Motor/Generator Requirements for 2G Wire

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Markets: SuperVAR® HTS Dynamic Synchronous Condenser - a VAR Generator

- Advanced prototype: 8 MVAR system successfully completes 1 year in-grid acceptance testing at TVA (1G wire)
- TVA orders first 2 commercial 12 MVAR units, first delivery by end 2006

Applications

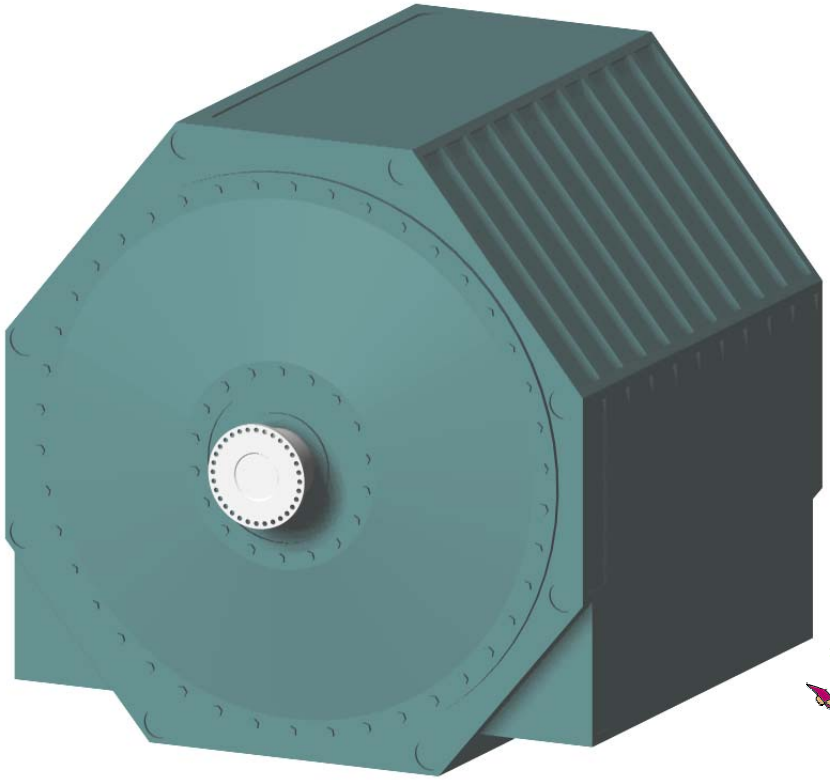
- Grid stabilization
- Power factor correction
- Flicker mitigation

Benefits

- Attractive $/kVAR
- High output in compact machine
- Improved reliability over conventional machines
- Lower Operating costs

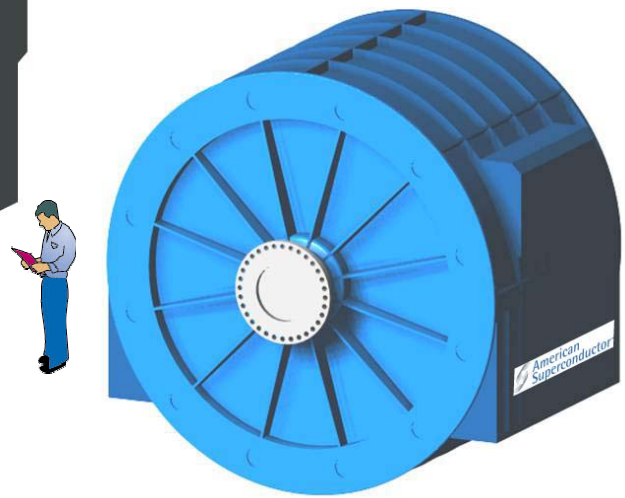
SuperVAR machines: world's first commercial HTS product for the power grid

HTS Ship Propulsion Motors: Transforming a 100-year old industry



36.5 MW Copper
(300 tons)

- Less than half the size
- Less than one-third the weight
- Higher net efficiency
- Inherently quieter



36.5 MW HTS
(75 tons)

HTS Ship Propulsion Motors Powered by AMSC

- ✓ Shipped first 5MW HTS motor to U.S. Navy in July 2003
- ✓ Based on 1G wire
- ✓ All testing successful

Ship propulsion current worldwide addressable market: $450M/year

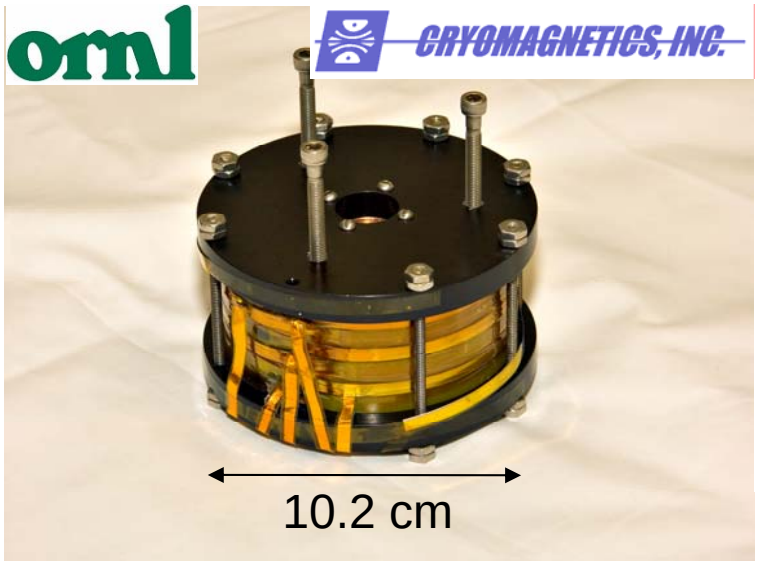
Status of 36.5MW Motor for U.S. Navy

- Currently manufacturing 36.5MW motor under U.S. Navy contract
- Uses 1G wire
- Deliver 36.5MW motor to U.S. Navy in September 2006

First Steps to Test 2G Wire for Rotating Machines

Stacked Pancake Coil

- No. of Amp-Turns 18,042
- Critical Current 31 A (77 K)
- Central Axial Field 0.32 T



Racetrack Coil

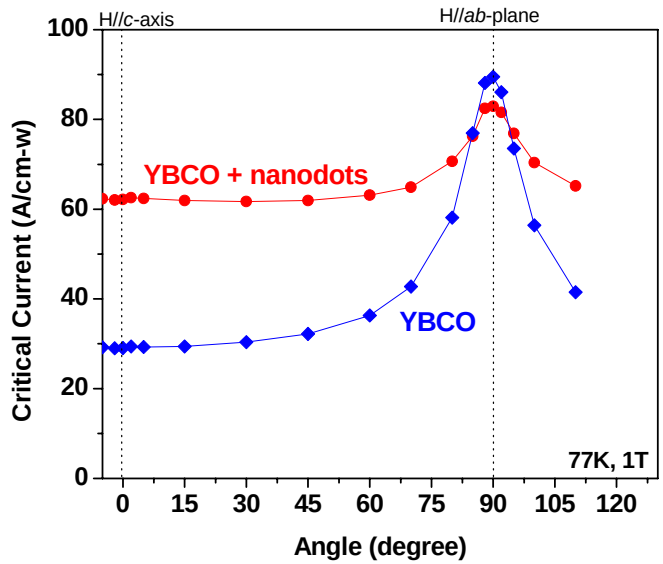
- Wire Length 87 m
- No. of Amp-Turns 4,620
- Critical Current 55 A (77 K)

2G Wire Specs for Rotating Machinery

- Focus: Rotor coils (quasi dc, low ac ripple)
- Basic requirement:
  - form-fit-function replacement for 1G wire, which works very well!
- But lower cost!
  - <$50/kAm
- Dimension option: 0.4 – 1 cm wide
- Piece length: 200-1000 m, a few splices acceptable

Rotating Machine I_c , J_e Specs

- Min I_c 120 A (77 K) in 4 mm by 0.175 mm form factor
  - J_e (77 K, sf) > 17,000 A/cm^2
- $J_e(T, H=2T_\perp)/J_e(77K, sf) > 2.0$
  - T > 35 K
- Field angle dependence of J_e
  - Monotonic between $\perp$ and $\parallel$
  - J_e (T, H=4T$_\parallel$) ~ J_e (T, H=2T$_\perp$)
- Index value N ($V \sim I^N$)
  - N>15 @ 0.01 to 0.1 μV/cm
  - N>10 @ 0.001 to 0.01 μV/cm



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Rotating Machine Specs: Mechanical

- 95% I_c retention for

  < 10 cm bend diameter @ 12 lb

  > 0.3% tensile axial strain

  >150 MPa tensile axial stress (back tension)

  > 0.14% compressive axial strain

  >16 MPa c-axis tensile stress

  >0.2% tensile, >0.1% compressive axial strain, 10^5 cycles

Rotating Machine Specs: Other

- Stability
  - Axial thermal conductance (for 1 cm length)
    - > 0.06 W/K at 30 K
    - > 0.04 W/K at 50 K
  - High electrical conductivity stabilizer
- Special requirements
  - High speed generator stator coils – most demanding ac loss and mechanical requirements
  - Increased mechanical requirements – utility generator designs