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Testing Performances of a Special AC Induction Motor Used in Electric Car

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Abstract

IN this practical research a laboratory testing desk was build with fully functional system including 3-Phase Induction Motor, AC Controller and Battery Bank with charger, enabling the practically verification of performances and behaviour of the complete electric drive system containing the exact parts that would be proposed to use in converting a diesel or petrol powered vehicle to an electric car. The tests were carried on a 3-Phase IM with special design and construction suitable to be used in electric car. The resistive loads of the car were simulated using a synchronous generator with a variable electric resistive load coupled to 3-Phase IM. An electronic car foot pedal and a battery bank were used as main source of power with a capacity suitable for the size of a light weight or medium size car.

The performances of 3-Phase IM were tested in several practical cases simulating the running of 3-Phase IM on no load, running of 3-Phase IM to accelerate the car from stop position to reach a certain speed fixed by driver, for different resistive loads of the car. Running of 3-Phase IM to accelerate the car from stop position to reach a certain speed fixed by driver, keeping this speed for a certain period of time and decelerate, with different resistive loads of the car. Variations of rotation speed in time and variation of active torque in time of 3-Phase IM were studied for these cases, when different resistive load coupled to 3-Phase IM. Some conclusions and remarks about practical performances and behaviour of IM were given.

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1. Introduction:

The purpose of this practical research is to build a laboratory desk with fully functional system including 3-Phase Induction Motor, AC Controller and Battery Bank with charger, enabling to study practically performances and behavior of the complete electric drive system. These parts are the exact parts that would be proposed to use in converting a diesel or petrol powered vehicle to an electric car. The tests were carried on 3-Phase IM constructed specially for use in electric cars. To perform practical tests of the behavior of the complete electric drive system in controlled environments, a mechanical electrical system was built that will allow varying the mechanical load on the 3-Phase IM to mimic the mechanical loads that the 3-Phase IM will encounter once installed in the selected vehicle. Such loads can simulate running of car with different loading on flat roads, start/run /stop running and accelerating 3-Phase IM on no load while car is stopped. [7], [12]

2. The practical testing desk:

To carry out the practical tests a lab desk was constructed containing: a 3-Phase IM of suitable power and size to drive a small to medium size car, a 3-Phase IM controller suitable for the size of the selected motor, a battery bank which would be the main source of power for the tests chosen with a capacity suitable for the size of a light weight or medium size car, throttle control, in the means of an electronic car foot pedal, a source of mechanical loading, this was chosen to be an AC electric generator with selective variable resistive loads connected to the output to convert measured electric load to relative mechanical load on the AC Motor.

For tests, we have chosen a 9 inch 96V 3-Phase IM model AC50-02-1 (see photo of Fig.1.). This motor has for specifications a Peak Power and a Continuous Power of 15 HP and 50 HP, respectively, a Voltage equal to 96 V with a Frame of 184. This 3-Phase IM is specially designed and constructed to run in traction vehicles, having rotor in squirrel cage with deep slots and aluminium bars. This construction gives possibility to increase starting torque and to reduce starting current due to skin effect. [7], [8]"

We choose a 3-Phase IM Controller Model 1238 with operating current up to 550 Amp (see photo of Fig.2.). This controller has 96Volts DC Supply unit and can handle up to 550Amp with proper thermal cooling. This controller is based on Field Oriented Control Technique. [2], [4]



Fig.1. Tested 3-Phase IM



Fig.2. Used controller

The battery bank was built using industrially available UPS grade lead-acid batteries that are designed for high current discharge. The battery bank used 8x 12V batteries with 90Ah capacity for a total of 96Volts DC with 90Ah capacity (see photo of Fig.3.).[9]

As a speed accelerator we use a Throttle Controller which is a specific unit that sends speed control commands to controller allowing the drivers foot control. This is an industrial class foot pedal designed for vehicles (see photo of Fig.4.). As a source of mechanical loading we arrange a special combination based on a 32.5 KVA continuous rated electric generator with 3 phase 380/220VAC output with 49.4 Amp current at 1500 RPM. The generator was mechanically coupled with the electric motor (see photo of Fig.5.). Due to the fact that 3-Phase IM peaks its output at 3000 RPM it was necessary to use a pulley system with a ratio of 2:1 to reduce the RPM to 1500 which is the maximum for the generator. Double belt pulleys were manufactured to minimize any slip factors during the load testing. The electric motor is capable of speeds up to 6000 RPM but for the purpose of this experiment we will limit the speed of the motor to a maximum of 3000 RPM through the programming of the AC controller settings. [11][12]

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