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CONDUCTOR R&D FOR QPS

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The current method being explored for cooling of copper cable conductor in compact stellarators is by using an array of copper chill-plates that surround the copper conductor. An alternative approach is to provide for internal cooling by having copper tubes inserted in the middle of each copper cable conductor. Some of the main issues that need to be addressed before employing such methodology are: a) crimping prevention of copper tube during the conductor lay-up; b) change in the flexibility of copper cable conductor; and c) the effect of copper tubes on the mechanical properties of copper cable conductor.

For crimping prevention, the copper tubes will be filled with MCP-124 (Bi, Pb, alloy; melting point at 124^{o}C (255^{o}F)). After conforming the copper cable conductor and copper tube combination to its required form, the MCP needs to be flushed out. This particular alloy was chosen so that it can be flushed out during the post-cure temperature of polymer (CTD-403) that post-cures at 170^{o}C (338^{o}F). Preliminary experiments were done to evaluate the feasibility of filling and removing the MCP. Samples of 50-ft long copper tubes were filled with molten MCP at 160^{o}C (320^{o}F). Cold and hot air were used to flush the molten MCP out of the tube. The weight and volume percents of MCP remaining in the copper tube were determined. The flow rates of water in the tube before filling it with MCP and after flushing it out were determined.

Test pieces of 4-turn stranded copper cable coils with and without the cooling copper tubes will be wound and impregnated with CTD-403 polymer to gain experience and develop procedures in winding compacted stranded copper cable conductor for QPS. For mechanical characterization, two types of samples will be used: 1) The complete wound 4-turn race-track shaped coil will be loaded in a testing machine and strain measurements will made on the two straight sections. These specimens will be subjected to cyclic loading to determine the fatigue properties; 2) Straight samples of the cured conductor will be cut and tested for thermal properties (conductivity), and tensile properties (stiffness and strength) using both uniaxial and 3-point bend loading.