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# Simulating DC/AC Electric Rotary Converter Machine Using MATLAB

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**Abstract**

Abstract: In this paper, a computer electric control simulation model of the DC/AC electric rotary converter machine which it has been designed previously by the first author for converting direct current voltage to multi-phases is applied. In the current circuit, the converting of the current rotary converter principle is being transformed during its whole operation track from the outer rotor direct current motor principle at starting period to reach its steady state running. Furthermore, the performance characteristics of the present machine are edited graphically using Matlab.

**Keywords:** Simulation, DC/AC, Rotary, Converter.

## INTRODUCTION

Most of the electric power generated is achieved using ac mode. But the electric power can be transmitted in two forms either ac or dc depending on the transmitted distance. For a distance less than 500 km, it is preferable to transmit the power using ac. For a distance more than 500 km, the dc is preferable in transmitting the power [1]. For most countries, in ac transmission, three phase lines are used before being redistributed to the customers in single phase. The reason for using single phase line to deliver power to the costumers is because the single phase line is cheaper compare to three phase lines, especially in rural areas. But three phase machines are more efficient, better quality and more economical than single phase machines. Therefore, three phase machine are preferable machines to be used in factories, workshops, and farms [2]. This is especially true in countries which are vast and lightly populated such as USA Australia, and Middle Eastern countries. As mentioned earlier, the three phase power lines are not always available in remote areas. Some of the workshops are only supplied by a single phase voltage even if they are not in remote regions.

The introduction of single-phase to three-phase converters is able to address their predicaments. In the seventieth, power electronic devices are also able to perform conversion from single-phase voltage to three- phase voltage. The power electronic devices shown to be more silent and perform well in closed venues such as ventilator inside communication mobile racks. It is worth mentioning that despite of the great development in the field of power electronic since the seventies of the last century; their usages are limited in cooled environments. Under high temperature environment, the power electronic devices tend to have shorter life span and prone to breakdown [3]. In remote and farm areas, the regions normally have hard climate during summer where the average temperature is round 50 to 60 degree centigrade for six to eight hours during mid-day and for three continuous months yearly.

It is worth mention that there are many types of converters had been manufactured for different purposes; work with different principles, for converting energy from one mode to another mode. In this paper, the conversion is limited to one form of electrical to another form of electrical energy. There are as listed below:

1) AC electric energy to DC electric energy.
2) DC electric energy to AC electric energy.
3) AC electric energy to AC electric energy (Cyclo-converter).

As mention previously, there are several methods of achieving the conversion above. Some of them are as listed below [4-6].

1) Electric Machine Motor-generator Set Converter.
2) Electric Machine Motor- Converter.
3) Electric Machine Synchronous Converter.
4) Electric Machine Phase Converter.
5) Electronic Power Converter.

## CONTROL CIRCUIT AND OPERATION

The operation of the present DC/AC electric rotary converter [7] and [8] is divided into two different consequent periods as shown in Fig. 1.

### 1-Transient period

It begins at starting moment; hence the machine should be unloaded. The principle of operation the first stage outer rotor DC motor as shown in Fig.2a.

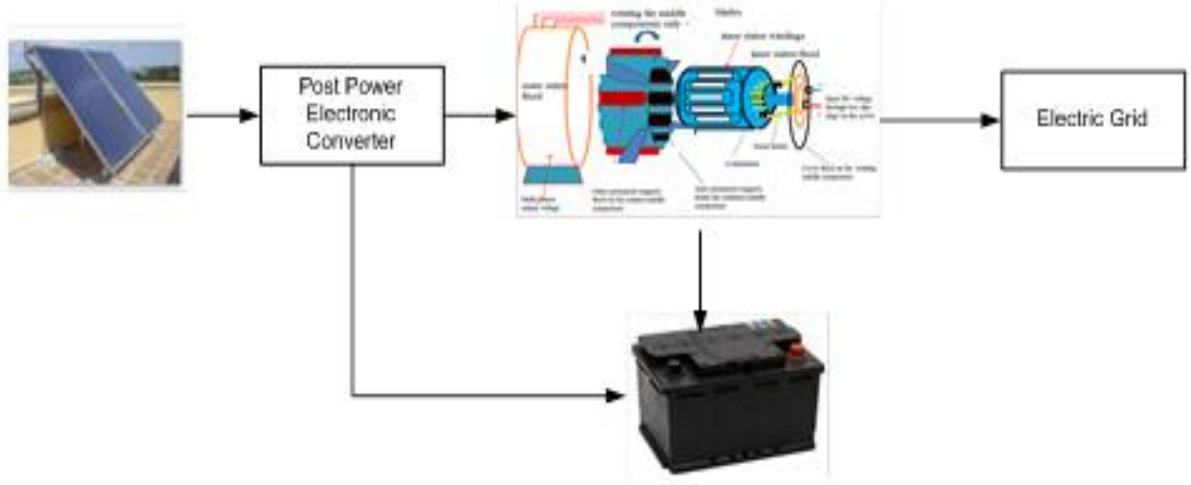


**Figure 1:** Layout of the Current Rotary Converter Machine

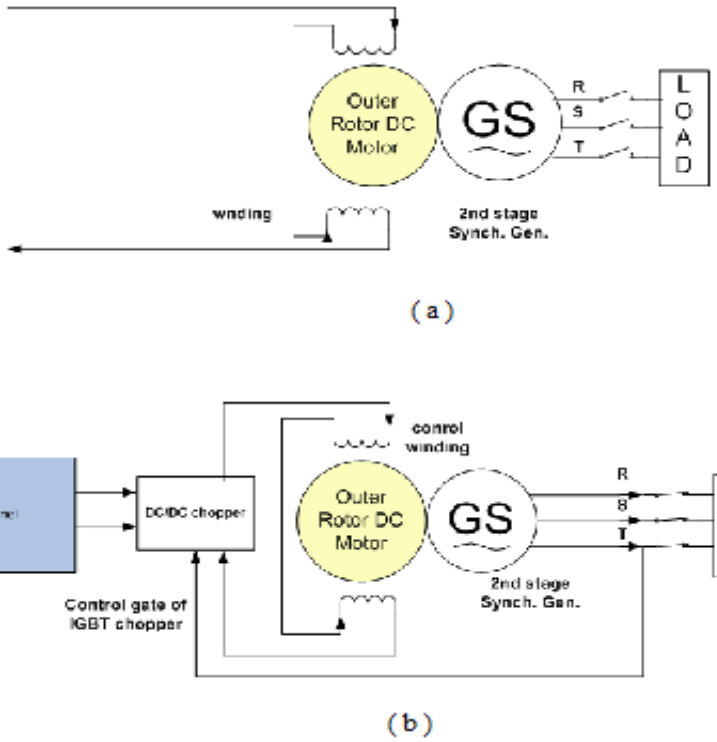


**Figure 2:** Control circuit of DC/AC electric rotary converter machine

(a) Without loading, (b) With loading.

**2- Unloaded, uncontrolled steady state period**

It starts from the ending moment of the transient period, where the input current takes one steady value at no load.

**3- Loaded and controlled steady state period**

After loading the rotary converter is as shown its circuit in Fig.2b. The input current will be increased proportionally with increasing the load. The outer rotor speed is decreased, multi-phase output voltage generated will be lower than the rated terminal voltages. Therefore, it is logically tends to restoring the rated value of output voltages. The principle of operation for the first stage will be represented by possibility to retain the rated speed of the rotor first stage by controlling the voltage applied upon pole windings. The feed error or difference voltage between the required rated output voltage and its present value is fed to feedback device electronic unit called Automatic voltage regulator (AVR). The AVR compensates the dropped voltage due to increase the load and

rise it again by controlling the feedback voltage to the windings of the DC motor. The details of this stage are shown in Fig. 2b.

## PERFORMANCE OF MACHINE

Performance characteristics of the rotary converter have been concluded from the simulated circuit of rotary converter by using matlab program Simulink as shown in Fig.3. These output performance characteristics of the machine are distributed between its two stages.

The input rotary converter current which is assigned to the first stage is shown in Fig.4. The starting current of five to eight times the rated or nominal input current recorded on the nameplate is common and reasonable. The encountered excessive current would lead to damaging heat build-up in the stator windings during the acceleration or staring interval.

The generated torque by the first stage is explained in Fig.5. The total torque is normally a function of speed through the slip variable. In addition, the speed of the converter from the moment of starting and reaching to steady state is shown in Fig. 6. From both figures of torque and speed, the high torque has been generated at low speed throughout starting interval.

The second stage characteristics such as the maximum line to line output voltage and output current are shown in Figs 7 and 8 respectively.

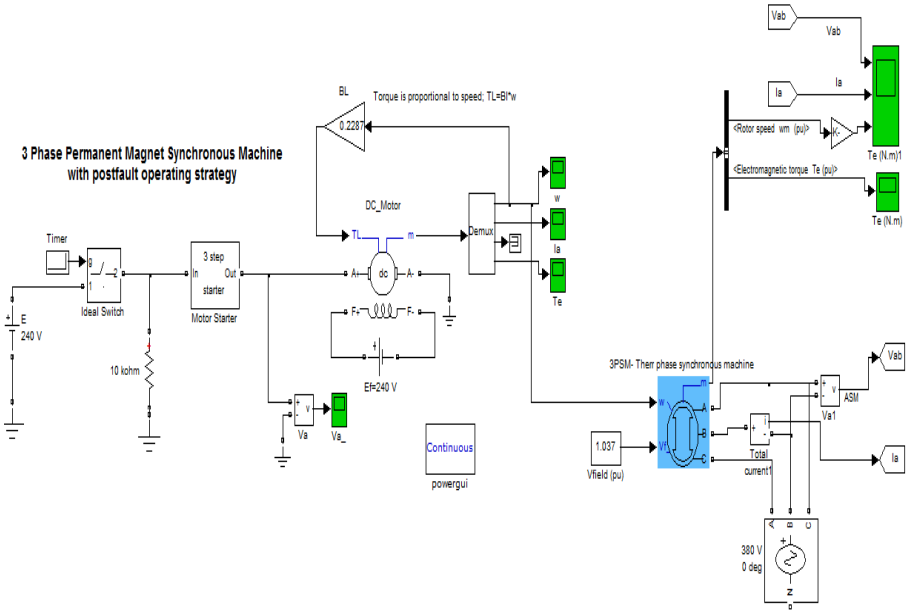


**Figure 3:** Simulink circuit of DC/AC electric rotary converter machine using MATLAB.

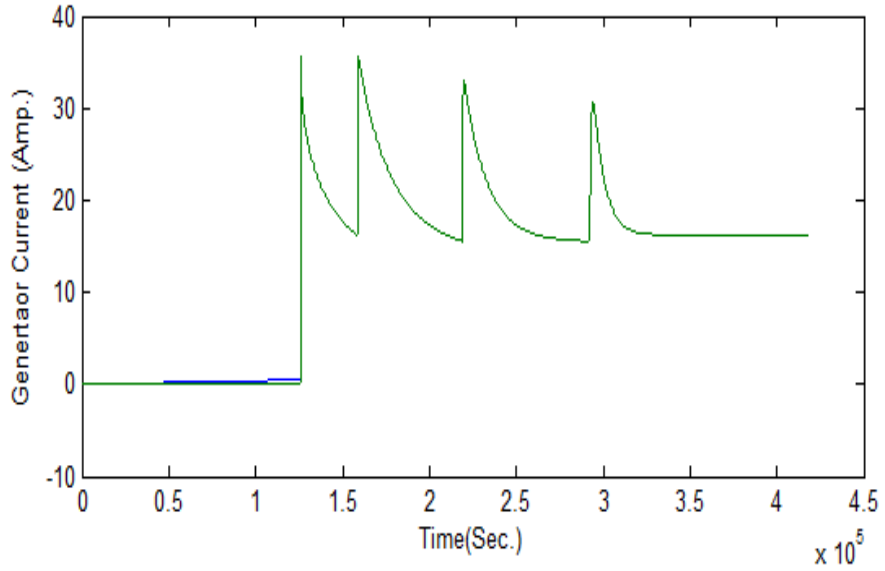


**Figure 4:** Input line current of the DC/AC electric rotary converter machine.

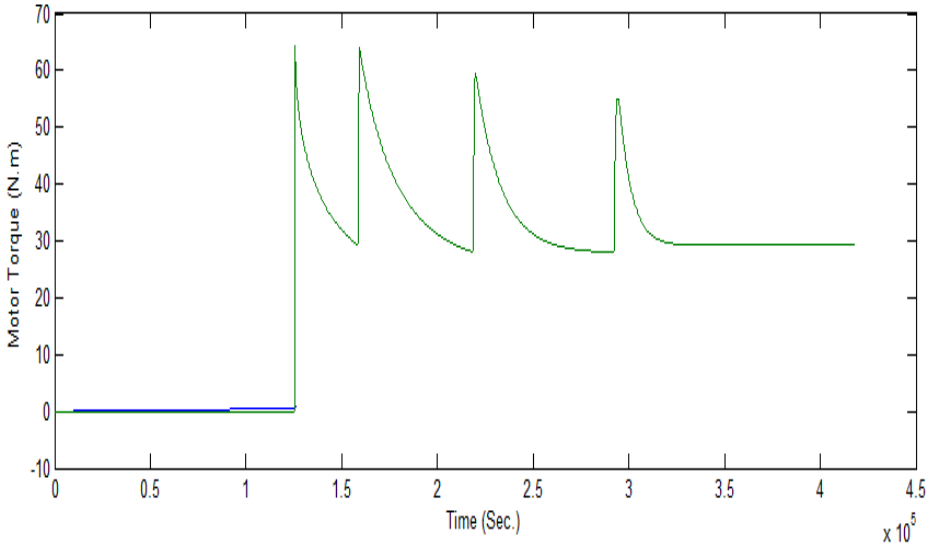


**Figure 5:** Motor torque generated by the DC/AC electric rotary converter machine.

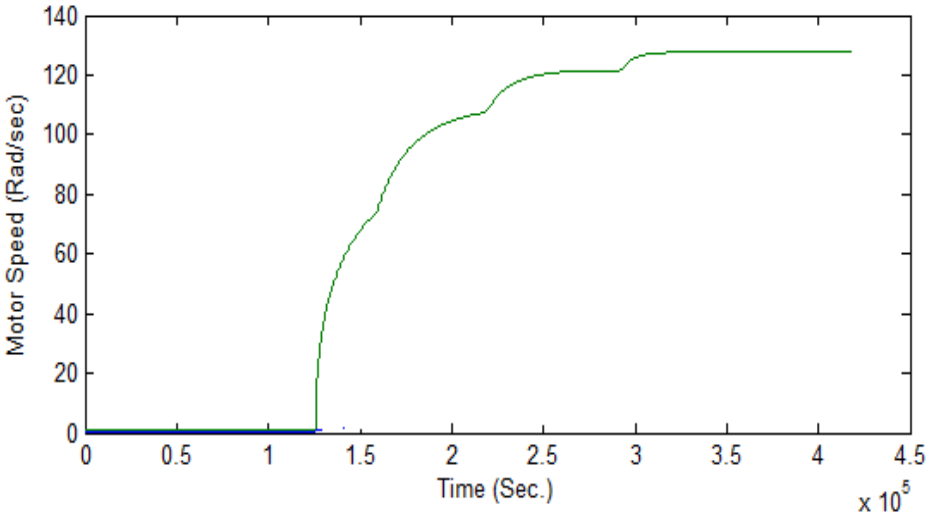


**Figure 6:** Speed of the DC/AC electric rotary converter machine.

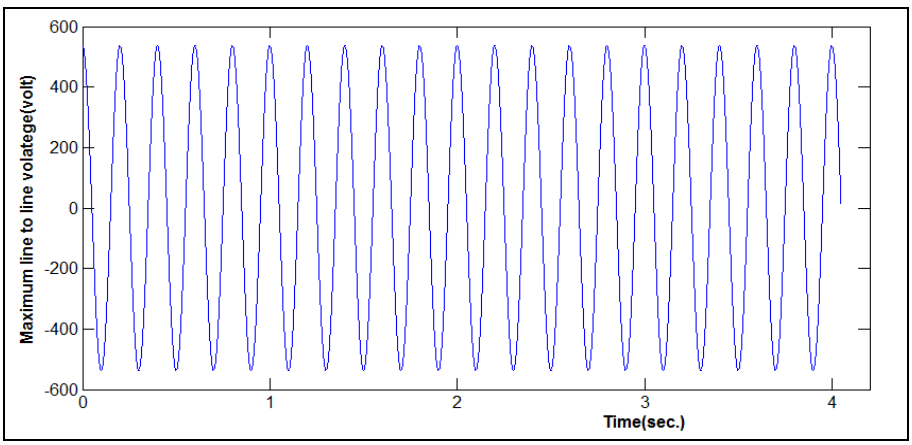


**Figure 7:** Maximum output line to line voltage of the DC/AC electric rotary converter machine.

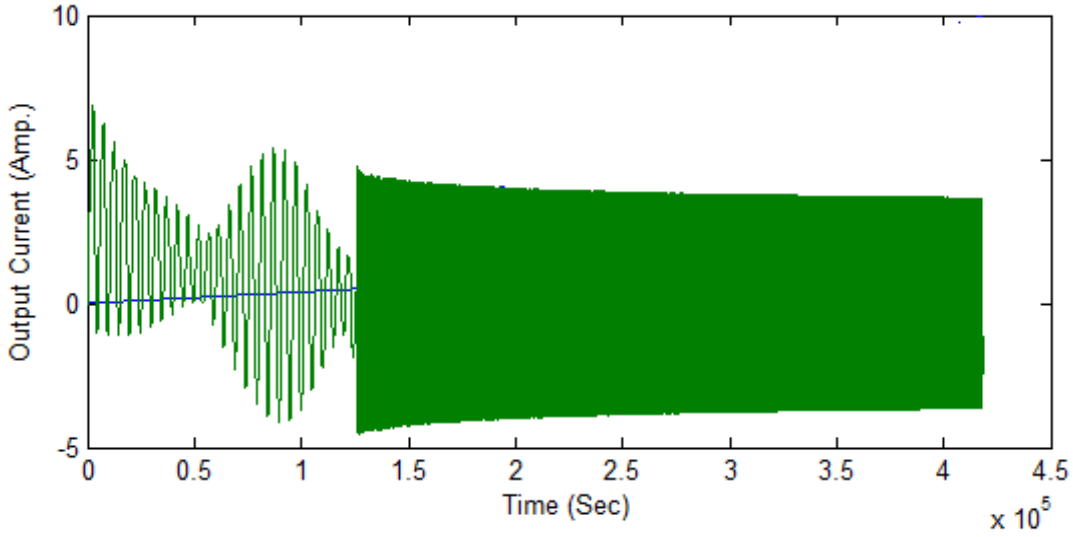


**Figure 8:** Output line current of DC/AC electric rotary converter machine.

## CONCLUSION

It is clearly that the constructed DC/AC electric rotary converter has expected behaviours or performance based on its construction is typical. The transient operation period nearly is taken one or slightly more than second where the fluctuating in input and output currents, speed and torque are pronounced. The next step is the steady state period where the performance such as current, speed and torque take stable values whilst the load is unchanged. In the first stage, the load is considered normally due to existing the second stage, as a mechanical load. In other words, the electric load will be directly and electrically loaded on the second stage and has indirectly effects on the first stage. Eventually, the current rotary converter performance characteristics are constrained and restricted by the outer rotor DC motor for the first stages and synchronous generator in the second stage.

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