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Analysis of Behaviour of Induction Motor with Conventional Converter & Matrix Converter

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ABSTRACT: ***In this paper the behaviour of Asynchronous Machine with conventional converter and matrix converter are analysed. The asynchronous machine used for simulation is Induction Motor. The simulator used for simulation is MATLAB/ SIMULINK .This paper presents the different simulation results of induction motor with conventional converter and matrix converter. Rotor currents, stator current, speed vs. time, torque vs. time curve for both the combination of induction motor with conventional converter and matrix converter are compared.***

Keywords: **Conventional converter, Matrix converter, Induction motor, Simulation results.**

I. INTRODUCTION

In this introduction we are going to discuss about the basics of Conventional converter and Matrix converter. Conventional converters are back to back converters. As the name tells conventional converters are used in various industrial applications. The conventional converter consists of a diode rectifier bridge and a inverter bridge [1][2]. In between the Diode Rectifier Bridge and inverter bridge there is one DC-link capacitor which also known as electrolytic capacitor or charge up circuit. The conventional converters are basically classifies in two types: (a) Uncontrolled converters (b) controlled converters. The uncontrolled converters consist of a diode bridge in rectifier side and inverter bridge. In rectifier side the diodes are used, diodes belong in the category of uncontrolled switches therefore the conventional converter with uncontrolled rectifier side known as uncontrolled converters. In controlled converters the rectifier side consist of controlled switches like MOSFET, IGBT etc, the inverter side same as uncontrolled converters i.e. the inverter side is already controlled [4].

Matrix converters are AC to AC converter without any DC-link capacitor. The matrix converters are firstly named as Unrestricted Frequency changer in 1976. And after few decades the unrestricted frequency changer are known as matrix converter now a days. The matrix converter consists of a nine bi-directional switches with three phase input and three phase output. Various topologies of matrix converters are direct matrix converter, indirect matrix converter, sparse matrix converter, very sparse matrix converter, ultra sparse matrix converter, Z-source matrix converter [18]. The difference in these topologies is they consist of different number of switches.

II. CONVENTIONAL CONVERTER

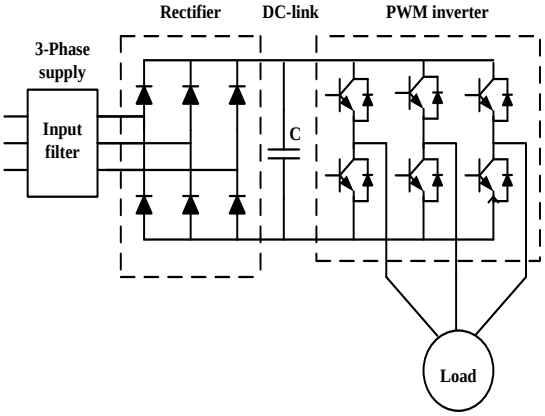


Fig1. 6-pulse rectifier with PWM voltage source inverter

In this section, Fig.1 shows the, the basic conventional converter circuit [6]. This diagram consist of a three phase supply , a 6-pulse rectifier bridge with diodes as switch , DC-link capacitor , inverter bridge consist of 6 IGBTs as switches with induction motor as a load. In this circuit a capacitor C is used to store energy due to this Fig1. Circuit is known as conventional converter with a voltage Dc-link. One another configuration of conventional converter is with current DC-link. In this configuration in place of voltage Dc-link an Inductor is used as an element to store energy. Both the configuration has their own advantages and disadvantages.

III. MATRIX CONVERTER

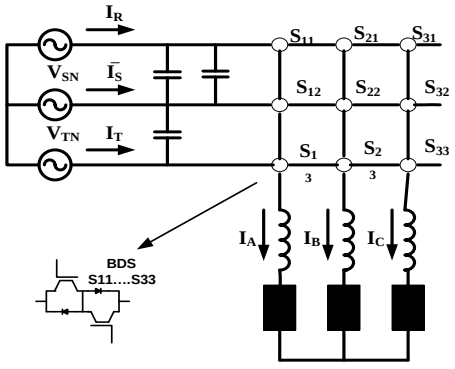


Fig.2 Basic matrix converter

Figure 2. Shows circuit of a basic matrix converter. This matrix converter consists of three phase supply with nine – bidirectional switches. GTO, MOSFET was used as switches in matrix converter. Now a day's IGBTs are used as switches in the matrix converter [12]. Theoretically in a matrix converter 512 switching combinations are possible. But for practical implementation of matrix converter we have to follow two basic rules: (a) switching combinations and commutation control must avoid line to line short circuit at the input and (b) switching combinations and commutation control must avoid open circuit at the output. After following these two rules only 27 switching combinations are allowed.

IV. COMPARISON OF CONVENTIONAL CONVERTER WITH MATRIX CONVERTER

a) A PWM rectifier (inverter) was often used to reduce the input current harmonics and to realize motor regeneration.
b) Matrix Converter, is able realize motor regeneration with almost no input current harmonics.

c) A single converter unit is able to provide performance equivalent to that of PWM rectifier and an inverter.

d) The charge up circuit is unnecessary since the large electrolyte capacitor is not needed for the matrix converter.

e) Smaller size longer lifespan can be achieved.

f) The matrix converter uses one-stage AC-AC direct conversion, a low loss system can be realized, achieving at least 1/3 lower loss then in the conventional system.

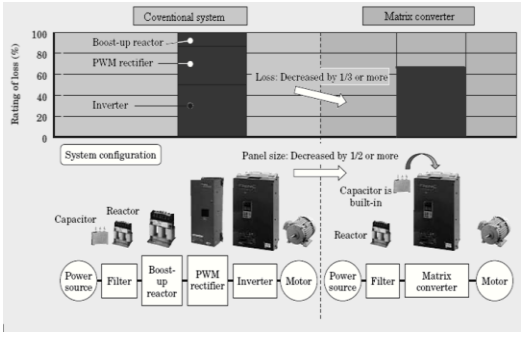


Fig.3. Conventional system versus Matrix Converter

V. MATHEMATICAL MODEL FOR SIMUATION

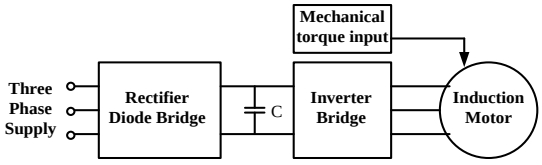


Fig.4 schematic diagram of conventional converter with induction motor

The mathematical model for simulation of conventional converter consist of a three phase supply, this three phase supply energise the 6-pulsediode rectifier bridge, the diode rectifier bridge converts the three phase supply in DC voltage, this DC voltage charge up the electrolytic capacitor, then this DC voltage is fed to the inverter bridge , this inverter bridge converts the DC voltage again into three phase AC, this AC is fed to the induction motor, and then the rotor currents, stator currents, speed and torque curve are analysed.

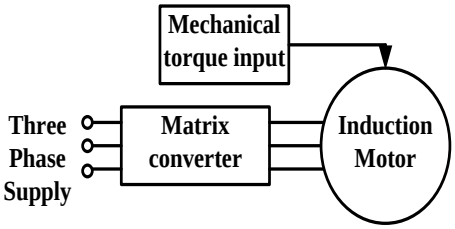
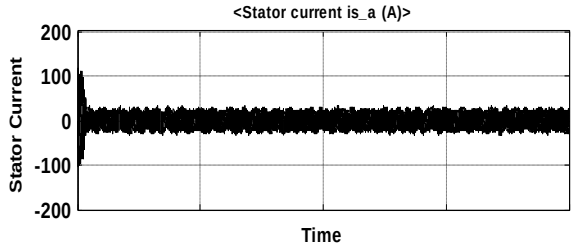


Fig.5 schematic diagram of matrix converter with induction motor

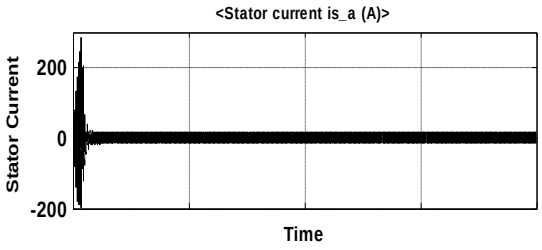
The mathematical model for simulation of matrix converter consist of a three phase supply, this supply energise the matrix converter. The matrix converter converts the AC to AC with the use of nine bi-directional switches without any electrolytic capacitor. This AC is fed to the induction motor and as output rotor currents, stator currents speed and torque curve are analysed.

VI. SIMULATION RESULTS

In this section, performance of induction motor is analysed. The rating of induction motor used for simulation is 10HP, 7.5 KW, 1440 RPM and 400V.

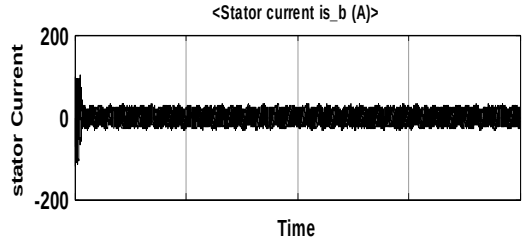


(a)

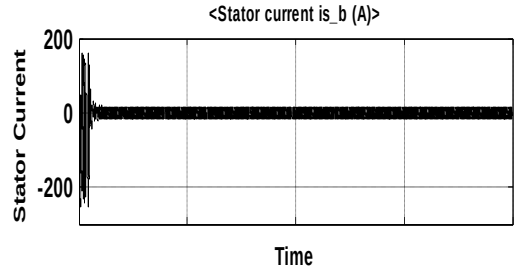


(b)

Fig.6. Stator Current of phase A (a) Conventional Converter (b) Matrix Converter

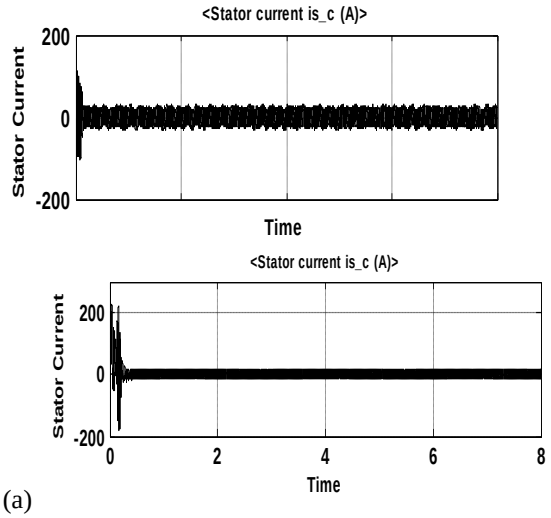


(a)



(b)

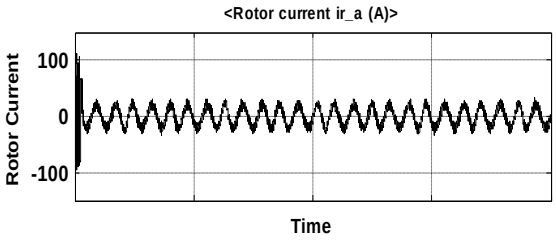
Fig.7 Stator Current of Phase B (a) Conventional Converter (b) matrix Converter



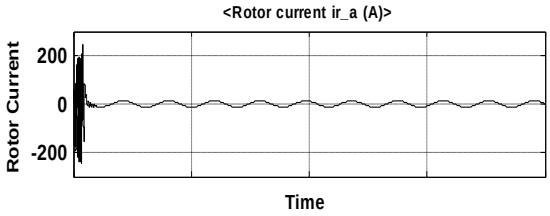
(a)

(b)

Fig. 8 Stator current of Phase C (a) Conventional Converter (b) Matrix Converter

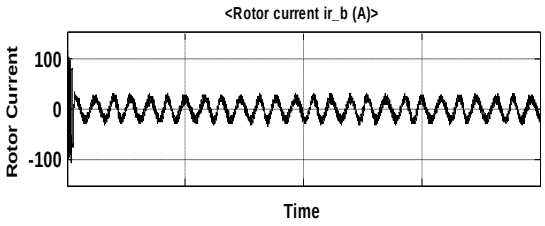


(a)

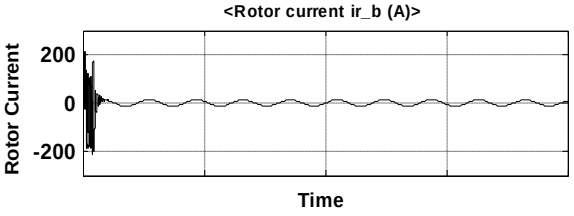


(b)

Fig.9 Rotor Current of Phase A (a) Conventional Converter (b) Matrix Converter

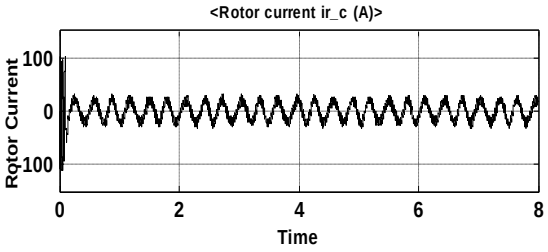


(a)

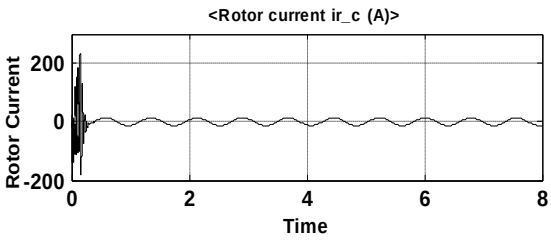


(b)

Fig.10. Rotor Current of Phase B (a) Conventional Converter (b) Matrix Converter



(a)



(b)

Fig.11 Rotor Current of Phase C (a) Conventional Converter (b) Matrix Converter

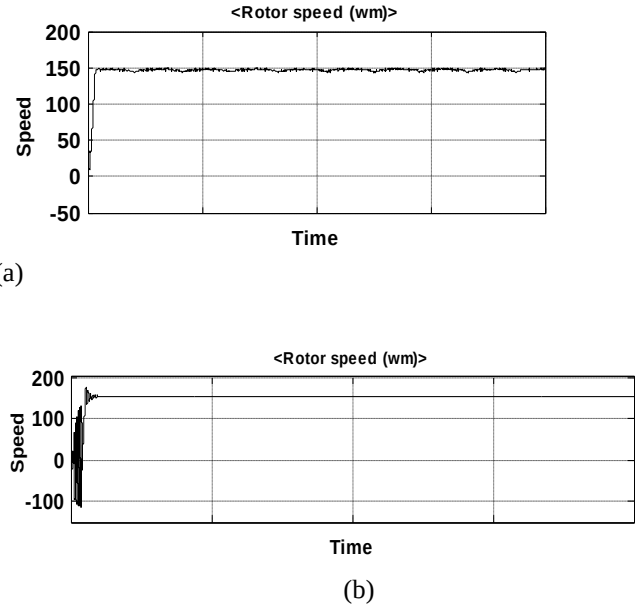


Fig. 12 Rotor Speed (a) conventional Converter (b) Matrix Converter

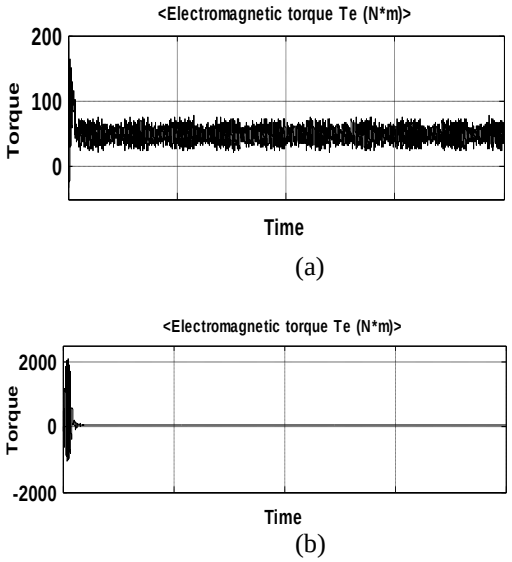


Fig.13 Torque Curve (a) Conventional Converter (b) Matrix Converter

VII. CONCLUSION

In this paper, Conventional Converter and Matrix Converter are discussed with their topologies, advantages and disadvantages. Then both the Converters are simulated with Induction motor as load. From the simulation results of Induction motor we observed that simulation results of induction motor is more distorted and uneven when Conventional Converter is used. And the Simulation results of induction motor with matrix Converter are very much less distorted. Therefore from the simulation results we find that matrix Converter gives better performance than Conventional converter.

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