Possible Blanket Concept for APEX

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Desirable Blanket Features

- High wall loading capability
- Good tritium breeding capability
- Low activation
- High thermal converting efficiency
- Reliable operation
- Easy maintenance
- Low tritium inventory

It is important to identify a blanket design which can fulfill all the requirements.

APEX Goal

To be able to identify a blanket concept which will have the capability to handling 7 MW/m^2 neutron wall loading, and a surface heat flux of 1, 5 MW/m^2. It also has to be able to fulfill all other requirements.

Structural Material Selection

There are very limited candidates for structural material which will fulfill the low activation and high temperature requirements. The only possible candidates are:

- Ferritic steel:
  - Limited temperature and wall loading capabilities.
- V-alloy:
  - Very sensitive to interstitial impurities.
- SiC composite:
  - Very low thermal conductivity after irradiation.
- SiC-metallic composites:
  - Very limited data base.

First Wall Heat Transfer

Conditions: First wall thickness 3 mm
First wall heat flux 150 w/cm2

	316 SS	Ferritic steel	V-alloy	SiC
K, w/cm-C	0.2	0.28	0.3	0.03
K/x, w/cm2-C	0.67	0.93	1.0	0.1
q^{III} k/x, c	224	161	150	1500
Max. structural T, C	500	550	700	1000
Min. coolant T, C*	300	300	400	300
Temperature window	-24	91	150	-800

*For He-cycle, a suggested Tc]in is 436°C.

First Wall Heat Transfer (II)

- The resistance to heat transfer from the first wall is very large. There is diminish return if the coolant heat transfer coefficient becomes larger than 1.0 w/cm2-C

- For a first wall heat flux of 150 w/cm2, there will be no design window for the SiC and 316SS designs.

- There will be a very narrow design window for FS, and only a moderate one for the V-alloy.

The Design Option

Remove the first wall!

Li20 Particle Concept

Concept Description

- This concept uses free drop of Li20 particulates.
- There is no first wall between the Li20 and the plasma.
- Free drop of Li20 particulates will also form the divertor surface.
- Due to the elimination of the first wall, this solid breeder blanket may be able to breed without Be as neutron multiplier.
- The Li20 is selected due to its low vapor pressure, low activation and good breeding potential.

Concept Description
(Contd.)

- Because there is no first wall, very high neutron wall loading is allowable.

- Mechanical conveyers will be used to lift the Li20 particulates.

- High Li20 exit temperature will result good thermal converting efficiency.

Example of Granular Flow Li_2O Blanket for ARIES-ST

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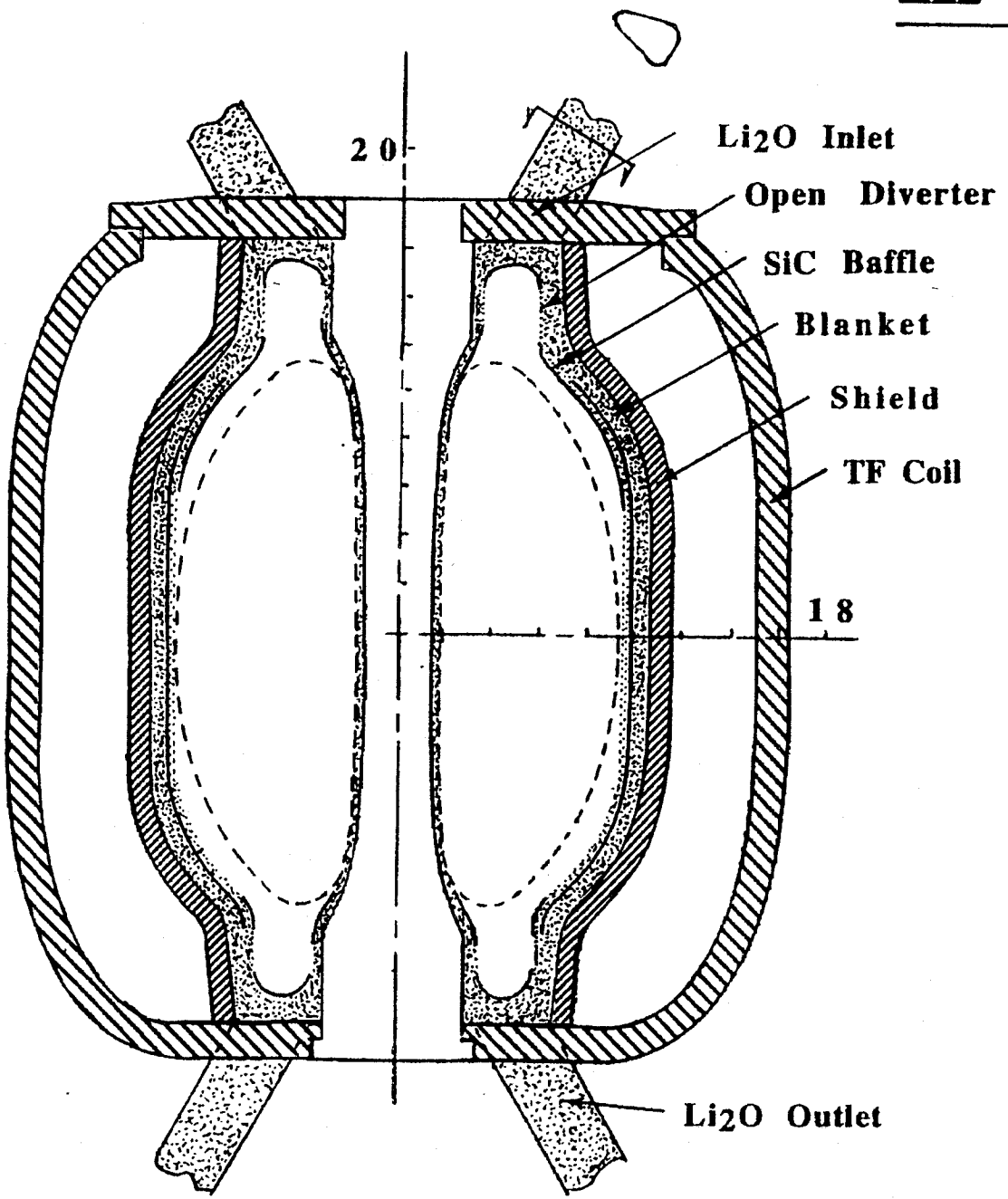
spheroid torous



Salient Features of the Granular Flow Li_2O Blanket

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- Low pressure-no pressure boundaries
- High coverage blanket, high TBR without Be
- Simple SiC structure
- Because Li2O vapor is low Z, may be tollerated by the plasma
- Potential for reducing heat load on diverters by intercepting flux lines at the mid-plane by free surface granules
- Potentially self pumping by ash embedding in and being trapped by the granules
- Potential for easy blanket maintenance. The whole OB blanket with the Li_2O granules removed, can be extracted through the top access port while leaving 85% of the shield undisturbed

Advantages

- The design here is to eliminate the structural first wall for the divertor and the blanket.
- The first structural wall will be behind the breeding zone, resulting in long life, reduced activation and after heat.
- Without the using of either Li or Be, the safety characteristics will be good.
- This blanket concept can handle high neutron wall loading and resulting high thermal efficiency.

Concerns

- This is a new concept with many issues to be resolved.
- Particulate handling, especially erosion, attrition, circulating system, have to be investigated.
- Velocity control inside the blanket regime is important to achieve optimum Li20 exit temperature.
- Tritium breeding will also be an issue for a system with no Be, and no breeding at the IB.