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M2Or2A-01 [Invited]: Design of MW-Design of MW-Class Industrial Motors by AMSC

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Superconducting machines are attractive for several industries; electric power utilities and industrial applications prefer higher efficiency and ease of operation; aerospace applications like compact lightweight and attractive efficiency; and wind-farm applications want high-efficiency, compact and lightweight generators.
Conventional machines are constrained to operate within saturation limit of iron core. However, HTS excitation windings generate high magnetic fields which easily saturate the iron and therefore, no iron is used. The absence of iron enables operate of the stator windings at much higher fields, which facilitate more compact lightweight designs for the HTS machines. In industrial and utility settings, efficiency is the most desirable feature. Replacing copper with HTS in the excitation winding leads to an efficiency gain of 1% or more. This feature provided impetus for developing 1000 HP and 5000 HP motors tested during 2000-01.
Industrial and utility machines operate synchronously with the electric grid at a fixed frequency. The dynamic stability of such machines is very importance. A conventional machine, with characteristically high synchronousness reactance, requires dynamic control of field excitation to stay within safe operating region. Most synchronous machines are operated by over-exciting the field winding for absorbing reactive power of the electric grid. However, during lightly loaded conditions, system reactive load becomes low and the machine is operated in under excitation mode for generating reactive power. But, internal heating of iron core usually allows operation at a very small fraction of the rated load capability. However, HTS machines employing no magnetic iron have characteristically low synchronous reactance, which enables operation in under-excited or over-excited regimes up to the rated load capability. This characteristic makes the HTS machines very attractive for operation as dynamic condenser on an electric grid. This feature encouraged AMSC to develop 8 MVAR synchronous condenser that was operated on the TVA electric grid for a year (11/2004-11/2005) next to an arc-furnace for voltage stabilization.
This talk covers experiences of designing, building and testing these machines and highlights lessons learned.

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