SYNOPSIS

Reluctance machine is cheap, robust and reliable. However, it suffers from a rather low power factor and specific output. These drawbacks have deterred its wide industrial application and have also been partially responsible for the limited literature on the subject. With increasing demand for synchronous drives in textile and nuclear controls, presently, the attempts are being made to improve its characteristics. However, no work has so far appeared in the literature on the performance of solid pole reluctance machine. Hence this investigation is of value. In addition it has the further significance that it can be applied to the study of starting performance of turbo-alternator.

The scope of the thesis is, therefore, to examine the behaviour of the solid rotor reluctance machine under both asynchronous and synchronous operation. The development of the subject matter, chapter-wise, is on the following lines.

1. The field distribution inside the rotor is governed by Maxwell's field equations and the electric and magnetic properties of the rotor. It is obvious that a successful comparison between theory and experiment will

involve an experimental investigation to cover a wide range of rotors with pole-pitch, and pole-arc to pole-pitch ratio varied. No prior work in this direction could be traced in the literature and an attempt is here made to report the results of such an experimental investigation carried out on more than 24 cases of rotors run as synchronous and asynchronous motors. The results bring out their characteristic differences and in addition, the effect of end terminations and the influence of axial copper conductors in the interpolar region.

2. This chapter presents a study on asynchronous performance of reluctance machine. For this, the existing linear theory, for the solid cylindrical rotor machines has to be modified to take account of saliency in the rotor structure. This has been attempted by using an analysis based on two-reaction theory of synchronous machines. Further, the proposed theory allows satisfactorily for the effect of rotor terminating end rings. Computations have been made on the basis of linear theory and the results have been compared with test values for different cases. Two methods of approach for the predetermination of performance based on (i) permeability corresponding to surface magnetization and (ii) permeability assumed constant for the entire range of operation, have been adopted and it is shown that the predetermination by either method does not lead to a satisfactory prediction.

3. To take into account the effects of saturation, attempts have been made to extend the non-linear methods available in the literature, and the predicted results based on non-linear theory are then compared against test results. An overall review of these investigations brings out forcefully the important aspects of saturation in controlling the losses and speed-torque characteristics. The non-linear theory is such that it gives predictions which are slightly in better conformity with the test results.

4. In this chapter an attempt is made to predict the asynchronous performance of solid reluctance rotors with the interpolar region filled with copper. Two simplified methods of approach have been presented, based on (i) copper and iron being considered as a single homogeneous medium with an equivalent resistivity and (ii) copper being treated as a second cage with iron forming the first cage. Next three different equivalent circuits suitable for the predetermination of performance have been considered. The study covers both the cases of rotors being terminated with and without end-rings and it has been shown that a satisfactory prediction can be made for the different cases of the rotors presented.

5. A successful design of reluctance rotor implies that it should have a good synchronous performance in addition to a satisfactory starting performance. In this chapter, an analysis based on synchronous machine theory is presented

to predict the reluctance machine performance at synchronous speed. Comparisons between theoretical and experimental results have also been brought out establishing the validity of approach for all rotors attempted.

6. The analysis presented in chapters 2 to 5 are based on assumed field distributions and verified on the basis of overall agreement with experimental results. A study of surface current density/electric intensity distribution and the flux penetration inside the rotor and their nature of attenuation is of fundamental importance. This is attempted in the sixth chapter. Sufficient experimental evidence is presented to lead to the conclusion that there is a further need to re-examine the problem of reluctance rotor to obtain an insight into the secondary phenomena observed.