

Preloading Loss Estimation With Aluminum Cylinder

Masayoshi Wake
Fermilab, 9 October 1990

The same estimation as TS-SSC 90-056 can be made for the case if we use aluminum cylinders. The summary of the calculation result with stainless steel cylinder for 40mm design is:

	contraction	effective contraction	pressure loss	
G10 para	0.00971	0.00527	18.166kg/mm ²	25.832 ksi
Stycast	0.00485	0.00187	6.459kg/mm ²	9.185 ksi
G10 ortho	0.00139	-0.00054	-1.875kg/mm ²	-2.666 ksi
Steel	0.00200	-0.00012	-0.405kg/mm ²	-0.577 ksi
Al5083	0.00420	0.00142	4.894kg/mm ²	6.959 ksi

The slight difference from 90-056 is due to the change of the thermal shrinkage of the coil. It was 0.004 but here 0.0042 which is the same value of aluminum is used. In the same way, the values for 50mm design is given as:

	contraction	effective contraction	pressure loss	
G10 para	0.00971	0.00524	19.027kg/mm ²	27.057 ksi
Stycast	0.00485	0.00187	6.792kg/mm ²	9.658 ksi
G10 ortho	0.00139	-0.00053	-1.919kg/mm ²	-2.729 ksi
Steel	0.00200	-0.00011	-0.384kg/mm ²	-0.545 ksi
Al5083	0.00420	0.00142	5.155kg/mm ²	7.331 ksi

The material change in the cylinder from stainless steel to aluminum causes the following results for 40 mm design:

	contraction	effective contraction	pressure loss	
G10 para	0.00971	0.00385	4.645kg/mm ²	6.606 ksi
Stycast	0.00485	0.00045	0.548kg/mm ²	0.779 ksi
G10 ortho	0.00139	-0.00196	-2.369kg/mm ²	-3.369 ksi
Steel	0.00200	-0.00154	-1.855kg/mm ²	-2.637 ksi
Al5083	0.00420	0.00000	0.000kg/mm ²	0.000 ksi

The results for 50 mm design with aluminum cylinder is:

	contraction	effective contraction	pressure loss	
G10 para	0.00971	0.00382	4.855kg/mm ²	6.904 ksi
Stycast	0.00485	0.00045	0.573kg/mm ²	0.814 ksi
G10 ortho	0.00139	-0.00195	-2.476kg/mm ²	-3.521 ksi
Steel	0.00200	-0.00153	-1.939kg/mm ²	-2.757 ksi
Al5083	0.00420	0.00000	0.000kg/mm ²	0.000 ksi

Since we have reserved space of 10 mm in 50 mm design, Aluminum cylinder can increase the thickness by 10 mm, In this case:

	contraction	effective contraction	pressure loss	
G10 para	0.00971	0.00382	6.969kg/mm ²	9.910 ksi
Stycast	0.00485	0.00045	0.822kg/mm ²	1.169 ksi
G10 ortho	0.00139	-0.00195	-3.554kg/mm ²	-5.054 ksi
Steel	0.00200	-0.00153	-2.783kg/mm ²	-3.957 ksi
Al5083	0.00420	0.00000	0.000kg/mm ²	0.000 ksi

The increase of the thickness of the cylinder gives a safety margin for the yielding of the material. But the pressure change during a cooldown increases because of the increase of the spring constant. If we use stycast with aluminum cylinder, which does not cause fatal loss of the preloading, we had better use thin cylinder. High strength aluminum such as 2219 may be suitable for it.

Distribution:

R. Bossert
J. Carson
S. Delchamps
N. Hassan
J. Kerby
W. Koska
P. Mantsch
D. Sims
J. Strait
M. Winters