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Forced Two-Phase Helium Cooling Scheme for Mu2e Transport Solenoid

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The Mu2e Transport Solenoid (TS) consists of two separate but similar solenoids, TS-u and TS-d. Each solenoid is in the shape of a quadrant with a centerline radius of approximately 3 m and has a helium cooling loop consisting of 25 vertically oriented rings with diameters ranging from 1 m to 1.25 m connected in series. This cooling loop configuration has been deemed adequate for cooling via forced single phase liquid helium; however it presents major challenges to forced two-phase flow such as “garden hose” pressure drop, concerns of flow separation from tube walls, difficulty of calculation, etc. Even with these disadvantages, forced two-phase flow has certain inherent advantages which make it a more attractive option than forced single phase flow. It is for this reason that the use of forced two-phase flow was studied for the TS magnets. This paper will describe the analysis using helium-specific pressure drop correlations, conservative engineering approach, helium properties calculated and updated at over fifty points, and how the results compared with those in literature. Based on the findings, the use of forced-two phase helium is determined to be feasible for steady-state cooling of the TS solenoids.

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