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Openloop simulation of medium frequency induction melting furnace with 12 pulse rectifier and H-bridge inverter

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ABSTRACT

The combination of 12-pulse Δ - Δ / Λ connected fully controlled rectifier and H-bridge inverter arrangement is fed the coreless medium frequency induction melting furnace. The current waveform is distorted because of the various characteristic current harmonics introduced in the source side due to non-linear IMF load on the power system.

Keywords— 12-Pulse rectifier, H-bridge inverter, Medium frequency induction melting furnace, Harmonics.

1. INTRODUCTION

The induction melting furnace has a competitive installation cost and low running cost offers a clean, energy efficient, and easily controllable melting process [1]. Due to low capital cost medium frequency induction melting furnace is used in small steel melt shops and alloy steel plants. Harmonic is a presence in the supply side wave form because the load continuous change during the melting process of induction furnace. These harmonics are injected in to the grid and power quality issues arise. [1]

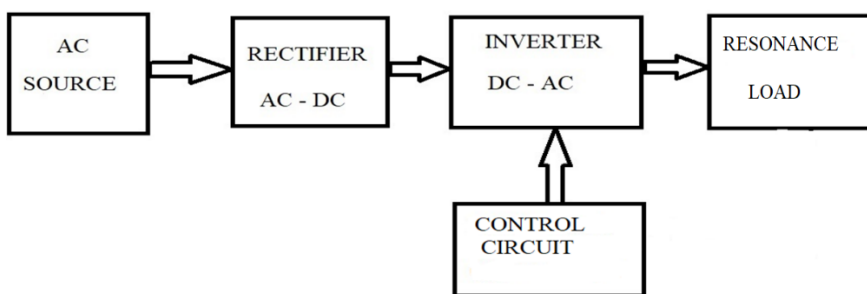


Fig. 1: Block diagram of Induction melting furnace

The medium frequency induction melting furnace generally consists of AC-DC- AC power converter with parallel resonance load and normally operate at range 150 Hz to 250Hz with an operating power range from 10KW to 15MW[1].

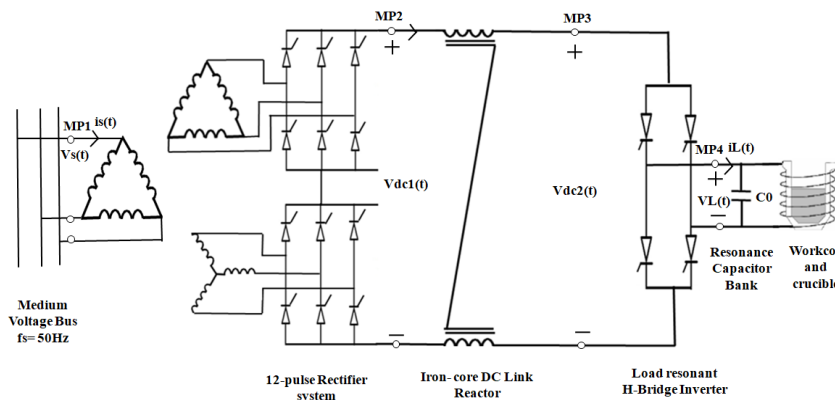


Fig. 2: Simplified power circuit diagram of a typical medium frequency, coreless IMF.

2. SYSTEM DESCRIPTION

Figure 2 shows the simplified power circuit diagram of a typical medium frequency, coreless IMF. The power circuit diagram of a typical medium frequency, coreless IMF consist of two series connected six pulse rectifier, dc link, and H bridge inverter. The 3-ph, 31.5KV/1.2KV, 12MVA, $\Delta - \Delta / \Delta$ transformer is connected to 31.5KV bus. The 12 pulse rectifier which converts AC supply in to DC supply to gets supply from the 3-ph, 31.5KV/1.2KV, 12MVA, $\Delta - \Delta / \Delta$ transformer. The dc link gets supply from the 12 pulse rectifier. The H bridge inverter converts the DC supply in to AC supply and induction melting furnace get supply from the H-bridge inverter. SPWM method is used for control for H-bridge inverter is used.

Table 1: power system parameter and furnace Specification

Input voltage	31.5KV
Transformer	12MVA, 31.5KV / 1.2KV-1.2KV, $\Delta - \Delta / \Delta$
Operating Frequency	150-250Hz
R	1.7 Ω
L	150 μ H
C	5.2 mF

2.1 Simulation of 12 Pulse rectifier, simulation result and FFT analysis

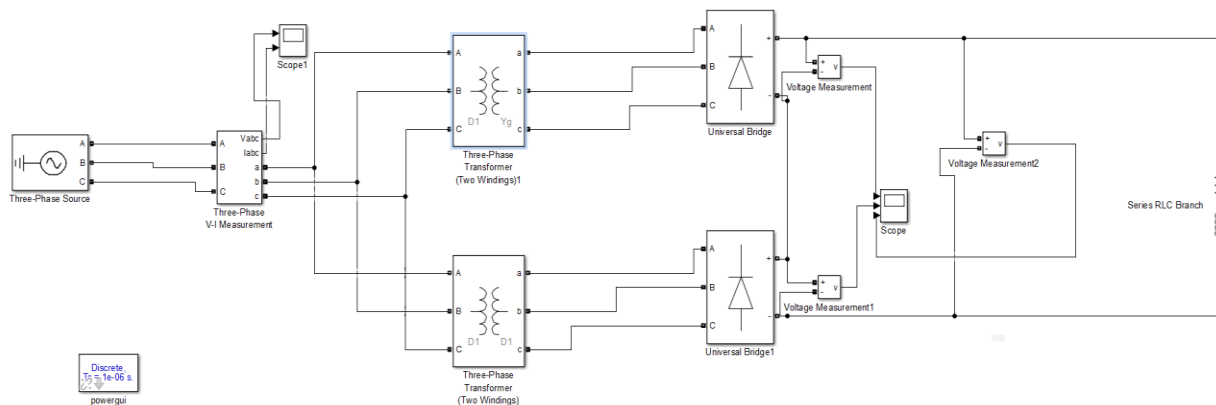


Fig. 3: 12 pulse rectifier Simulink model

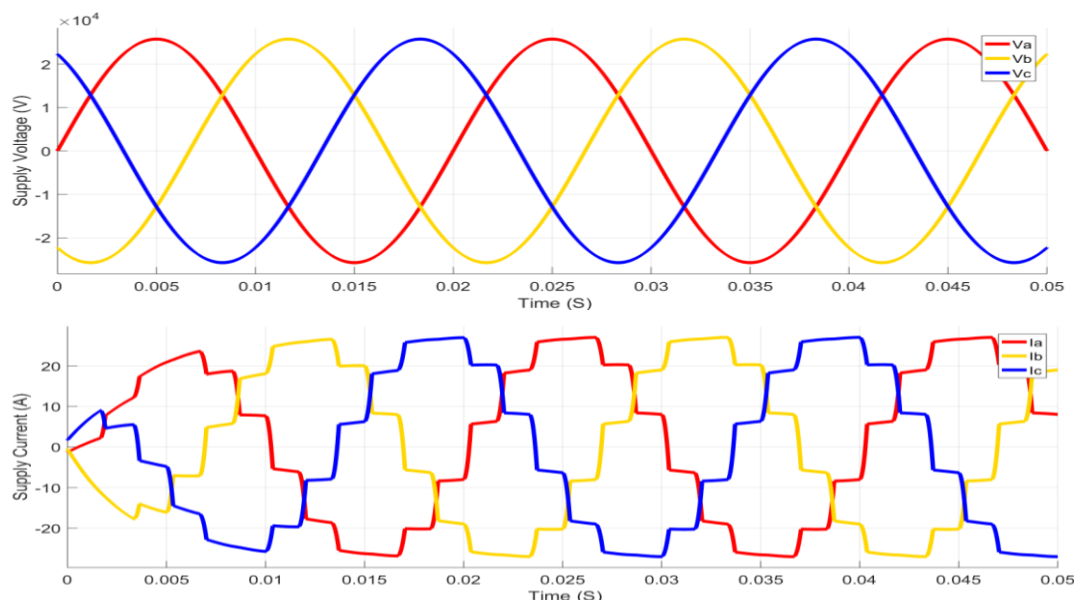


Fig. 4: Input voltage and current waveform of 12 pulse rectifier

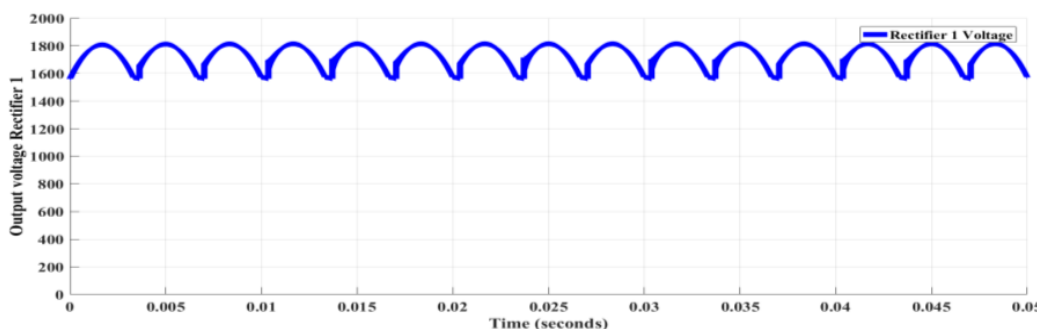


Fig. 5: Output voltage 12 pulse rectifier 1

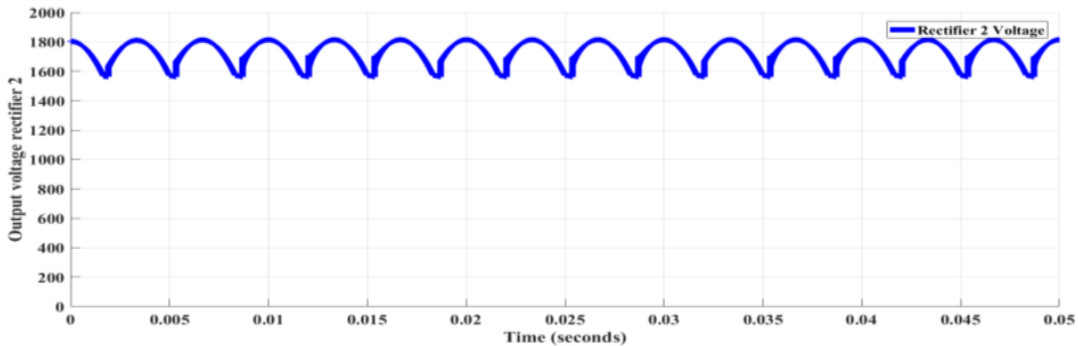


Fig. 6: Output voltage 12 pulse rectifier 2

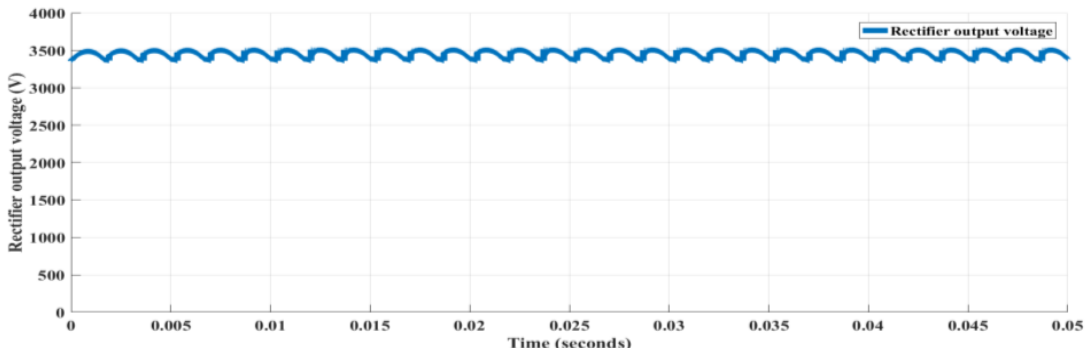


Fig. 7: Total output voltage 12 pulse rectifier

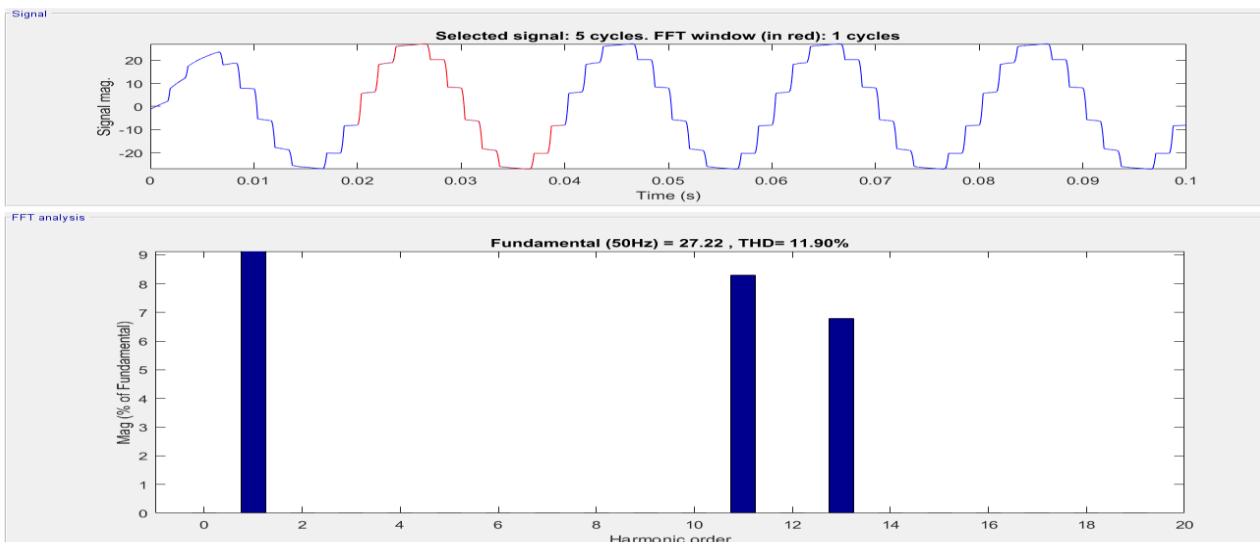


Fig. 8: FFT analysis of 12 pulse rectifier input current

2.2 Simulation of H Bridge and simulation result

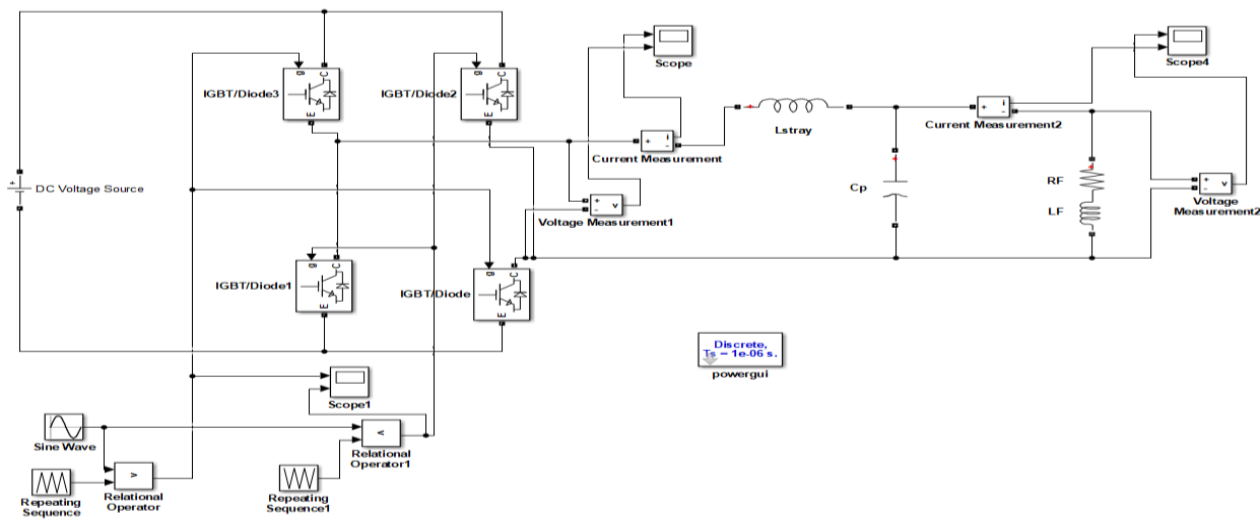


Fig. 9: H bridge inverter Simulink model

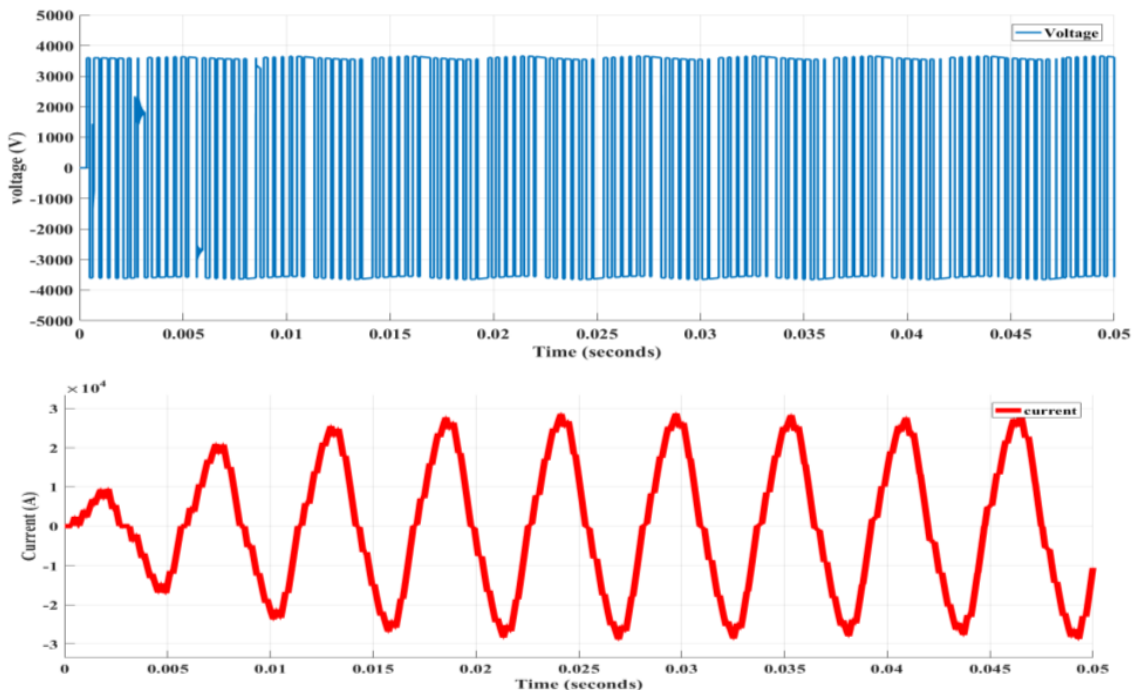


Fig. 10: Output voltage and current of H bridge inverter

2.3 Open loop simulation of medium frequency induction melting furnace

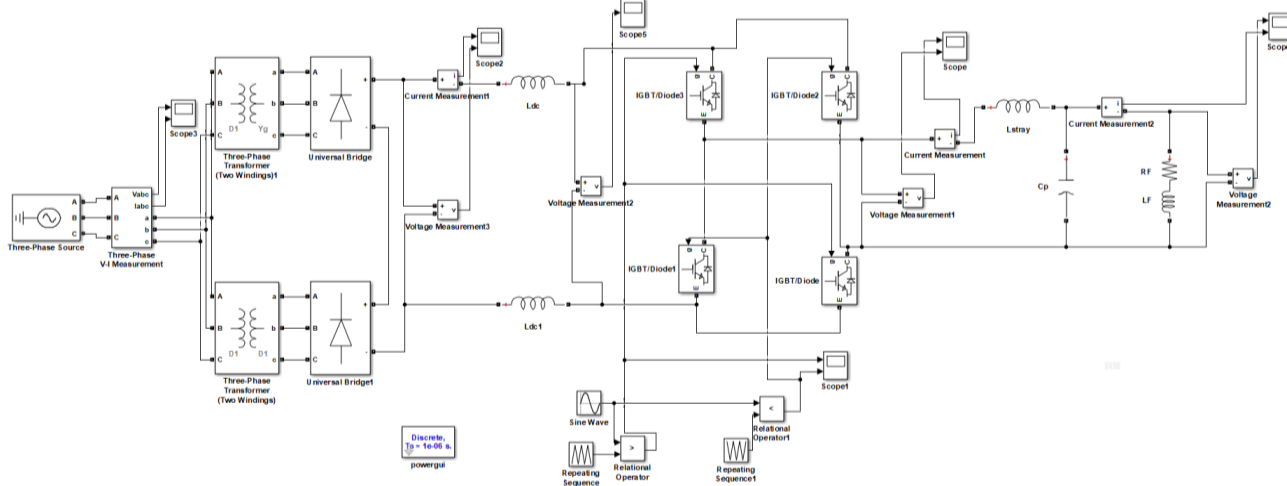


Fig. 11: Open loop Simulink model of medium frequency induction melting furnace

At MPI

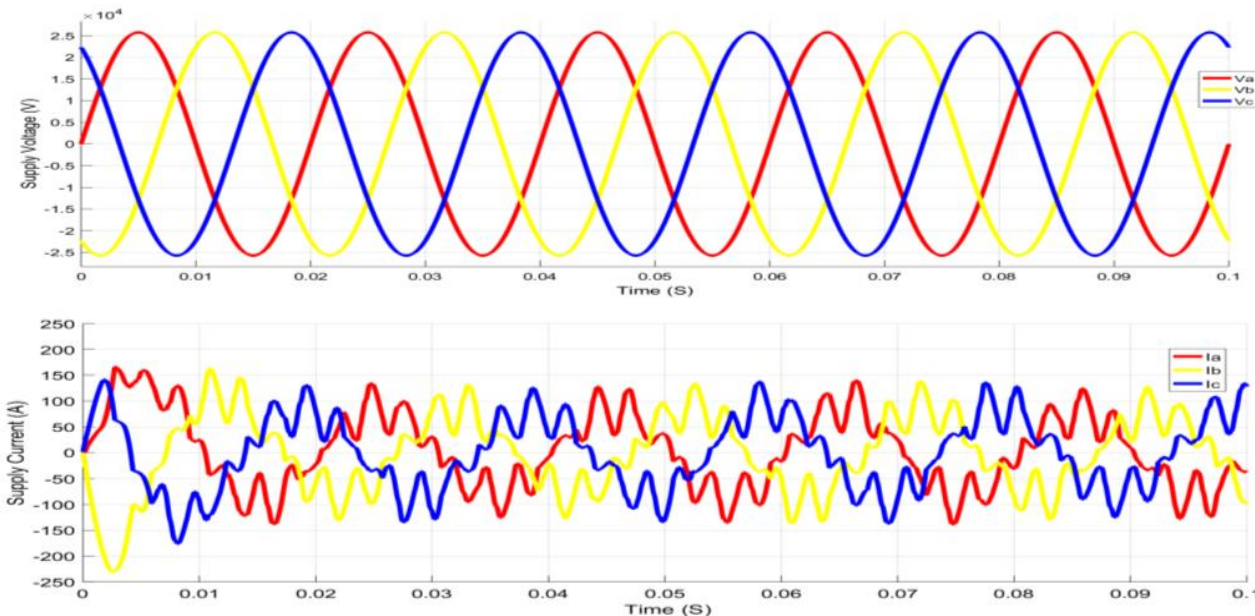


Fig. 12: Supply voltage and current wave form

At MP 2

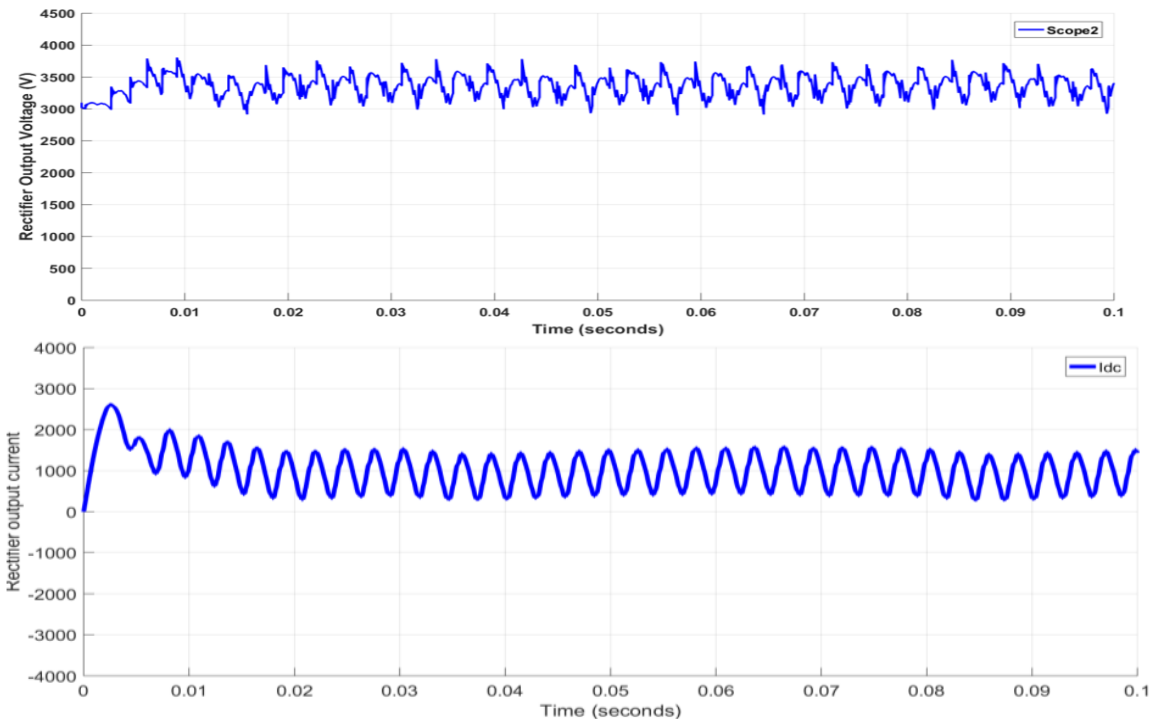


Fig. 13: Rectifier output voltage and current wave form

AT MP 3

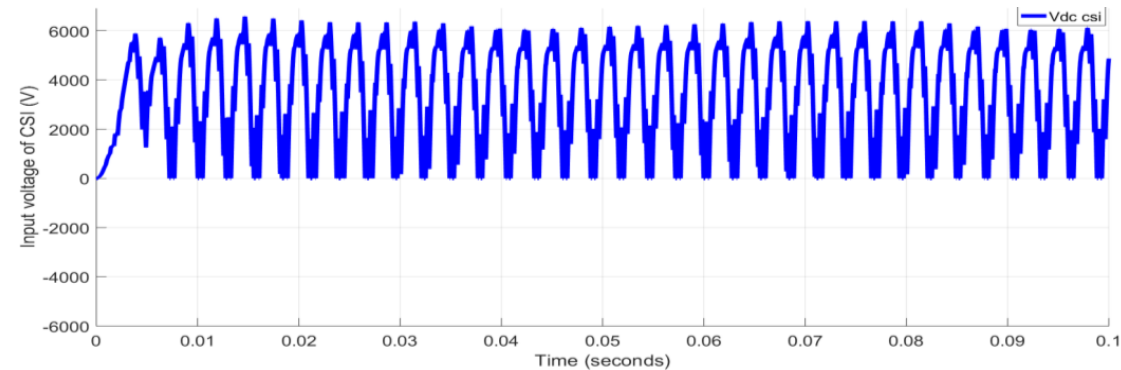


Fig. 14: Inverter input voltage wave form

At MP4

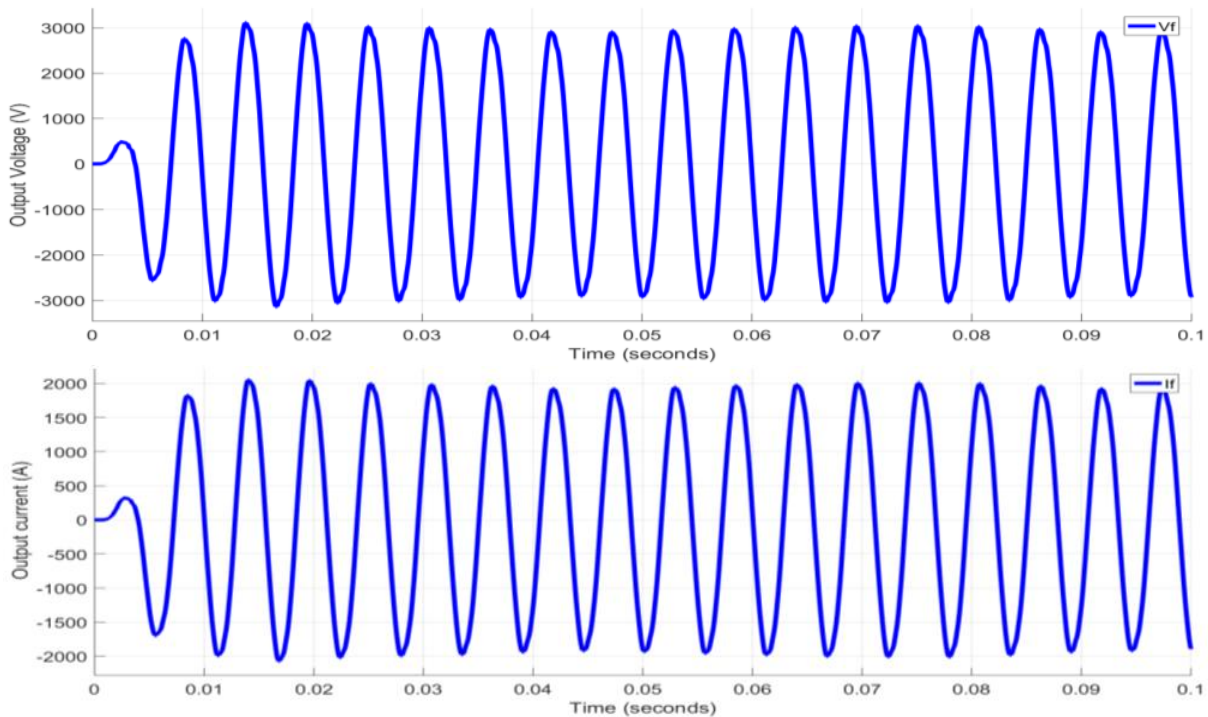


Fig. 15: Output voltage and current wave form

2.4 FFT analysis

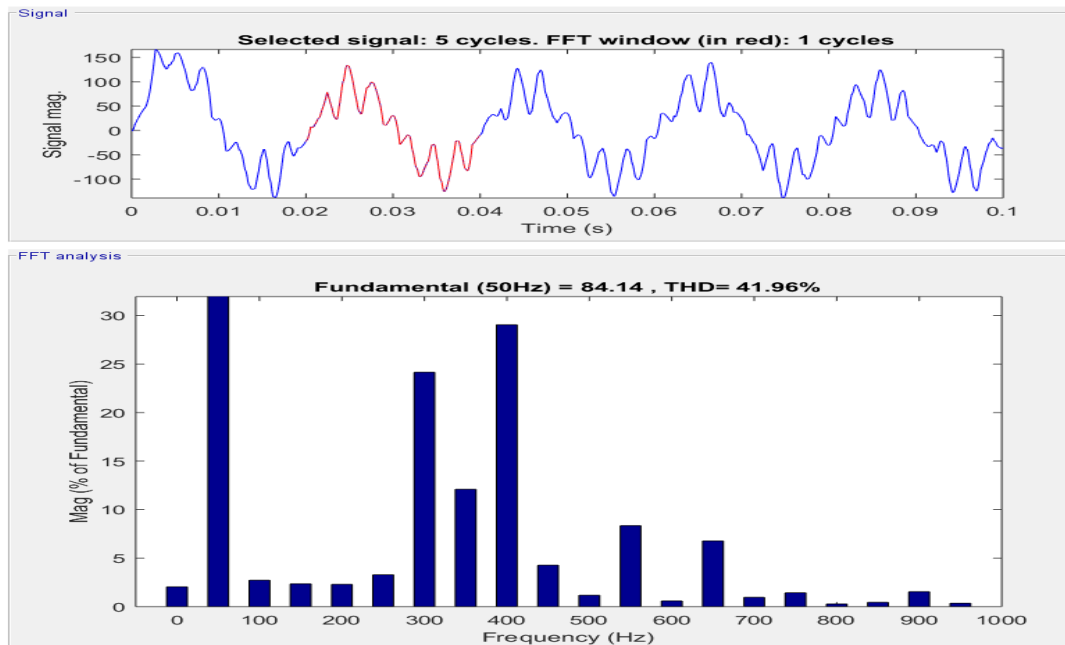


Fig. 16: FFT analysis of input current wave form

3. CONCLUSION

11th and 13th harmonics are present in the 12 –pulse rectifier and 5th and 7th order harmonics are not present in 12 pulse rectifier input current as shown in FFT analysis of 12 pulse rectifier. The Total harmonic distortion is 41.96% observed in FFT analysis of input current wave form of open loop simulation of medium frequency induction melting furnace which is done in matlab software.

4. REFERENCES

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