventory external to the core
→ total ^{235}U used: 61kg

Piping

seamless piping → for corrosion

Thermal expansion → pre-stressing the pipe
→ expansion loops
→ expansion joints

heaters & th. insulation → prevent freezing
→ minimize heat losses

Sensors

flow rate - venturi tubes

pressure - pressure transmitters

temperature - thermocouples

level - electrical probes & floats

Free liquid surfaces

inert gas - prevent oxidation

→ to transfer liquid ("push liquid")
for filling & draining

off-gas system - ch 17

Pumps

Considerations: {
- cavitation → can test with water
- thermal stresses
- irradiation stresses

Radiation hardening - larger shaft

- added shielding for bearings and motor

- hollow metal O-rings to replace elastomer seals

- oil lubricated seal is a problem - cokes under irradiation



use phenyls instead

* bearing - hemispherical gas-cushioned bearing
- hydrostatic, or hydrodynamic design - oil free

* seal - labyrinth-type seal, oil free
→ no rubbing surfaces

Pumps

Motor windings provide shielding

Beryllium & boron - for neutron shielding
heavy metal - for γ - shielding

- motor totally enclosed \Rightarrow no need for a shaft seal

Functions

- ① Impeller & Pump Bowl
- ② Expansion Tank (tolerate level variation)
- ③ Cooling - impeller, casing, bearings
remove irradiation-induced heating
in the metal parts
- ④ Sealing to cover gas
- FD containment
- maintain inert cover gas
- ⑤ Bearings - tolerate thermal expansion

RB-FHR $976 \text{ kg/s} = 2.54 \text{ m}^3/\text{s} \approx 2000 \text{ m}^3/\text{h} = 8,800 \text{ gpm}$

$10^6 \text{ Pa} \approx 5 \text{ m} \approx 16 \text{ ft}$

Valves

Alignment

fusion-bonding \rightarrow Molybdenum } Tungsten ok
gas-tight seal } or copper

cermet seats - $< 2 \text{ cm}^3/\text{hr}$

rapid valve is not necessary

freeze valves

flattened section of piping - slow-response
(tens of minutes)

System Heating

Trace heating

Resistance heating of piping

\downarrow
doesn't work well for pipe bends - hot spots form.

Joints

* minimize as much as possible

- flanged \rightarrow challenging to make leak-tight
- welded \rightarrow remote cutting & welding is difficult

Flanges 1 freeze-flange

2 cast-metal - sealed flange

\downarrow
melt metal to open flange

3 Gasket - soft metal gasket

Instrumentation

Flow - Venturi - has been used

- magnetic - doesn't work, salt el. conductivity too low
- ultrasonic - being tested presently

Pressure

- pneumatic force - balance \rightarrow transfer fluid line - additional containment
- displacement unit - diaphragm

Temperature

- thermocouples
- bulk temperature - in pump bowl (3 well mixed)

Level

- Gas bubbling - continuous reads
- spark-plug - on/off measurements