ABSTRACT

The thesis essentially deals with the transient analysis of parallel capacitor inverter for medium frequency induction heating. The analysis has been applied to study the transients of inverter voltage and currents during starting in 'open loop', open loop to closed loop frequency control of operation and subsequent changes in circuit parameters during heating process, removal or insertion of work piece in the inductor coil etc.. A simple analytical method called **'Stroboscopic'** method has been used for the first time to study the transients arising out of the conditions mentioned above. The results predicted are verified with the results obtained by numerical method and also with experimental oscillograms. The essence of the stroboscopic method of analysis is that it deals with transient behaviour of the amplitudes of voltage and current (envelopes) rather than with the instantaneous values. The fact that the envelopes vary relatively slowly results in considerable simplification in the analysis. Furthermore, the formulation by this method converts an essentially discrete time system into an equivalent continuous time system so that the tools of analysis of continuous system could easily be applied.

The present thesis consists of five chapters. The first chapter deals with the transient analysis of the inverter during starting in open loop. The analysis has been done using three methods viz (i) Numerical method (ii) Exact analytical method and (iii) Stroboscopic method. Because of some assumptions made, the order of the system has increased to fifth order(from third order) in the case of stroboscopic method. This method is further simplified so that the order of the system is brought back to original 3rd order. This simplified analysis is given in Chapter-II. In the same chapter, the effect of various circuit parameters(normalized suitably) on the inverter performance during starting has been studied and conclusions are drawn regarding the favourable conditions for smooth starting in open loop.

As heating process proceeds, the circuit parameters are likely to change and it is necessary for the inverter to operate in closed loop frequency control. Chapter-III mainly focusses on two experimental methods of switching the inverter from open loop into closed loop operation. In this chapter, in addition to making some modifications to existing constant lead angle method, the author has proposed a new

method of constant lead time control and a simple experimental realization of the same was given.

In Chapter-IV, the transient analysis of the inverter during open loop to closed loop transition and due to sudden changes in circuit parameters (due to removal or insertion of work piece, heating through Curie temperature etc.) has been given both by numerical and stroboscopic methods. The difficulties encountered in the analysis due to slowly varying frequency during transient period are tackled suitably. The analysis has been done for both constant lead angle and constant lead time control strategies.

Because of the turn off time limitations of the thyristor a simple parallel capacitor inverter cannot be operated above a certain frequency limit and to overcome this difficulty a 'time sharing inverter' is normally used. The time sharing inverter can be considered as a multistage development of a series parallel capacitor inverter. In Chapter-V the transient analysis of a series parallel capacitor inverter and a time sharing inverter during starting has been dealt with by numerical as well as stroboscopic methods. The stroboscopic method of analysis is relatively simple and yet the results predicted are found to be in good agreement with the experimental oscillograms.

Key Words: Induction heating, parallel capacitor inverter, stroboscopic method of analysis, closed loop frequency control, constant lead angle control, constant lead time control, series parallel capacitor inverter, time sharing inverter.