Application Note

Instructions for use of wound rotor motors with AC inverters

INTRODUCTION

A wound rotor motor is principally the same as a squirrel cage induction motor, except instead of a shorted rotor the rotor connections are tied to slip rings for external connection.

Variable speed can be achieved by varying the resistance across each slip ring, as was accomplished in the past by stepping through the resistors until all resistors were shorted. This method produced a crude way of varying the output speed and torque of wound rotor motors. When using an AC variable speed drive, the electronics of the control vary the voltage and frequency supply of the primary stator in the motor eliminating the need for resistors in the secondary. Therefore, the slip rings can be shorted together, in essence creating a squirrel cage motor. There however may be special cases where some secondary resistance may be useful during operation with a variable speed drive. For example, should the drive be sized with ample capacity to allow a dead stall of motor rotation, secondary resistance is advisable to maximize the motor's output torque. This case is not typical of most applications. If any questions exist please contact Drivecon Corporation or the motor manufacturer.

PROCEDURE

When applying an AC drive to an older wound rotor motor, it is advisable to have the motor rebuilt and windings upgraded with inverter grade insulating varnish, preferably Class H; (180 degrees C). IGBT type inverter operation will require a full stator rewind in most cases due to voltage spikes created by these inverters. Stator must be rewound with suitable spike resistant magnet wire. The most effective way to convert a wound rotor motor is to actually short the slip rings right on the rotor itself. This eliminates the need for brushes. In cases where this is not feasible, tying the 3 collector brushes together will work with variable frequency drives only. Please keep in mind however, regular brush maintenance is still required. Flux vector AC drives require directly shorted rotors. Also, apply a meggar test of stator insulation. Resistance to ground resistance must be above 10M OHM with a 1000VAC test voltage. Any suspect motors should be fully reconditioned and rewound. Consult Drivecon if unsure.

In circumstances where the motor is to be operated above the designed speed precautions should be addressed. Since the wound rotor motor has copper windings, care must be taken in preventing the added centrifugal force acting on the windings from pushing the windings out of the rotor's slots, as a DC motors' would. When over-speeding a wound rotor motor check with a qualified motor re-builder or the motor manufacturer for suggested RPM limits. This is where squirrel cage motors differ greatly from would rotor motors. Squirrel cage motors will withstand 200% of base speed, up to 3600 RPM with no modifications.

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Some suggestions for adapting a wound rotor motor for use with an inverter:

a) wrapping the rotor's windings and dipping the rotor in high strength epoxy
b) removing the brushes and internally shorting the motor's rotor
c) balancing the rotor for high speed operation
d) high quality bearings
e) Class H rotor and stator insulation
f) Rewind stator with IGBT spike resistant magnet wire when using IGBT type inverters especially with cable runs of over 50 feet between drive and motor.
g) Center drill rotor shaft to accept a motor stub shaft adapter for encoder coupling.

CONNECTION

The wound rotor motor can be connected to the AC variable speed drive just as any ordinary motor would connect. Keep in mind the different connections for high and low voltage operation. Separate motor primary and secondary connections if motor still has secondary connections. Damage to inverter may result if the secondary is connected to the inverter.

SPECIAL PRECAUTIONS

A) Operation with flux vector can be achieved with wound rotor motors with directly shorted secondaries. Drivecon's advanced VF61 flux vector AC drive will allow measurement of the motor's characteristics building a model of the wound rotor motor in it's memory. With this achieved vector operation can be realized. Note that oversizing the vector drive may be necessary in order to achieve sufficient torque at all operating speeds. Pay close attention to the motor's rated current verses the drives maximum continuous amperage. The addition of encoder to the motor's shaft will also be required.

B) Typically, wound rotor motors draw more current than modern squirrel cage motors; since this is true oversizing the AC drive may be necessary. A rule of thumb would be oversizing the rated current at 125% of the motor's rated full load draw. This is only a rule of thumb and may not apply in all cases. Please consult Drivecon if in question.

C) Special precautions must be taken if the inverter used contains IGBT type output devices. Turn to turn short circuits may occur in phase windings due to the high IGBT generated surge voltage. Consult motor manufacturer or rebuilder for proper measures to prevent such damage. Normally a complete stator rewind is required in these cases.

D) Wound rotor motors may not have the thermal capacity to develop continuous stall torque capable when operating with Drivecon vector drives. Such operation may require a new motor with adequate auxiliary cooling.