NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY
[IJIERT] ISSN: 2394-3696 Website: ijiert.org
VOLUME 10, ISSUE 4, April -2023

HIGH FREQUENCY CONVERTER FOR INDUCTION HEATING APPLICATION

Prof. Shaikh A. H. A. R.
Head of Department of Electrical Engineering.
V.V.Polytechnic.Solapur-413008

Mr. Dhayagonde Sachin Basappa
Mr. Jadhav Rajat Ramesh
Mr. Ohol Harish Dadasaheb
Students of Electrical Engineering.
V.V.Polytechnic.Solapur-413008

Abstract

The proposed topology reduces the harmonic distortion of high frequency AC/AC converter well below the acceptable limit. This project deals with a novel single phase AC/AC soft switching utility frequency AC to high frequency AC converter. A combination of R-L-C circuit along with the MOSFET is used in front end for converting utility frequency instead of conventional diode bridge rectifier to provide continuous sinusoidal input with nearly unity power factor at source side. This power converter is more suitable and acceptable for cost effective high frequency (HF) consumer induction heating application. A contactless power transfer system has many advantages over conventional power transmission due to the elimination of direct electrical contacts with the development of modern technologies. IPT (Inductive Power Transfer) has become a very attractive technology for achieving wireless/contactless power transfer over the past decade and has been successfully employed in many applications, such as materials handling, lighting, transportation, bio-medical implants, etc.

Keywords: Harmonic distortion, High frequency converter, RLC circuit, MOSFET, Inductive Power Transfer.

I. INTRODUCTION

Electric heating is a process in which electrical energy is converted to heat energy. Common applications of electric heating include the heating of buildings, industrial processes and cooking of food. The heat generation through energy conversion processes is related with energy losses. Electric heating are broadly categorized into two parts, i.e. the power frequency heating and the high frequency heating. Heating technology without contact had been known for more than hundred years. It comprises a wide field of applications in metal working and in the metal casting industry because of its inherent benefits. The induction heating is a well known method for producing heat in a localized area on a susceptible metallic object.

II. LITERATURE SURVEY

High frequency resonant converters are used widely for induction heating. The circuit designed has the load as induction coil and high frequency electricity is requiredto heat the work piece placed within the induction coil. The output power of the load coil is varied by changing the frequency of the inverter. Thecircuit uses the Power MOSFET instead of the IGBT.

The series-resonant inverter is implemented to provide Zero Current Switching (ZCS) for all the switches at turn off conditions and Zero Voltage Switching (ZVS) at diode turn on. The main features of the proposed inverter are simple PWM control strategy and high Efficiency.

Electromagnetic induction refers to the phenomena by which electric current is generated in a closed circuit by the fluctuation of current in another circuit placed next to it.The heating process does not contaminate the material being heated and it is very efficient since the heat is actually generated inside the work piece Induction heating is working by applying a source of high frequency electricity to drive a large alternating current through a work coil. The passage of current through the work coil generates a very intense and rapidly changing magnetic field in the space within the work coil Induction heating is a reliable and innovative technology is characterized by the fact that the required energy is non-contacting transmitted into the work piece. The work piece to be heated is placed within this intense alternating magnetic field. The work Piece to be heated is placed within this intense alternating magnetic field. Recent advances Of the high-power semiconductor devices technology; the research on high-power solid-state high frequency power supply has achieved great progress. The IGBT offers low on resistance and requires very little gate drive power, it is widely used in generators with frequencies up to100 kHz, but the frequency about 400 kHz is hard to achieve for the state-of-the art IGBT. The SIT has the defects like high conduction loss compared to IGBT, complicated fabrication process, high cost and price that restrict it in its applications. This very high switching frequency can be achieved using MOSFETs.

MOSFET has the advantages like high switching speed, easy to be paralleled, so MOSFET is Used in the range of high frequencies (in the range of 100-800 kHz) and high-power applications. Probably the biggest concern with conventional energy sources is the amount of Pollutants that are released into the atmosphere. These growing concerns over the environmental changes caused by power generation with conventional energy sources has lead to the need for developing an alternative energy source; one that is highly efficient and pollution free. The most common method of heating uses fossil fuels such as coal. However, the burning of fossil fuels releases CO_2 gas which has been directly associated with global warming due to the greenhouse effect. The demand for better quality, safe and less energy consuming products is rising. Safe, efficient and quick heating appliances attract more customers. Heating of electrically conducting or non-conducting materials is one of the essential processes in many industries. Electrical heating is preferred over conventional heating methods using fuel. This preference is due to certain advantages of electric heating such as high efficiency, low cost, free from pollution, compactness, quick start up and shut down easy temperature control etc. Due to these advantages electric heating is more convenient.

III. BLOCK DIAGRAM

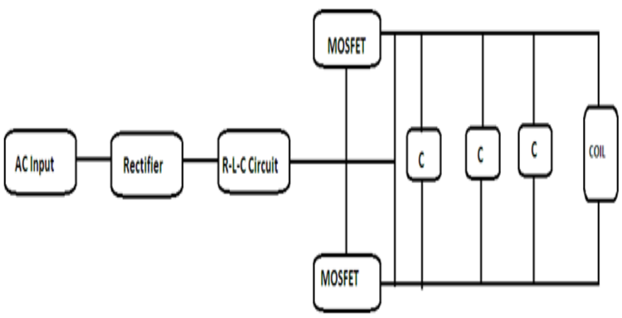

Fig.1 Block Diagram

IV. PROBLEM IDENTIFICATION

Nowadays, industrial applications show a significant increase in the usage of high voltage and high power for production heat. Implementation of normal technique or general method of heat production is not suitable for industrial condition, may cause many troubles. To overcome this problem electric heating system is utilized. This study is motivated by several problems which are the less efficient, high cost, and high heating losses of other typesof heating techniques. Besides, this project is driven by high efficiency and low heating losses in converter. On the other hand, this project is prompted by the low total harmonic distortion (THD) of other type of electric heating such as use of thyristor or IGBT etc.

V. CIRCUIT DIAGRAM

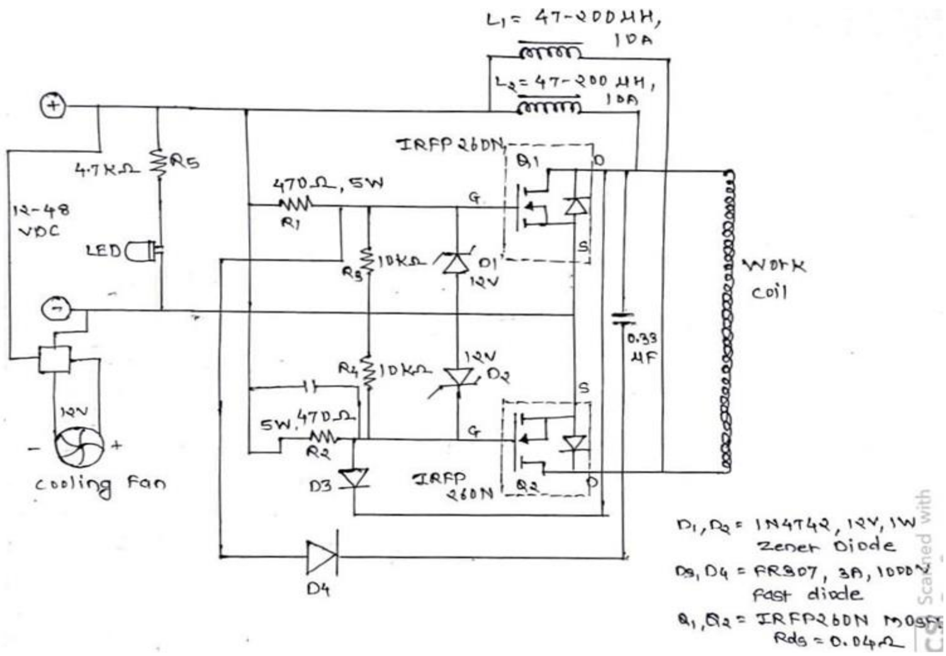

Fig. 2 Circuit Diagram

VI. METHODOLOGY

The resonant circuit of a resonant converter consists of a capacitor, an inductor, and resistance. When power is connected, electric energy is stored in the inductor and transferred to the capacitor. The amount of energy stored in the capacitor to be sent to theinductor. Resonance occurs while the inductor and the capacitor exchange the energy. The total amount of energy stored in the circuit during resonance remains unchanged. Thistotal amount is the same as the amount of energy stored at peak in the conductor or capacitor. As some energy is lost due to resistance in the resonance process, the total amount of energy stored in the inductor decrements in each resonant exchange. The resonance frequency, which is the speed of energy transfer, is determined by capacitance (C) and inductance (L).

Energy stored in inductor = $1/2\ Li^2$ (2)

Energy stored in capacitor = $1/2\ CV^2$ (3)

$X_L = 2\pi fL$ (4).

$X_C = 1/2\pi fC$ (5)

As we mentioned before, the operating frequency of inductive heating-facility has much to do with output power. When the operating frequency is equal to resonated frequency, heating system would gain the largest output power. The resonated frequency could be calculated according to formula (7).

At Resonance

X_L=Xc

f = 1/2π$\sqrt{LC}$ ……………… (7)

Z = (8)

Q = ωoL/R = 1/ωoCR = Zo/R (9)

At the resonance frequency, the inductive reactance of formula and the capacitive reactance of Formula. (4) And (5) become the same, i.e. the voltage of the power source and the current in the circuit stay at the same level. The resonance frequency can be summarized as shown in Formula (7).

The current in the circuit reaches its peak when the source frequency becomes identical to the resonance frequency. It decrements when the source frequency gets higher or lowerthan the resonance frequency. The properties of reactance in a circuit are called special impedance, which can be described as shown in the Formula (8).

From above block diagram we can understand the whole working of the circuit that howcurrent flows through the circuit. The power supply gets input of 230V; 50Hz AC supplyand gives the output of 48V, 20A to the circuit or coil as well as gate of one MOSFET. During flow of current to the gate of MOSFET the voltage and current gets limited to the respective value and whole process becomes continues. The MOSFET get flip-flopped or gets push-pulled so that the signal can vary or flow throughout the circuit.

During that all process oscillations of frequency gets increases rapidly which results to cause a loss i.e. eddy current and hysteresis loss which is directly proportional to the frequency or square of the frequency which in turn use of the this loss in the coil.

This coil acts as a primary and the metal to be heated acts as a secondary which in turn the expected output comes out i.e. circuit gets worked.

VII.COMPONENTS DESCRIPTION

Sr. No.	Components Used	Ratings of components	Number of required component
1)	Metal Oxide Semiconductor Field Effect Transistor (MOSFET)	IRFP260N	2
2)	Resistors (R1, R2)	470 ohm	2
3)	Resistors (R3, R4)	10K ohm	2
4)	Zener Diode (D1, D2)	12 Volt, 1 Watt	2
5)	Fast Diode (D3, D4)	FR307, 3A, 1000V	2
6)	Resistor (R5)	4.7 KOhm	1
7)	Power Supply	48V, 20A	1
8)	Inductor	25 turns, 47-200 micro-Henry, 10A	2
9)	Capacitor Bank	0.33 micro-Farad, 250V	6
10)	Power Supply	12V	1
11)	Cooling Fan	12	1
12)	High Temperature (Polycarbonate) Double Sided PCB	-	1

VIII. ADVANTEGES

1. It is an effective method of heating.
2. This power converter is more suitable and acceptable for cost effective high frequency(HF).
3. Heat control is easy.
4. Ease of automation and control.
5. Less requirement of floor space.
6. Quick, safe and clean working conditions.
7. Requirement of less maintenance.

IX. FUTURE SCOPE

For manufacturing industries, induction heating provides a powerful pack of consistency, speed and control. This is neat, rapid and non polluting heating process and the advanced technology in this induction heating gives efficiency, low power loss and effective heating.

As we made this project for frequency up to 40KHz and generating current up to 21A so in future the scope of this project is that this can be implemented for high frequency up to 1000KHz and generating current up to 100A approximately, this will reduce the heating time as well as give huge output and gives very effective induction heating. Also this project can be executed with the help of MATLAB/SIMULINK software.

X. CONCLUSION

This report presents a high frequency resonant converter topology for induction heating applications. The MOSFET technique utilizes the increased oscillations to control the frequency of converter. The dynamic performance of the proposed system is investigated using the output which is taken out from the project. Output results reveal that the proposed resonant modular converter for induction heating applications is capable of adjusting the output current at different conditions with the resonant frequency.

The switching technique achieves ZVS which results in decreasing the switching losses and enhancing the overall system efficiency. Besides the operation principle of the converter system with the proposed control scheme has been demonstrated.

In this study, a circuit is driven by fixed-frequency was implemented in a variable power, variable frequency inductive heating facility in which the circuit was adapted Resonant-Transition in Zero-Voltage-Switching, Clamped-Voltage (ZVS-CV).The main advantages of this converter system are characterized as follows; Wide heat generation range applicable to metallic load such as iron as well as magnetic load Effective operation under ZVS condition irrespective of largely-changed input parameter.

REFERENCES

1. Induction heating system topology review, Discrete Application, Power Device Division, Fairchild Semiconductor, AN9012, July, 2000.
2. Prof. Ruchit R.Soni, Prof. Hirenkumar D. Patel, Mr. N. D. Patel,Mahendra Rathod.Hardware Implementation of MOSFET based high Frequency Inverter for induction heating Journal Of Information, knowledge and research in Electrical Engineering ISSN: 0975 – 6736| Nov 12 to Oct 13 | Volume – 02, ISSUE – 02.

3. A 50-150 kHz half-bridge inverter for induction heating applications" Mokhtar Kamli, Member, IEEE, Shigehiro Yamamoto, and Minoru Abe.IEEE transaction on industrial Electronics Vol 43, no. 1, february1996.
4. N. Sanajit and A.Jangwanitler "A series resonant inverter half bridge inverter for Induction iron applications" 978-1-4577-0001-9/11/$26.00 ©2011 IEEE.
5. A fundamental overview of induction Heating" by Nathan Rhoades. April 22, 2006.
6. Muhammad H. Rashid, "Power electronics circuits, devices, and application," Third Edition, September 2003, Pearson/Prentice Hall, New Jersey United states Young- Sup Kwon, Sang-Bong Yoo, and Dong-Seok Hyun: "Half bridge series resonant Inverter for induction heating application with load adaptive PFM control strategy,07803-5160-6/99/$10.00,1999 IEEE.