

Inter Harmonics of Cycloconverter Excited Induction Motor and Design its Filter Circuit

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Abstract

Harmonics are voltages or currents with a frequency that is an integral multiple of the fundamental supply frequency. Inter harmonics are voltages or currents with a frequency that is a non integral multiple of the fundamental supply frequency. Inter harmonics, always present in the power system, have recently become of more importance since the widespread use of power electronic systems results in an increase of their magnitude[1]. Induction motors can be sources of inter harmonics because of the slots in the stator and rotor iron, particularly in association with saturation of the magnetic circuit (so-called “slot harmonics”). LC filter circuit designed to filter these inter harmonics from cycloconverter controlled output voltage.

Keywords: Filter, Inter Harmonics , Sub Harmonics, Frequency spectrum, THD

Introduction

There are two basic mechanisms for the generation of interharmonics. The first is the generation of components in the sidebands of the supply voltage frequency and its harmonics as a result of changes in their magnitudes and/or phase angles. These are caused by rapid changes of current in equipment and installations, which can also be a source of voltage fluctuations [2]. Disturbances are generated by loads operating in a transient state [3], either continuously or temporarily, or, in many more cases, when an amplitude modulation of currents and voltages occurs. These disturbances are of largely random nature, depending on the load changes inherent in the processes and

equipment in use. The second mechanism is the asynchronous switching (i.e. not synchronized with the power system frequency) of semiconductor devices in static converters. Typical examples are cycloconverters and pulse width modulation (PWM) converters. Inter harmonics generated by them may be located anywhere in the spectrum with respect to the power supply voltage harmonics. Sub-harmonics are inter-harmonics with frequency lower than fundamental frequency. Sub-harmonics can be generated by some of contemporary loads: among others cycloconverters, arc furnaces, motors driving cyclic loads, rectifiers and wind generators (as a consequence of tower-to blade interaction causing the modulation of the generator torque). Consequences of voltage sub-harmonics, even for very low amplitudes are important. All interharmonic components from 15 to 85 Hz can cause light fluctuations. Furthermore, sub-harmonics can cause asymmetrization and core saturation of transformers, thermal aging of induction motors and perturbation of generators function manifesting as sub-synchronous torques. In another study, measurements of the R.M.S. voltage magnitude of the sub-harmonic group and subgroup, defined as grouping of the output bins of an IEC harmonic measurement instrument below 50 Hz, were investigated in a low-voltage distribution system. The results showed considerably higher magnitude of these components than expected.

The Cycloconverter Power Circuit with RL load

Cycloconverter are suitable for large a-c machine because it has advantages: it has high efficiency owing to the simple construction of the main circuit, which consist in its basic form simply of an array of thyristor switches and it is also naturally commutative and no force commutation circuit are necessary. As the same time it suffers from some disadvantages. It has a low maximum output frequency compared to input frequency, and it suffers from voltage distortion [4]. Single phase to single phase cycloconverter is designed in MAT LAB SIMULINK Software with its firing circuit and control circuit [5] as shown in Fig.1 and its output voltage waveform shown in Fig.2 and Fig.3 with different value of filter capacitor. To filter out the output voltage of cycloconverter an capacitor of particular value connected in cross the load. The magnitude and order of different number of harmonics and inter harmonics and sub harmonics of output voltage of cycloconverter with different value of filter capacitance shown in Fig.4 and Fig.5. and also shown the effect of different filter capacitance on the peak value of output voltage and Total Harmonics Distortion. In Fig.4 the fundamental voltage is 64.45 volt and THD is 92.33% of fundamental and with the filter capacitance of 10F Fundamental voltage is 73.68 volt and THD is improved to 19.43% of fundamental that means with improved filter capacitance fundamental voltage value increase and THD is reduced but magnitude of inter harmonics and sub harmonics of the voltage is increased.

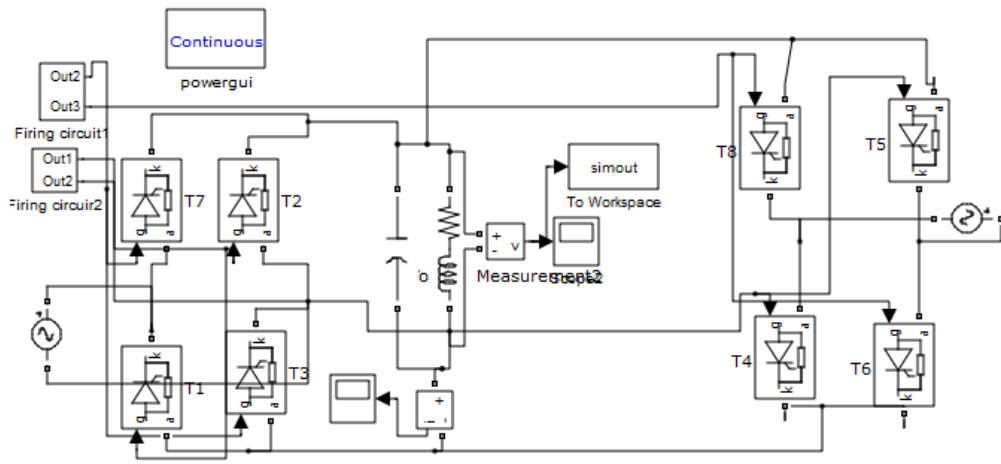


Figure 1: Power circuit of single phase to single cycloconverter

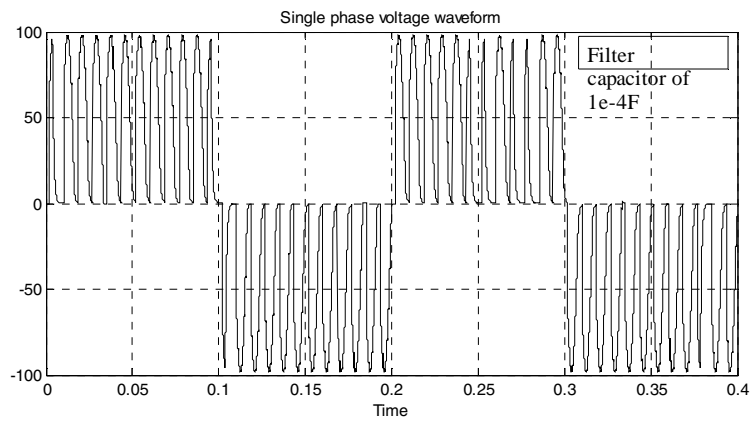


Figure 2: Output voltage waveform of cycloconverter with filter capacitance of 0.0001F

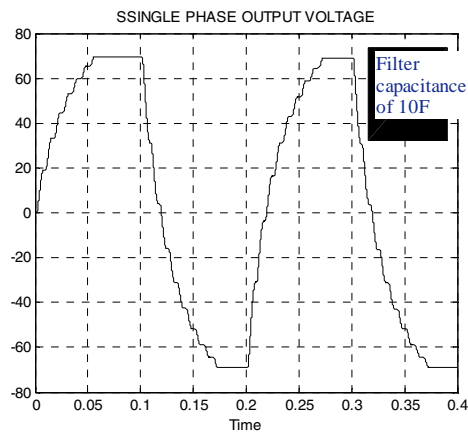


Figure 3: Output voltage waveform of cycloconverter with filter capacitance of 10F

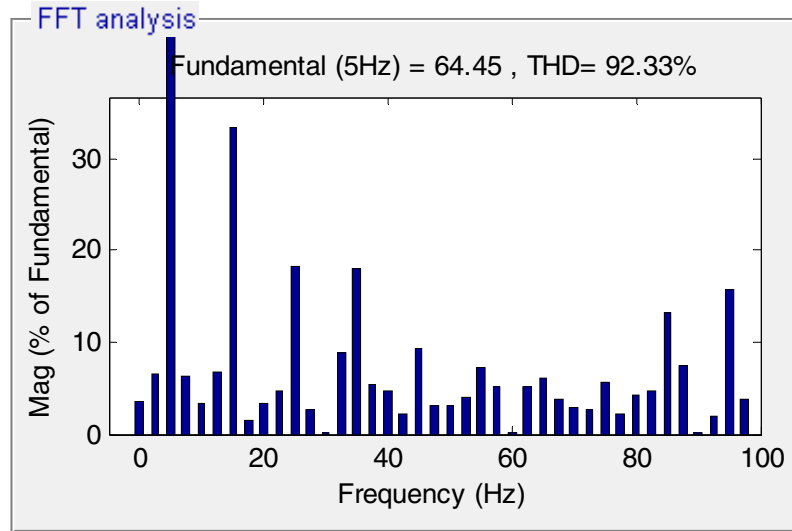


Figure 4: FFT for output voltage with 0.0001F.

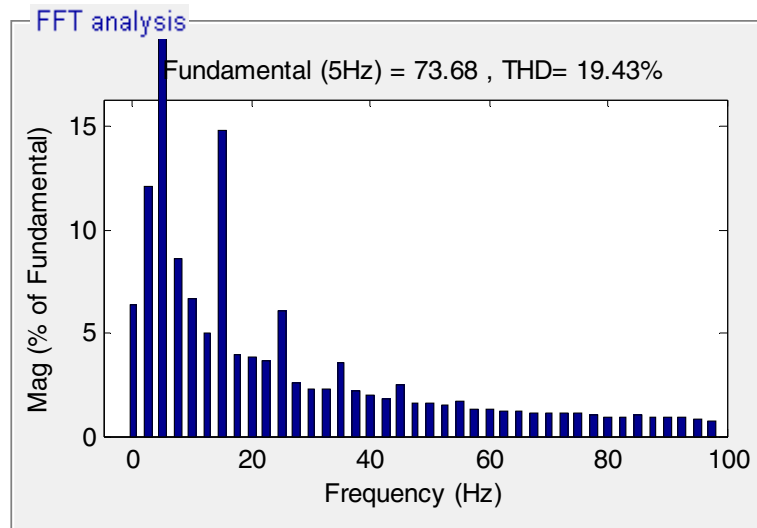


Figure 5: FFT for output voltage with 10F

Circuit of Three phases to single phase cycloconverter is also designed with R-L load. Frequency spectrum of output voltage of this cycloconverter as shown in Fig.6 without filter capacitance and Fig.7 with filter capacitance of 10F.

As shown in Fig.6 and Fig.7 Fundamental value of output voltage is reduced and THD is also reduced but the magnitude of inter Harmonics and sub Harmonics are increased with improved filter capacitance of three phase to single phase cycloconverter.

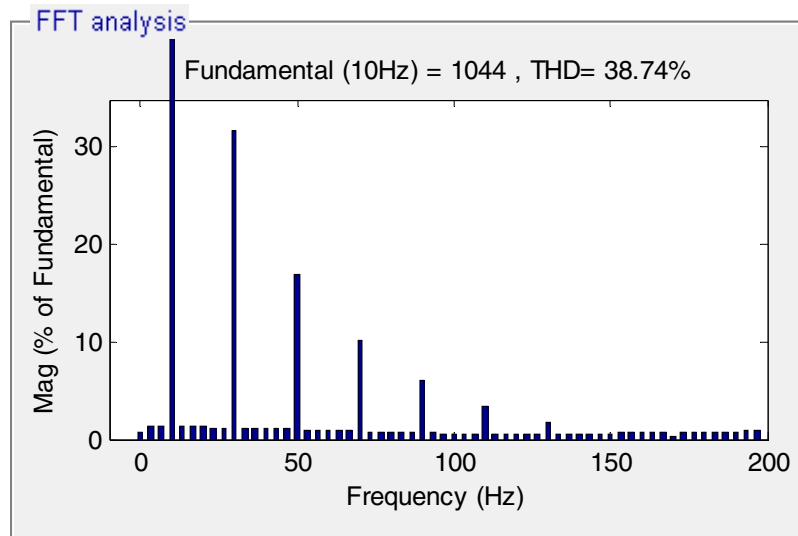


Figure 6: FFT of three phase to single phase cycloconverter without filter capacitance

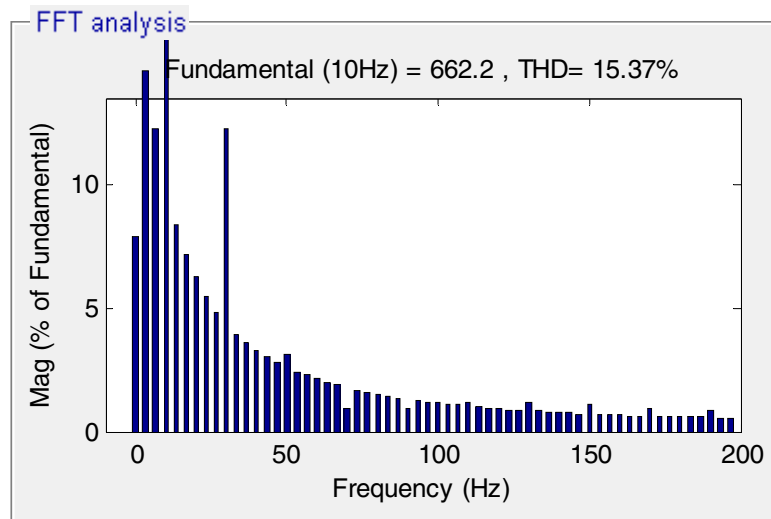


Figure 7: FFT of three phase to single phase cycloconverter with filter capacitance of 10F

Conclusion

In this simulation, Output voltage of single phase to single phase cycloconverter circuit with different value of filter capacitance having different magnitude of Harmonics and inter harmonics and sub harmonics. The effect of modified filter capacitance improved Total Harmonics Distortion but increases the magnitude of interharmonics and sub harmonics term. It's the limitation to improve the filter circuit. These inter harmonics and sub Harmonics term produce fluctuated torque and speed in induction motor.

References

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