SIMULATION OF PWM CONTROLLED CYCLOCONVERTER

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Abstract: In this paper Simulink model of PWM controlled Cycloconverter with Thyristor and IGBT switches has been analyzed. The dynamic performance of Cycloconverter has been compared with Thyristor and IGBT switches. In the Simulation, PWM control the output voltage with change in input voltage of Cycloconverter. The output frequency of Cycloconverter has been taken as two times the input frequency to the Cycloconverter. The output voltage and frequency of Cycloconverter can be adjusted without a DC link.

Index Terms: Cycloconverter, PWM, Pulse generator, Thyristor, IGBT, Simulation

I. INTRODUCTION

The variable frequency has always been of great importance in the industrial world. The generating station generates electricity of the constant frequency (50 Hz) which is not always applicable for some electrical appliances. Some electrical devices need variable frequency. Therefore the variable frequency generation becomes necessary for meeting the ever growing demand of industrial application. The Cycloconverter is such a device which generates variable frequency. Cycloconverter is essential for controlling a.c. motors at low speed drives especially in high power application. Cycloconverter (CCV), which is also known as direct converter [1], is basically ac to ac power converters where the alternating voltage at supply frequency is converted directly to a variable frequency without going through any intermediate dc power conversion stage. In order to improve the performance and reliability of CCV-fed drives, two current issues are being faced: network harmonic interaction and commutation failures [16]–[18]. To increase efficiency and quality of the grinding process, it is usual to use power converters to control the energy delivered to the synchronous motor. Over the last few years, the Cycloconverter has been the selected alternative, mainly due to its high efficiency and global performance [2], [3]. A commutation failure can produce a short circuit at the machine terminals through the CCV, as described in [19]. The use of Cycloconverter also creates adverse effect on the input of the Cycloconverter system. Harmonics are produce in the input current, and the input power factor can be low depending on the load. These affects are consistent with rectifiers, though harmonics occur at different interval in Cycloconverter than occur in rectifiers [4]. The harmonic currents cause torque pulsations, as well as additional power losses in the motor [9]. Generation of harmonic currents, which cause harmonic voltages in the power supply network. Installation of filter circuits is often necessary. This has enabled the use of Cycloconverters (CCVs) for the development of high power drive systems for control in low-speed range and high torque applications, such as cement mills, ore grinding mills, ship propulsion, and mine winders [11], [12]. The mechanical limitations of girth gears have motivated the use of wraparound synchronous motors (SMs) for gearless motor drives (GMDs) fed by high-
power CCVs operating with variable speed [13], [14], [15]. The CCV can also be found in hydropumped storage [7] applications. Power factor correction can be achieved by the proper design of the LC filters [10]. The power converters used for Variable-speed constant-frequency (VSCF) Aircraft. These new system of VSCF contains a lot of harmonics due to the existing of power converters. To meet the standards of harmonic contents passive filters and active power filters are used [5]. Analysis of induction motors controlled with Cycloconverter has been investigated extensively [6]. As mentioned before, the CCV is also used in ship propulsion [20]. Matrix converters also belong to this category and the power rating of these converters is only up to 150 kVA [8].

II. Simulation of Cycloconverter
In this dissertation work Cycloconverter has been studied. The Cycloconverter model has been designed using Thyristor and IGBT switches. The Cycloconverter is to increase the efficiency & performance of the system. The objective of dissertation is to analysis and design of a Cycloconverter using Thyristor and IGBT switches. The step-up Cycloconverter model using Thyristor and IGBT as switches has been shown in figure-1 and 2 respectively.
As shown in fig.3 that the shape of output voltage waveform is not identical in all the cycle when Thyristor is used as switches while in fig.4 that the shape of output voltage waveform is identical in all the cycle when IGBT is used as switches. Hence it is clear that IGBT working as better switch than Thyristor. IGBT improves dynamic performance and efficiency and reduced the level of audible noise. IGBT has low driving power and a simple drive circuit due to the input MOS gate structure. IGBT can be easily controlled as compared to current controlled device Thyristor in high voltage and high current applications. IGBT have also the advantage for high speed, high power switching for building Pulse Generator controlled Cycloconverter. The Insulated Gate Bipolar Transistor (IGBT) is a minority-carrier device with high input impedance and large bipolar current carrying capability. It is equally suitable in resonant-mode converter circuits. Optimized IGBT is available for both low conduction loss and low switching loss.

III. Modeling of PWM Generator

The pulses of pulse width modulator (PWM) are generated by comparing a triangular carrier waveform to a reference modulating signal.

The PWM Generator model has been shown in figure-5. The PWM waveform, triangular carrier waveform and reference modulating signal of pulse width modulator (PWM) has been shown in figure-6.

IV. Simulation of PWM Controlled Cycloconverter

The fundamental magnitude of the output voltage from a Cycloconverter can be controlled to be constant by exercising control within the Cycloconverter itself that is no external control circuitry is required. The most efficient method of doing this is by Pulse Width Modulation (PWM) control used within the Cycloconverter. In this scheme the Cycloconverter is fed by a fixed input voltage and a controlled ac voltage is obtained by adjusting the on and the off periods of the Cycloconverter components. The PWM Controlled Cycloconverter model has been shown in figure-7. The output voltage and current waveform of PWM controlled Cycloconverter when R-load and RL-load is applied, has been shown in figure-8 and 9 respectively. IGBT voltage in positive and negative inverter switches with R-load and RL-load has been shown in figure-10 and 11 respectively. IGBT current in positive and negative inverter switches with R-load and RL-
load has been shown in figure-12 and 13 respectively. The pulses G1, G2, G3 and G4, applied to IGBT gate has been shown in figure-14.

Fig.7. PWM Controlled Cycloconverter

Fig.8. (a) Source Voltage (b) Output Voltage Wave (c) Output Current waveform of Cycloconverter, when R-Load applied

Fig.10. IGBT Voltage in N and P switches with R-Load

Fig.11. IGBT Voltage in N and P switches with RL-Load
V. CONCLUSION

In manufacturing and process industries, the variable frequency is required for driving various electrical machineries. The Cycloconverter or variable frequency generator plays a significant role in driving those electrical machineries. In the present paper mainly focuses on the design and construction of the PWM controlled Cycloconverter. The PWM controlled Cycloconverter circuits has been designed and simulated and finally desired results has been obtained. In this study, the proposed design of PWM controlled Cycloconverter with both resistive and inductive loads, has been described in detail and got optimum result for input frequency of 50 Hz.

REFERENCES

Reference Figures

Fig. 1 STEP-UP CYCLO CONVERTER WITH THYRISTOR SWITCHES
FIG. 2 STEP-UP CYCLOCONVERTER WITH IGBT SWITCHES

FIG. 7. PWM CONTROLLED CYCLOCONVERTER