SYNOPSIS

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Thesis Title: **DESIGN AND ANALYSIS OF THREE PHASE INDUCTION DIELECTRIC HEATING (IDH) USING TRAVELLING WAVE PHENOMENA WITH SPACE VECTOR MODULATION**

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Electric heating can be accurately applied at the precise point needed in a process, at high concentration of power per unit area or volume. Electric heating apparatus can be built in any required size and can be located anywhere within a plant. Electric heating processes are generally clean, quiet and do not emit much by-product heat to the surroundings. Electrical heating equipment has high speed response, lending it to rapid-cycling and mass-production equipment.

Design of heating system starts with assessment of the temperature required, the amount of heat required and the feasible modes of transferring heat energy. In addition to conduction, convection and radiation, electrical heating methods can use electric and magnetic fields to heat the material.

Methods of electric heating include resistance heating, induction heating, and dielectric heating. In some processes (for example, arc welding), electric current is directly applied to the workpiece. In other processes, heat is produced within the workpiece by induction or dielectric losses. The heat can be produced and, transferred to the work-piece by conduction, convection or radiation.

Induction heaters produce heat by means of a periodically varying electromagnetic field within the body of a nominally conducting material [2]. This method of heating is sometimes called eddy-current heating and is used to achieve temperatures below the melting point of metal [5]. Induction heating is used to temper steel, to heat metals for forging, to heat the metal elements inside glass bulbs and to make glass-to-metal joints [8], [9], [10].

Dielectric heaters use currents of high frequency which generate heat by dielectric hysteresis (loss) within the body of a nominally nonconducting material. These heaters are used to warm to a moderate temperature, certain materials that have low thermal conducting properties; for example, to soften plastics, to dry textiles and to work with other materials like rubber and wood [4], [6].

The present technique used for induction heating is to heat the object by single phase coil through converter inverter technique. Where there is more loss of power conversion, poor power factor, poor efficiency and increase cost and space.

3-phase linear induction heating system is very rarely and lately introduced [3], [53], [99]. It works on the principle of linear induction motor using travelling wave technique to flat surface heat up [53]. In this method, power can be fed at any frequency and accordingly the electronic system device is selected as discussed [99]. It has been mainly used for surface heating and gluing of two dissimilar metals.

Therefore, the motivation behind the work presented in this thesis are:

(i) To develop three phase control circuit for three phase induction dielectric heating system.

(ii) To develop the induction dielectric heating system which is applicable for both conducting and non-conducting material to heat up.

(iii) To explore a new method to determine the material characteristics and performance.

(iv) To study the effectiveness of optimal adjustment of control circuit, switching losses and IDH output in temperature stability.

(v) To develop high efficiency heating system for conducting and non-conducting.

(vi) To explore a new concept to preserve food (lemon) using IDH. It is also useful for industrial and commercial application like drying, forging, surface hardening etc.

A brief description of the research work reported in the thesis is given below:

Chapter 1 introduces the electric heating application and problem, which presents a brief state-of-art survey of research work carried out in the areas of induction heating and dielectric heating. The various modulation techniques have been presented for switching devices used for heating to material. The latest development on three phase linear induction heating application and problem has been reviewed and lays down the motivation behind the research work carried out.

In chapter 2, a symmetrical space vector modulation pattern has been proposed, to reduce Total Harmonic Distortion (THD) without increasing the switching losses. The design and implementations of a 3 phase PWM inverter for 3 phase IDH to control temperature using space vector modulation (SVM) has been carried out.

Chapter 3 presents the mathematical model for steady state IDH process for conducting & non-conducting material and its numerical solution using Matlab and finite element method (FEM).

Chapter 4 describes the three phase MOSFET based inverter for non-conducting material sample as dehydration of food (lemon) application. The operating frequency has been adjusted by the micro controller to maintain constant leading phase angle when parameters of IDH load are varied. The output power can be controlled by setting frequency. The load voltage is controlled to protect the MOSFETs.

Chapter 5 deals with experimental verification of three phase IDH, which converts main frequency AC power into three phase high frequency AC power. The control system presented here control the output temperature of the load and responds accordingly by adjusting the driving frequency of the three phase inverter, to keep the IDH load at resonance throughout the heating cycle.

Chapter 6 summarizes the main finding and significant contributions of the thesis and provides a few suggestions for further scope of research work in this area.