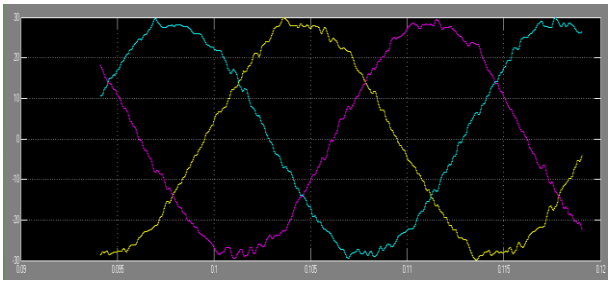

Figure 9: Souce current waveform

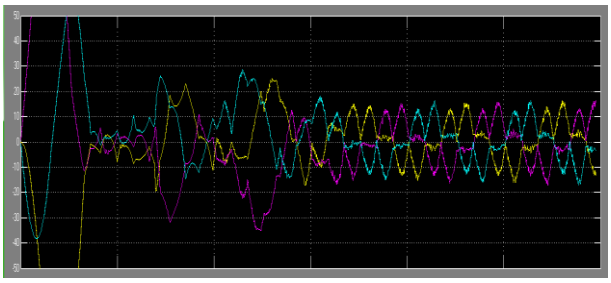

Figure 10: Filter Current waveform

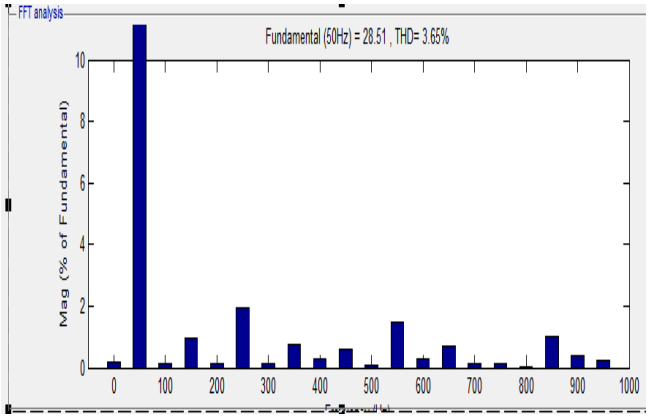

Figure 11: FFT Analysis of Souce Current (THD=3.65%)

When the filter is not being used, the source current is highly distorted with THD equal to 18.85% (figure 6). As seen from the FFT analysis (figure 7), the source current contains a high percentage of 5^{th} and 7^{th} harmonic.

By using filter the THD is reduced from 18.85% to 3.65% (figure 11). Figure 10 shows the current injected by the filter which is nothing but the harmonic current. Since this harmonic current is injected by filter, the source current is almost sinusoidal.

C. System without Shunt APF under Unbalanced Source Voltage Condition

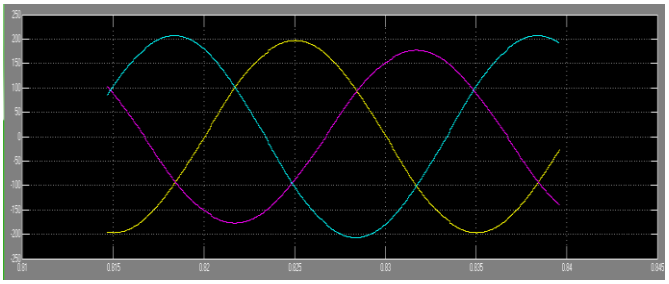

Figure 12: Souce voltage waveform

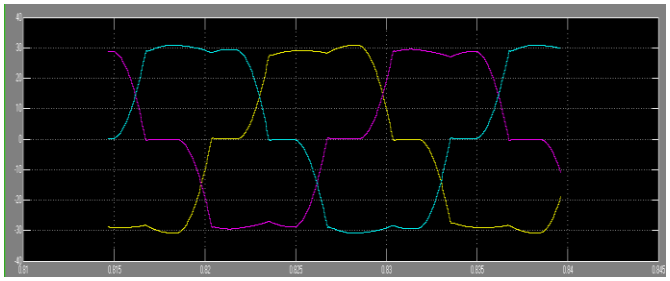

Figure 13: Souce current waveform

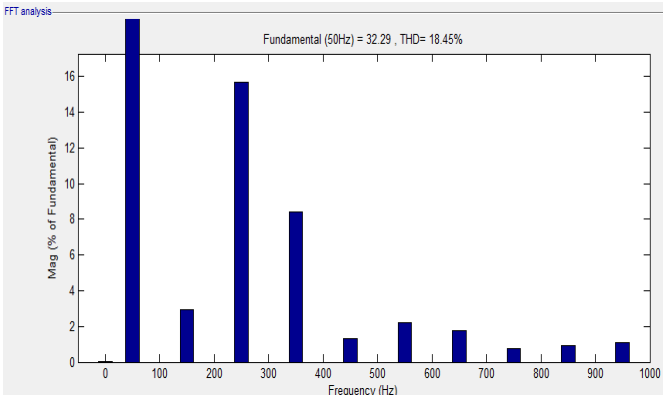

Figure 14: FFT Analysis of Souce Current (THD= 18.45%)

D. System with Shunt APF under Unbalanced Source Voltage Condition

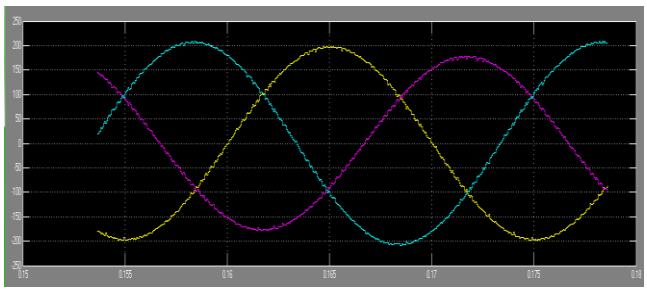

Figure 15: Souce Voltage waveform

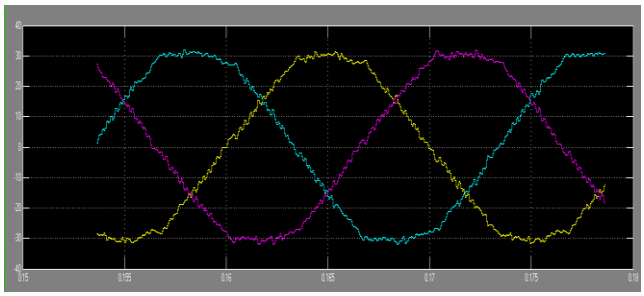

Figure 16: Souce current waveform

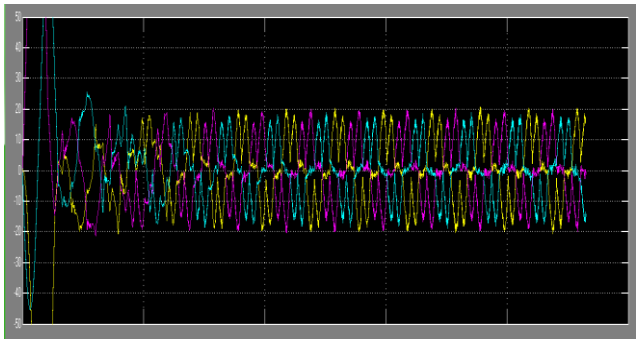

Figure 17: Filter current waveform

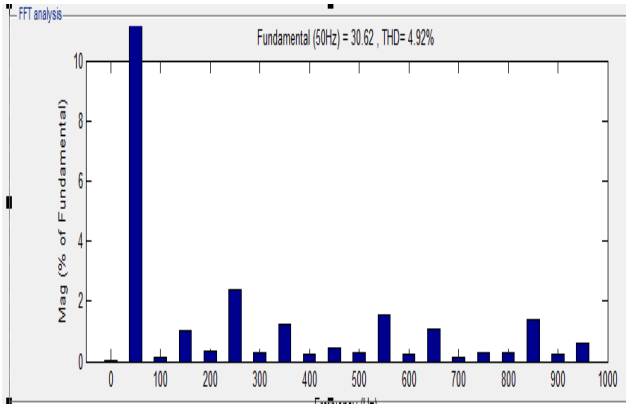

Figure 18: FFT Analysis of Souce Current (THD= 4.92%)

When the source voltage is unbalanced the distortion increases, but since the shunt APF contains positive sequence detector the THD is reduced to 4.92% (figure 18). The simulation results obtained are summarized through table 1 and table 2. As shown in table 1 and 2 the power factor is also improved and is very close to unity due to reduction in harmonics.

Table 1: Simulation Result for Balanced Voltage Condition

Parameter	*Values without Shunt APF*	*Values with Shunt APF*
Is(THD)	18.85%	3.65%
P.f	0.7	0.98

Table 2: Simulation Result for Unbalanced Voltage Condition

Parameter	*Values without Shunt APF*	*Values with Shunt APF*
Is(THD)	18.45%, 20.8%, 17.6%	4.92%
P.f	0.67	0.9

5. Conclusion

This paper presented shunt APF based on SCC algorithm for reducing current harmonics injected by nonlinear RL load under balanced and unbalanced source voltage condition. Shunt APF allows compensation of current harmonics and unbalance along with correction of power factor. SCC algorithm guarantees sinusoidal source current even if the source voltage is unbalance because of the presence of positive sequence detector which extracts the fundamental positive sequence component of input voltage. Therefore even if the voltage at PCC is unbalanced, it will not affect system's performance.

References

[1] Bhim Singh, Kamal Al-Haddad and Ambrish Chandra. "A Review of Active Filters for Power Quality Improvement" IEEE Transaction on industrial electronics,Vol. 46, No. 5, October 1999.
[2] Joao Afonso, Carlos Couto, Julio Martins, "Active Filters with Control Based on the p-q Theory" IEEE Industrial Electronics Society Newsletter vol. 47, nº 3, Sept. 2000, ISSN: 0746-1240, pp. 5-10
[3] Leszek S. Czarnecki, "Instantaneous Reactive Power p-q Theory and Power Properties of Three-Phase Systems" IEEE Transactions on Power Delivery, Vol. 21, No.1, Jan. 2006, pp. 362-367.
[4] H. Akagi, E. Watanabe and M. Aredes, "Instantaneous Power Theory and Applications to Power Conditioning", IEEE Press Series on Power Engineering, 2007.
[5] V. F. Corasaniti, M. B. Barbieri, P. L. Arnera, M. I. Valla "Comparison of Active Filters Topologies in Medium Voltage Distribution Power Systems" Power and Energy Society General Meeting- Conversion and delivery of Electrical Energy in the 21 century, 2008 IEEE.
[6] Gabrio Superti-Furga, Grazia Todeschini, "Discussion on Instantaneous p-q Strategies for Control of Active Filters'', IEEE tansaction on industrial electronics, Vol. 23, No. 4, July 2008.
[7] Reyes S. Herrera, Patricio salmeron, "Instantaneous reactive power theory: A reference in the nonlinear loads compensation" IEEE tansaction on industrial electronics, vol-56, no-6, june 2009.