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Simulation of H–bridge Inverter used for Induction Melting Furnace

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Abstract: *Obtaining for variable dc voltage in industries 3-phase thyristor is used. 3-phase thyristor involve large lower level harmonics in the input currents. 6-phase thyristor produce comparatively less harmonics to 3-phase thyristor. For high power grid source application used 12- pulse thyristor rectifier involves two 6-pulse rectifiers. These 12-pulse rectifier reducing harmonics content comparatively more to 3-phase and 6-phase. But 12-pulse rectifier include the (12m + 1)th (m: integer) harmonics. This paper proposes to medium frequency induction melting furnace as a load on the power system.*

Keywords: *Induction melting furnace, 12 – pulse rectifier, H – bridge inerter, Harmonics.*

1. Introduction

Different rectifier connects with system than it includes lower – order harmonics in source current. In case of high power application more harmonics problem include. One of the solutions for this harmonics problem reduction is the

Utilization of active power filter, but this solution is more expensive. Another solution for harmonics reduction is installation of passive filter, than passive filter is mandatory to reduce source current harmonics problem introduced by the different rectifier to the power system. This solution creates expensive rectifier system and overall rectifier system is bulky [1].

Diode rectifier used passive component and switching devices for reduce harmonic problem, but they are create more complicated system include in high power grid application. The 6-pulse rectifier is involving most AC drive because of its low cost and simplest structure. The input current THD can exceed 100% with no harmonics filter with 5th, 7th and 11th harmonics at full load condition. Harmonics filter with 5th, 7th and 11th harmonics being dominant harmonics component. A 12-pulse rectifier involves two sets of 6-pulse rectifier is very popular for different types high power grid application. The multi-phase transformer can be an autotransformer or an isolated transformer with some phase displacement to provide two three-phase voltage sources that cancel the 5th and 7th harmonics. 12-pulse rectifier with a delta-delta-wye isolation transformer and the resulting input current waveform where 11th and 13th harmonics are the dominant harmonic components [1].

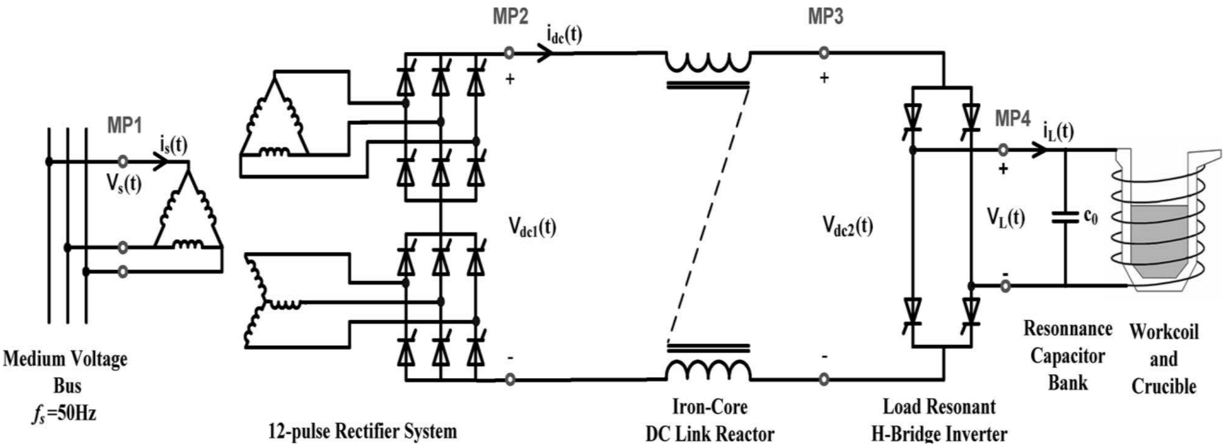

Fig. 1. *Simplified power circuit diagram of a typical medium-frequency coreless IMF.*

In this paper use a series connected 12- pulse thyristor rectifier connect with the H – bridge inverter and represented the coreless induction melting furnace circuit diagram. This diagram represented the time varying parallel RLC circuit model. In particularly in this addition investigate of the input, output voltage and current of the system.

2. SYSTEM DESCRIPTION

Simple power circuit diagram of induction melting furnace show in figure 1. During the melting period variable frequency supplied by load resonant single phase H – bridge inverter circuit for maximize the power transferred to the work coil. Resonant capacitor bank is connected across the work coil for maintain the resonant situation. 12 –Pulse rectifier is connecting with the H – bridge inverter circuit via dc link reactor. It is one types of dc choke. It also serves as a current limiting reactor against fault on the inerter side. 12 – Pulse rectifier system is formed by using a three phase delta-delta/star transformer bank and two six pulse rectifier connected in series. Operation of the induction melting furnace system shown in figure 1 and discussed their input, output voltage and current result in next section. Field data are collected on a 25-t 12-MVA IMF system for several melting cycles at measurement points MP1–MP4 in Fig. 1, by using a custom-designed power quality measurement system which is programmed to collect raw data.

Each voltage and current quantity is sampled at a rate of 12.8 kS/s with time synchronization. At MP1, voltage and current signal are taken from secondaries of conventional current and voltage transformers. At MP2–MP4, voltage signals are taken by the use of high-voltage active differential probes, and current signals are taken by the use of coils. Some sample records of currents and voltages at measurement points MP1–MP4 are shown in Figs. 7–10, respectively [2].

3. CALCULATE OUTPUT PARAMETERS FOR RLC COMPONENT

3.1 R can be calculated from.

R = equivalent resistance in parallel with coil

P_{ω} = 6.875 Mw

V_{ω} = 3535 V = true r.m.s. value of the o/p voltage.

$$\mathbf{R = \frac{V_{\omega}^2}{P_{\ \omega}}}$$

$$R = \frac{(3535)^2}{7250000}$$

R = 1.71 Ohm

3.2 Equivalent Inductance of the Heating Coil .

$$\mathbf{L = \frac{V_{\omega 1}}{2\pi f I_{L1}}}$$

$V_{\omega 1}$= true r.m.s. value of the o/p voltage

$V_{\omega 1}$= = 3535 V

I_{L1} = r.m.s. value of the fundamental component of the operational inductance current

I_{L1} = 2900

$$L = \frac{3535}{6.28*225*2900}$$

L = 0.0008 H

3.3 Calculation of the Value of the Resonant Capacitor.

$$\mathbf{C = \frac{1}{L(2\pi f_0)^2}}$$

$$C = \frac{1}{0.0008(3.14*225)^2}$$

$$C = \frac{1}{0.0008*1996569}$$

C = 0.0006 F

4. 12 - PULSES RECTIFIER CONECT WITH H – BRIDGE INVERTER IN CLOSE LOOP CIRCUIT

Close loop circuit of 12 – pulse rectifier and H – bridge inverter diagram is show in fig. 2. Hear Close loop circuit of 12 – pulse rectifier and H – bridge inverter connected with cascade RLC load. Velue of resister R, inductor L and capacitor C is calculated show in above.

This all diagram circuit is called induction melting furnace, it is used for small melting shop. In close loop circuit generate Id-fill and Iq-fill by use of coordinate the both phase current. And also generate Vd^* and Vq^* signal with use of coordinate the both phase voltage. With use of this Vd^* and Vq^* signal generate the Id-reference and Iq-reference signal. Id-fill and Iq-fill and Id-reference and Iq-reference signal are used in PI control circuit and generate the carrier signal. These carrier signals are comparing with d.c reference signal and generate the getting pulse.

When h – bridge inverter connect with 12 – pulse rectifier in close loop then input wave form of source current and source voltage in fig. 3. H – bridge inverter connect with 12 – pulse rectifier in close loop then rectifier output and inverter input wave form of current and voltage in fig. 4 & 5. Inverter output voltage and current is show in fig. 6.. Current wave is rectangular and voltage wave is sinusoidal. Harmonics of inverter source current and source input voltage is show in fig. 7. THD in current wave form is 11.70% and voltage wave THD is 0.083%. Harmonics of inverter output current and inverter output current and output voltage show in fig. 8. THD in current wave form is 18.06 and voltage wave 26.44%.

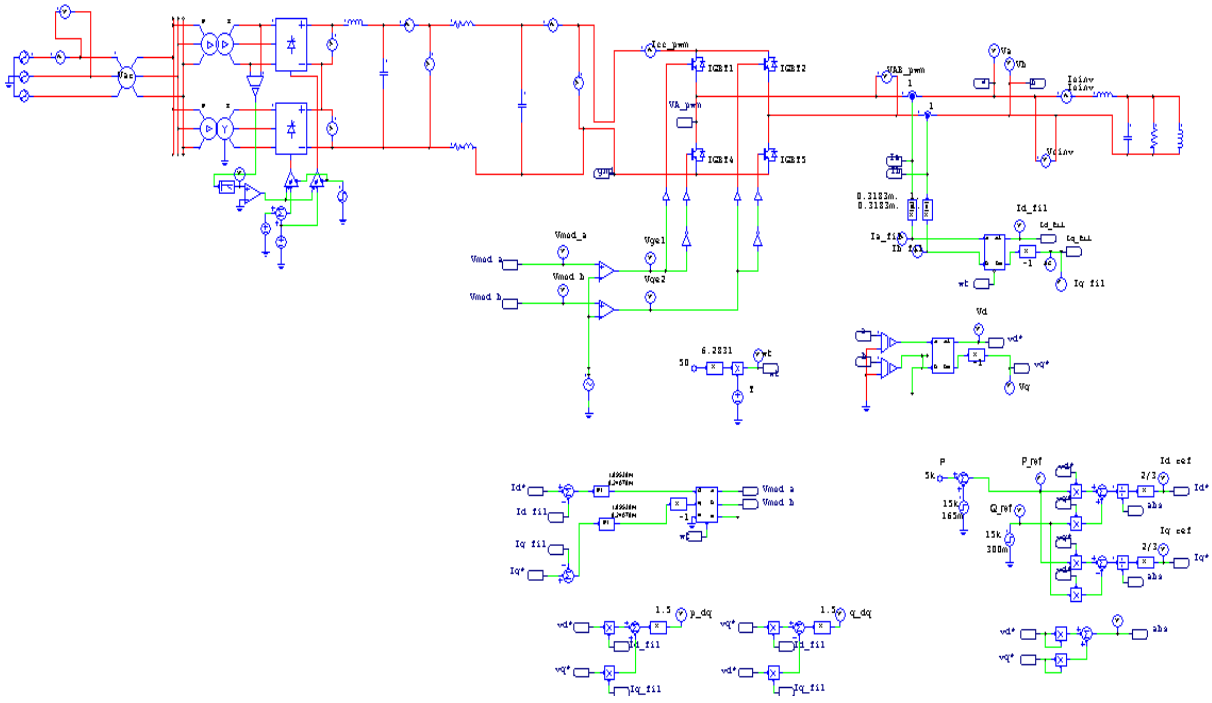

Fig. 2. *Circuit diagram of a typical medium-frequency coreless IMF in p-sim.*

At MP 1

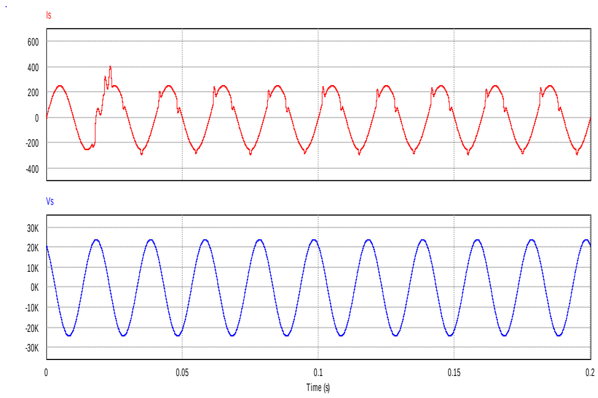

Fig 3. *Source current, source voltages.*

At MP 2

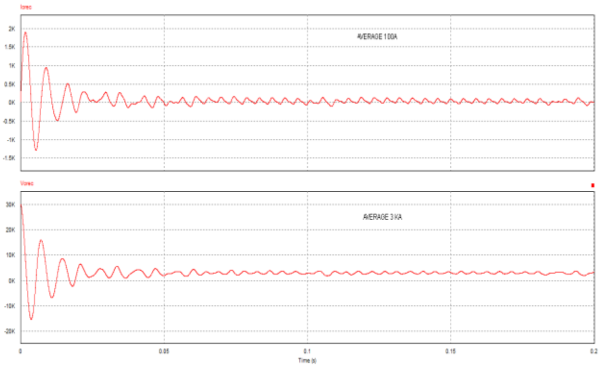

Fig 4. *Rectifier output current & voltage.*

At MP 3

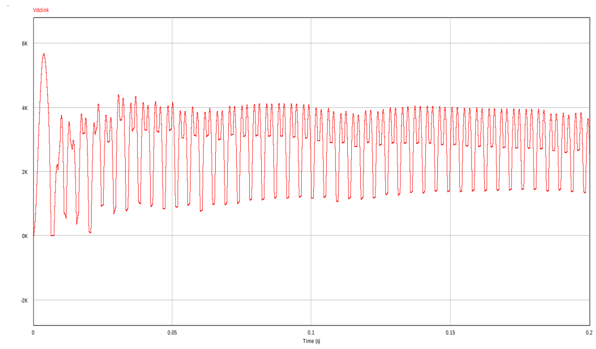

Fig 5. *Inverter input voltage.*

At MP 4

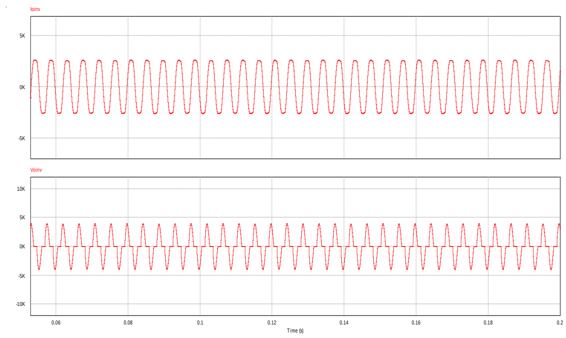

Fig 6. *Inverter output voltage and current.*

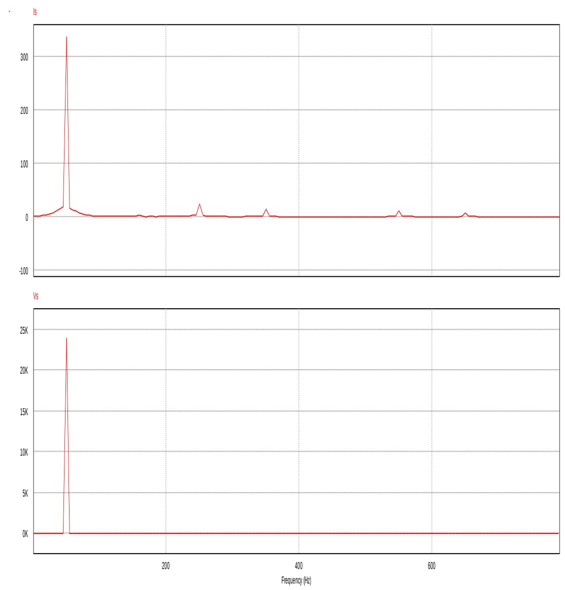

Fig 7. *Harmonics of source input current and input voltage.*

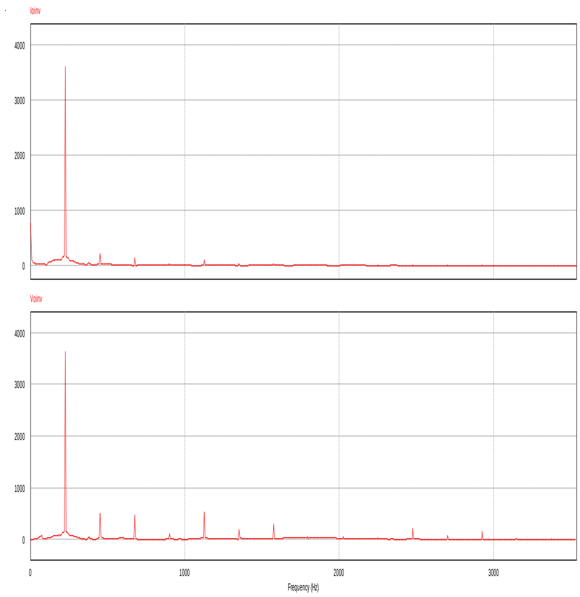

Fig 8. *Harmonics of inverter output current and output voltage.*

5. Conclusion

The Coreless medium frequency induction melting furnace supplied from 12-pulse rectifier and single phase h-bridge inverter, it is one types of cascade load resonant current fed Inverter has been investigated as a load on the power system. The variable-frequency operation of the Induction melting furnace has been represented by a variable *RLC* model, derived from simulation measurements carried out for typical melting cycles. All power quality parameters of the IMF system have been investigated according to the related standards, and it has been shown that the major power quality problem for the utility grid is due to the injection of time-varying interharmonic currents to the supply. The harmonic and interharmonic currents caused by the IMF system have been investigated in simulation result. The frequencies and magnitudes of the uncharacteristic harmonics and interharmonic caused by the cross modulation across the ac–dc–ac link have been derived by simulation for a practical IMF operation. Different cross-modulation types have been shown to occur between harmonic frequencies of the supply current and those of inverter output current referred to the dc link, in practice.

References

[1] Shoji Fukuda, Senior Member, IEEE, and Issei Hiei, "Auxiliary Supply-Assisted 12- Pulse Phase-Controlled Rectifiers with Reduced Input Current Harmonics." IEEE transaction on industry application, vol. 44, NO.1, January/February 2008.

[2] Ilker Yılmaz, Muammer Ermi¸s, and IssikÇadırcı, "Medium-Frequency Induction Melting Furnaces as a Load on The Power System" IEEE Trans. On industry application, vol. 48, No. 4, July/august 2012.