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M2Or3A-02 [Invited]: AC Loss of Superconducting Materials- refined loss estimates for very high density motors and generators for hybrid-electric aircraft: MgB2 wires, Coated conductor tapes and wires

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Superconducting winding are enabling for the development of the highest power density motors and generators for aircraft use. It is presently estimated that motors with normal conducting can reach a future limit of at best 20 kW/kg. On the other hand, superconducting winding are estimated to be able to produce more than double this, at 45 kW/kg. Superconducting windings carry very large current densities (1 kA/mm2 winding Je and more) and can generate much higher winding fields (even as high as 3-8 T in some designs), but do generate losses in the windings which must be removed at cryogenic temperatures. Here we compare loss values under realistic design constraints for the two most appropriate conductors for motor-generator applications; MgB2 and YBCO coated conductor. MgB2 is available in the form of wires (about 1 mm OD), and coated conductor either as tapes (4 mm x 0.1 mm) or wire-sized cables (2-3 mm OD). Here comparisons are made with best of class MgB2 and YBCO conductors where various loss contributions are incorporated, including applied fields, applied currents, and interaction terms. It is shown that present day MgB2 conductors are usable for motors and generators with sufficient attention to cooling design, and that filament numbers of 10-100 in a 2 mm wide YBCO tape will make it a viable candidate for use. YBCO coated conductor in the form of small wires is also quite promising, with low reductions due to twisting. Specific loss values are very dependent on rotational speed, number of poles, and conductor design, but detailed and specific losses are given for frequencies of 200-400 Hz and field amplitudes from 0.5-4 T, as well as scaling rules to extend these regimes. We in particular include here also the effect of maximum field amplitude variation in the windings, and include for the conductors a semi-bean approximation which allows for more realistic loss modelling results.

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