Techno-economic aspects of high current leads system for fusion devices

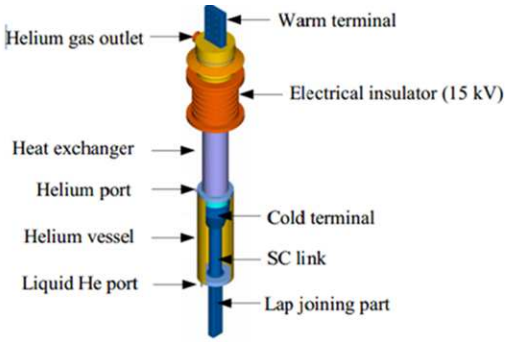
In order to power the superconducting magnets of a fusion reactor, many pairs of steady state and pulsed current leads are required in temperature range of 4.5 K – 300 K.
Almost 25-30% operational cost of any fusion reactor is consumed by only current leads system.

Optimum and innovative technical solution is needed.

Literature survey has shown that tens of kA class various types of current leads have been developed, tested and now operating or will be operated on the fusion devices Viz. SST-1 (India), EAST (China), KSTAR (Korea), LHD (Japan), JT-60 SA (Japan), ITER (France), W-7X (Germany) and many more R & D test facilities across the world.

The first time in the world the combination of MgB2 and Brass based Overloaded current lead is proposed as an innovative solution.

As the MgB2 is much cheaper than that of HTS materials as well as the use of higher melting point and lower thermal conductivity of Brass can be the potential combination as binary current leads. Using this MgB2 and Brass current leads can give significant cost savings in capital as well as operational cost.



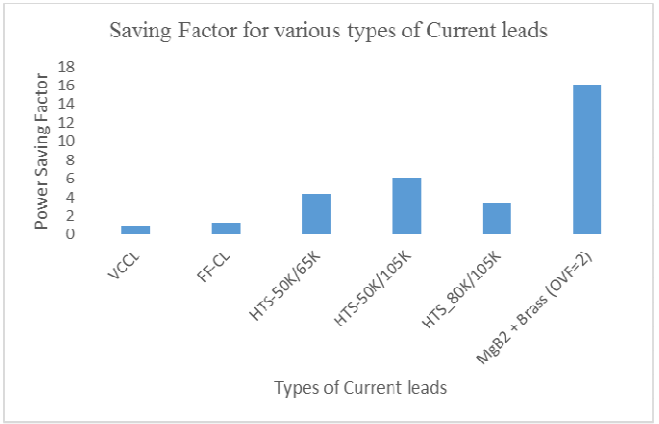
State of art: Current lead

Governing Equations

$$\frac{d}{dx}\left[K(T)A\frac{dT}{dx}\right]-mf\frac{dh}{dx}+\frac{I^2\rho(T)}{A}=0$$

$$mfCp(T_2-T_1)=Q_{Convection}$$

$$Q_{Total}=Q_{Rad}+Q_{Conduction-Resistive}+Q_{Rgc}$$



Comparison of Cryo Power Savings for various types of Current leads