Progress on Thick Liquid Wall Concepts for High Power Density MFE FW/Blanket Designs

Presented by
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APEX IV, Albuquerque, NM
July 27-29, 1998

Topics to be Discussed:

1. Mechanisms of maintaining a neutronically thick liquid blanket for APEX applications
   - Design description
   - Supporting analyses - FLOW_3D results using Flibe
2. How stable can the plasma be in thick Flibe and lithium blanket configurations?
3. Status on Flibe surface temperature evaluation
4. Issues and FY 99 Tasks- Hydrodynamics stability, Experiment needs for heat transfer into high Prandtl number turbulent jets, Design conceptualization and penetrations

Design Progress of Thick Liquid Wall Concepts

APEX II (Jan., 98)

APEX III (May, 98)

APEX IV (July, 98)

Heat transfer analysis to help define liquid flow characteristics

Finding- to reduce liquid surface temperature (evaporation rate) requires

(1) high speed jets for surface heat removal

(2) turbulent heat transfer enhancement for Flibe jets

2-D Free surface hydraulic analysis for thick liquid blanket designs

Finding- to reduce pumping power for a neutronically thick liquid column

(1) it appears difficult to form a zero structure thick liquid blanket:

a slow moving jet results in gravitational thinning and inadequate radiation protection

a fast moving jet results in a large inventory and negligible temperature increases

(2) need "ideas" for thick liquid blanket formation

Mechanisms of Maintaining a Neutronically Thick High Payoff Liquid Blanket for APEX Applications

Base Design Idea- Present Focus:

A **minimum structure** thick liquid wall concept in which the "thick" liquid inside the blanket pocket is held up against the gravity by the fluid reflectors

New "Wild" Design Idea- will evolve later:

A **zero structure** thick liquid wall concept in which the fluid is pushed against the wall by centrifugal force through rotation of the liquid container wall
(A separate presentation of this idea will be given by Gulec.)

Design Description of the Base Design Idea

Motivation-

to increase fluid residence time inside the vessel while minimizing the use of the structures and external momentum

surface heat = 2 MW/m^2 (hard Bremsstrahlung radiation spectrum)
neutron wall load = 10 MW/m^2

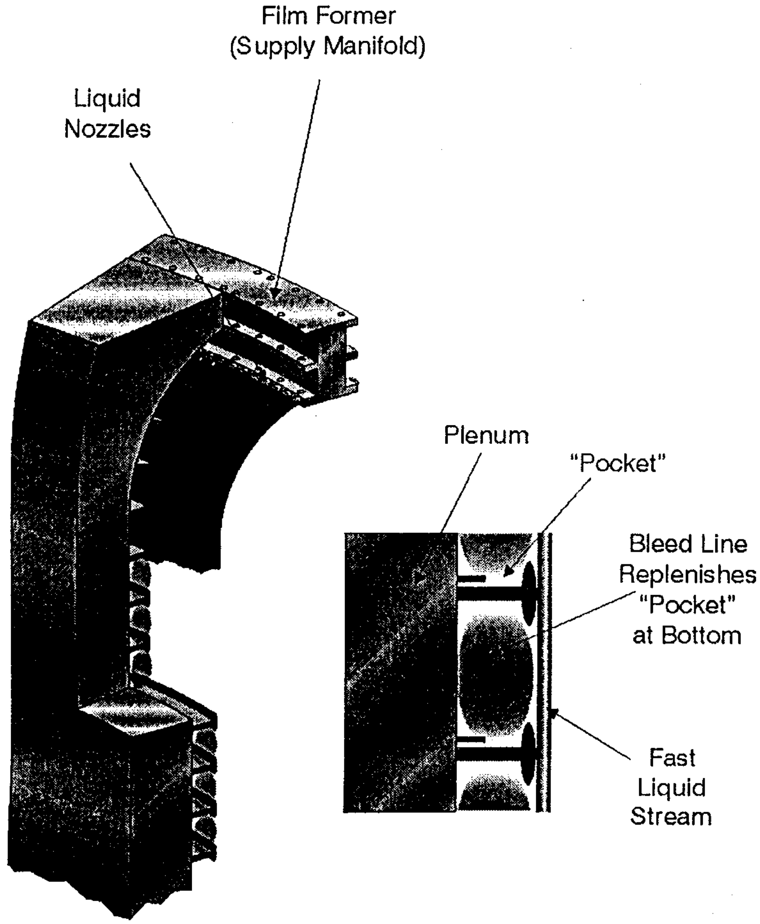
Fluid	Reflector Material	Velocity FW/Blanket	Temp. /ΔT FW exit	Overall Temp. Rise (ARIES Configuration)
Flibe	Tungsten	20/5 m/s	750/245 C	50 C
Flibe	FS perforated plate	20/5 m/s	750/245 C	50 C
Lithium	Vanadium	20/5 m/s	350/113 C	105 C

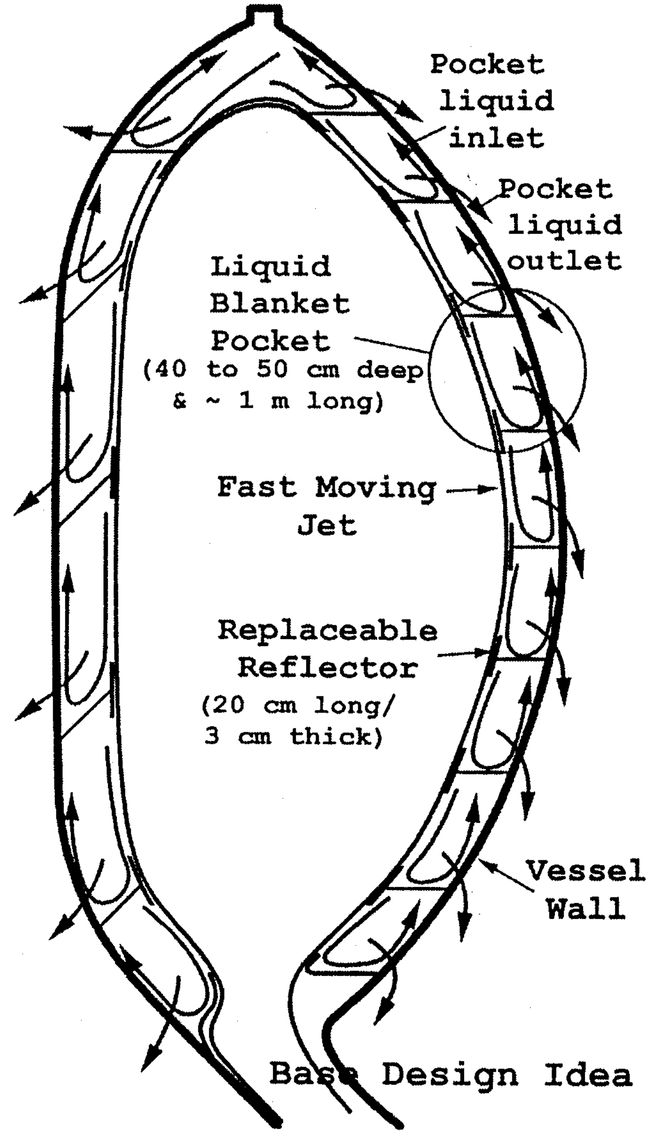
T too high? slug flow no turbulence consideration

equivalent h = 8200 w/m^2k

outlet T too low? 2 coolant streams required ?

Can T be higher ?


Film Former
(Supply Manifold)
Liquid
Nozzles
Plenum
"Pocket"
Bleed Line
Replenishes
"Pocket"
at Bottom
Fast
Liquid
Stream


Pocket
liquid
inlet
Pocket
liquid
outlet
Liquid
Blanket
Pocket
(40 to 50 cm deep
& ~ 1 m long)
Fast Moving
Jet
Replaceable
Reflector
(20 cm long/
3 cm thick)
Vessel
Wall
Base Design Idea