SUBMERSIBLE MOTOR ENGINEERING

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SME Submersible Motors when used with VVVF Drives Rev3

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General

SME Submersible Motors have been extensively tested and used with modern GTO and IGBT VVVF Drives, however, care must be taken to ensure reliable and satisfactory operation.

Please pay attention to the following guidelines.

VVVF Drive set-up considerations:

1. Accurate and Calibrated Quick Trip overloads must be installed and set to trip if the current in any phase exceeds the S.F. full load current. Water filled submersible motors generally use Y class water tight winding wire perfectly suited for operating temperature up to 85°C. Any excessive temperature can cause insulation softening resulting in reducing insulation thickness in mechanically stressed locations. It is essential to set the overload protection accurately. The thermal time constant for submersible motors is much shorter than an air filled motors of a similar rating.

2. The motor should not be operated continuously at less than 70% of Synchronous Speed – 3000 x .7 = 2100 RPM for a 50 Hz 2 pole motor, (60% for a 60Hz motor = approx 2100 RPM for 2 Pole), or 1500 x .7 = 1050 RPM for a 50Hz 4 pole motor, (60% for a 60Hz motor = approx 1050 RPM for 4 Pole). Minimum speed limits are required for the safe and long term operational life of the thrust bearing. Operation at reduced speed can cause overheating depending on the water flow past the motor.

3. Maximum Speed is the nameplate synchronous speed – 3000 RPM for a 50 Hz 2 Pole motor, 3600 RPM for 60Hz 2 Pole motor, 1500 RPM for 50 Hz 4 Pole Motor, and 1800 RPM for a 60Hz 4 Pole motor.

4. Maximum Run Up time must not exceed 4 seconds.
   SME recommend that the motor stall protection is properly set up so that if the motor is not able to reach required speed within 4 seconds the power is switched off immediately. Repetitive starts can only be attempted after at least a 5 min cool

down period. Operation with a long Run Up time can cause problems in the Down Thrust bearing, due to insufficient lubrication between the Pivot Shoes and the Carbon Thrust Bearing Disc.

5. Maximum Run Down time to Power Off shall not exceed 4 seconds. Coast down stopping instead of ramping down is preferred to avoid temporary voltage increases resulting from the VVVF generator mode if the motor is decelerated too fast.

6. The VVVF Drive must be set up to supply a constant linear Volts to Hertz ratio, i.e. at 25 Hz the Voltage should be 207 Volts for a 415 V 50 Hz motor or 230 Volts for a 460 V 60 Hz motor. The voltage boost (increasing of the motor voltage at low frequencies) must be set to a sufficient value to ensure a quick run up time according to the required ramp. Most inverter manufacturer's default value will be sufficient, but sometimes this value must be adjusted during commissioning. If the cable impedance causes considerable voltage drop the motor rated voltage drive parameter should be increased by this voltage drop to avoid current overload.

7. Use the VVVF manufacturer's recommended (default) switching frequency for non dynamic loads like pumps. This is usually the lowest one.

Electrical installation considerations:

1. dV/dT. Modern highly efficient VVVF drives use fast IGBT's to minimise switching losses at high switching frequencies. The resulting high dV/dT - especially in combination with long power cables - can cause excessive voltage stress to the motor insulation system. SME uses high quality water tight insulation wire, supplied from leading world manufacturers, and SME properly test this wire for voltage stress immunity up to 15kV/50Hz (sine wave). However, there are physical limitations arising from the design of water tight wire – mainly the water tight layer can't be totally bonded to the conductor. There will be some air between insulation and conductor so partial discharges can occur at some level of dV/dT, or peak voltage transients. **SME STRONGLY RECOMMEND THAT THE VVVF DRIVE IS INSTALLED WITH AN OUTPUT REACTOR, dV/dT FILTER, OR SINE WAVE FILTER TO PROTECT THE MOTOR INSULATION BECAUSE MOST INSTALATIONS FOR SUBMERSIBLE MOTORS REQUIRE LONG CABLE RUNS. IF MOTORS FAIL DUE TO dV/Dt, AND ARE NOT PROTECTED FROM dV/dT, SME WARRANTY CONDITIONS WILL BE VOIDED**. Follow the VVVF Drive manufacturer's requirements for reducing dV/dT. In extreme cases motors will fail quite quickly due to dV/dT.

2. Earthing. The VVVF Drive manufacturer's installation user guide will specify the correct size and connection for the motor earthing cable. The high frequency capacitive leakage current will be passing from winding to the motor frame while VVVF Drive is running, except with a sine wave filter installation. If the earthing cable between motor and VVVF Drive does not have a sufficiently low impedance, the capacitive leakage currents will find the lowest impedance loop, and can cause problems with excessive erosion of various parts of the motor or the pump.

Generally the output power should be balanced, free of High Voltage Transients, and harmonics, and within the rated voltage and frequency of the motor.

Cooling water flow past the motor must exceed 15 cm/sec or 0.5 feet/sec at all times and under all operating condition except during Start Up, however, water flow should not exceed 300 cm/sec or 10 feet/sec as this can also create an overheating condition.

Other operating requirements still apply as specified in Submersible Motor Engineering’s Installation and Maintenance Procedures.