Cool-Down Experiences with The SST-1 Helium Cryo System Before and After Current Feeders System Modifications


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Abstract:
The SST-1 machine comprises of superconducting magnets system (SCMS) which includes TF and PF magnets. In order to charge the SCMS, we need superconducting current feeders system consisting of SC feeders and vapor cooled current leads (VCCLs). We have installed all (+/-) 10 pairs of vapor cooled current leads for the TF and PF systems. While conducting initial engineering validation of SST-1 machine, our prime objective was to produce circular plasma using only the TF system. During SST-1 campaign-I to IV, we have closed the PF magnets cooling in order to get the cryo stable conditions for current charging of the TF magnet system. In that case, the cooling of the PF current leads is not essential. It has been also observed that after closing of the PF system cooling, there was a limited experimental window of TF operation. Therefore, in recent SST-1 campaign-VII, we removed the PF current leads (9 pairs) and kept only one (+/-) pair of the 10 kA rated VCCLs to realize the charging of the TF system for extended window of operation. We have observed better cryogenic stability in TF magnets after modifications in CFS. In this paper, we report the comparison of the cool down performance for SST-1 machine operation before and after modifications of the current feeders system.

Overview of Current Feeders System (CFS)
- The current feeders system (CFS) is essentially an optimised bridge between the power supply at room temperature and super conducting magnet system (SCMS) of the SST-1 machine at 4.5 K.
- CFS is a complex electrical and cryogenic network consists of ten pairs of 10 kA rating helium vapour cooled conventional current leads (VCCLs) and superconducting current feeders.

SST-1 Cool-Down Experience Before CFS Modifications
- PF & TF current leads become temperate after PF path bypass.
- Due to PF hydraulics imbalance, PF magnets have been cooled down to 12 K at inlet and 38 K at outlet.
- It requires to abort PF magnets cool down in order to achieve cryo stable conditions in TF magnets.
- Gradual rise in temperatures of PF magnets and CLs were observed after PF path bypass.
- Subsequently HRS plant cooling capacity as well as LHe yield were compromised.

SST-1 Cool-Down Experience After CFS Modifications
- SCMS data before bypassing PF path after CFS modifications.
- PF magnets return temperatures were made down from 38 K to 24 K.
- Cryo stable condition achieved in TF magnets.
- Removal of PF CLs resulted in 70% saving of cold standby power.
- Enhanced SST-1 experiment window of 7 days more.

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SST-1 CFS Achievements in Recent Campaign
- TF current leads snap shot at the time of 6.8 kA current charge.
- SST-1 TF magnets have been energized with 4.7 kA for more than 20000 seconds of TF flat-top.
- SST-1 TF magnets have been energized with 7.644 kA for 340 s in 1.5 Tesla fundamental mode of ECRH.

Conclusion
- Removal of standby PF CLs from CFS resulted in to 70% saving of cold standby power.
- Additional two vacuum barrier for PF lower and upper duct were installed inside CFS.
- Before bypass PF magnets, their temperatures were made down from 38 K to 24 K.
- Extended experiment window of 7 days more was observed after CFS modifications.
- TF magnets have been energized for 4.7 kA for more than 20000 seconds of TF flat-top.
- CFS performance was found to be satisfactory and reliable during the SST-1 campaign.

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