SDC SOLENOIED DESIGN NOTE #128

TITLE: Preliminary Calculations For a Combined- Support System

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INTRODUCTION: This design note contains a preliminary calculation for the coil support system which includes the maximum stress, maximum deflection and the heat leak calculation. It starts by assuming that the support rod is attached after the system cools down. Therefore, the maximum stress of support rod will be mainly due to the axial magnetostatic force and the radial force which is assumed to be 130 (Ton) for axial force and 80,000 lbf for the radial force, respectively. The study of the system stiffness is by assuming the different positions for the support rod along the coil to achieve a optimum value. A pre-load condition is also considered to ensure the tension rod only . Those results are shown in Table-1, Table-2 and Table-3.

CALCULATIONS: In the first calculation, it is assumed that the support rod is attached to the cold mass 1/4 L in from the edge as seen in Fig-1. The length of the rod will be Lr = 2.299 m and the calculation result are shown on the Table-1. In the second case, the attachment point is 1/8 L in from its edge. It gives Lr= 1.214 m. In the third calculation, the rod attaches right on the edge of coil and Lr= 0.148 m. The results are shown in Table-2 and Table-3.

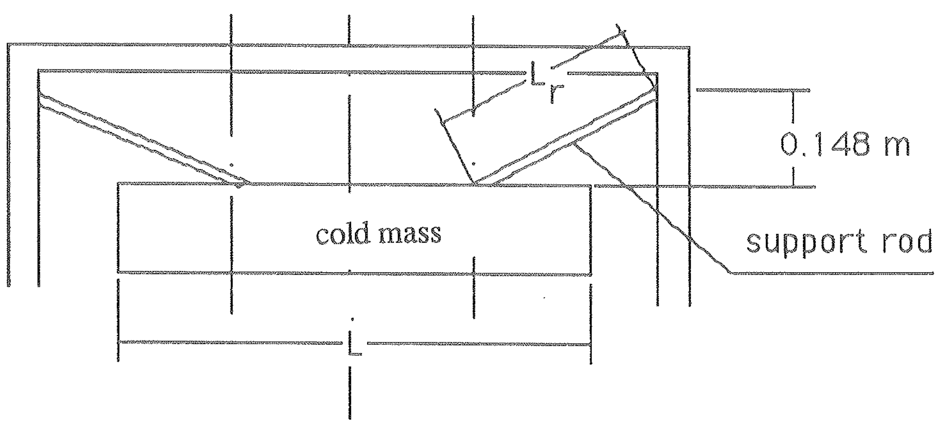

Fig-1 The position of support rod

CONCLUSION: The calculation shows that a bigger diameter of rod is required as the attachment point moves towards the center of the cold mass. The radial stiffness is also getting worth because the angle α between the rod and cold mass becomes smaller. The heat leak calculation shows that the third case, the rod attaches right on the edge of the cold mass, has a biggest value among those cases even though it has a smallest diameter. It can be explained that the short length of rod results a low thermal resistance. In further, if one can be assumed that the heat leak can be improved by moving the L-He intersection closer to the warm side, the third case will be highly recommended.

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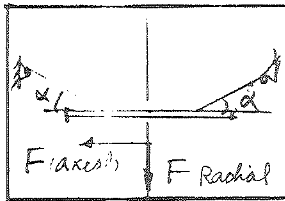 	$\alpha = 3.6°$ $F_{Radial} = 80{,}000$ lbf $F_{axial} = 130$ T $\phi_{min} = 55$ (mm) $n = 12$	
	$\phi = 60$ mm	$\phi = 70$ (mm)
q (HEAT LEAK)	0.255 (W/ROD)	0.347 (W/ROD)
σ_0 (PRELOAD)	25,094 (PSI)	18,468 (PSI)
σ_L (MAX. COMPRESSION)	0	0
σ_R (MAX. TENSION)	50,188 (PSI)	36,937 (PSI)
MAX DEFLECTION (AXIAL DIRECTION)	0.22 (mm)	0.172 (mm)
MAX DEFLECTION (RADIAL DIRECTION)	31 (mm)	19 (mm)
AXIAL STIFFNESS	5.79×10^9 (N/m)	7.4×10^9 (N/m)
RADIAL STIFFNESS	1.128×10^7 (N/m)	1.87×10^7 (N/m)

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$\alpha = 7°$ FAXIAL FRADIAL	$\alpha = 7°$ $F_{RADIAL} = 80,000$ (lbf) $F_{AXIAL} = 130$ T. $\phi_{MIN} = 43$ (mm) $n = 12$.	
	$\phi = 60$ (mm)	$\phi = 50$ mm
q HEAT LEAK	0.486 $\frac{W}{ROD}$	0.337 ($\frac{W}{ROD}$)
σ_o (PRE LOAD)	14,9[illegible]5 (PSI)	21,499 (PSI)
σ_L (MAX COMPRESSION)	0	0
σ_R (MAX. TENSION)	29,[illegible] (PSI)	42,998 PSI
Max Def. (AXIAL DIRECTION)	0.14 (mm)	0.188 (mm)
Max. Def (RADIAL DIRECTION)	5.7 (mm)	7.5 (mm)
AXIAL STIFFNESS	9.1×10^9 ($\frac{N}{m}$)	6.77×10^9 ($\frac{N}{M}$)
RADIAL STIFFNESS	6.23×10^7 ($\frac{N}{M}$)	4.73×10^7 ($\frac{N}{M}$)

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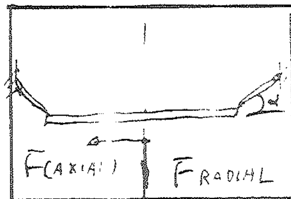	$\alpha = 52.15°$ $F_{AXIAL} = 130\,T$ $\phi_{MIN} = 27$ (mm) $F_{RADIAL} = 80{,}000$ $R=12$	
	$\phi = 30$ mm	
q (HEAT LEAK)	0.78 $\left(\frac{W}{ROD}\right)$	
σ_0 (PRELOAD)	24,975 (psi)	
σ_L MAX COMPRESSION	0	
σ_R MAX TENSION	49,951 psi	
MAX DEFLECTION (AXIAL DIRECTION)	0.888 (mm)	
MAX DEFLECTION (RADIAL DIRECTION)	0.5976 (mm)	
AXIAL STIFFNESS	1.44×10^9 $\frac{N}{m}$	
RADIAL STIFFNESS	5.94×10^8 $\frac{N}{m}$	