THYRISTOR CONTROL OF SLIP RING INDUCTION MOTORS

by

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CERTIFICATE

Certified that the dissertation entitled "THYRISTOR CONTROL OF SLIP RING INDUCTION MOTORS" which is being submitted by Nitin Kumar Jain in fulfilment for the award of the Degree of Doctor of Philosophy in Electrical Engineering of the Indian Institute of Technology, New Delhi, is a record of the student's own work carried out by him under our joint supervision and guidance. The matter embodied in this dissertation has not been submitted for the award of any other Degree or Diploma.

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ABSTRACT

This investigation deals with the development of a variable speed drive using slip ring induction motor (SRIM) incorporating thyristor converter rotor control scheme. Study of available literature in this area highlights various problems associated with the realisation of this scheme. The main bottleneck in realising a wide speed range of SRIM operation has been the presence of slot ripple in the rotor voltage particularly at high speeds. These ripples are responsible for spurious zero-crossing determination leading to unreliable motor operation at high speeds with the trigger control schemes reported so far. Moreover, obtaining a speed independent linear relationship between the trigger angle of the thyristors and control voltage is also a problem. Another aspect needing attention has been the requirement of a suitable method of analysis for predetermination of the performance of the SRIM with thyristor converter rotor control. Different methods of analysis of the induction motors employing thyristorised controllers, reported so far, do not prove to be quite adequate for the present case. Furthermore, the use of hybrid rectifier for SRIM rotor control, which offers certain economic advantages, has not

been fully exploited. Yet another bottleneck in realising a variable speed SRIM drive using thyristor converter rotor control has been a poor load-speed regulation of the SRIM.

The investigations reported in this thesis make an attempt towards the solution of the problems discussed above. The thesis reports about the development of a reliable trigger control scheme for operation of the thyristors in the rotor circuit of a SRIM. The trigger controller uses phase-locked loop technique and the ripple in the rotor reference voltage is eliminated by designing a suitable interface circuit.

Direct three phase model of the SRIM is modified to incorporate the rotor current switching constraints imposed by the thyristor converter. The model thus obtained is simulated on a digital computer to predetermine the steady state performance of the SRIM. The analytical results thus obtained are compared with the experimental results to ascertain the validity of the model. Study of the system performance under typical converter fault conditions is also carried out.

The performance of the SRIM with hybrid rectifier rotor control is experimentally investigated and a comparative study of the SRIM performance with these two rotor control schemes is presented.

Closed loop operation of the SRIM thyristor converter system with speed and speed-current feedback is studied to obtain a better load-speed regulation and modified torque-speed characteristics of the SRIM. Small signal linearised model of the system is developed for analytical studies. The feedback system is found to be stable in both the cases.

It is shown that the thyristor converter rotor control using the trigger controller developed earlier in the investigation, permits the realisation of a SRIM based variable speed drive which compares favourably with the dc motors in terms of cost, maintenance, and load-speed regulation.

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