resulting controller performances are illustrated by Figs.7 to 10. Figs.7-8 show that independently of the load current level, the AC three-phases filter currents track well their references, confirming the theoretical results. The resulting network line current is plotted in Fig. 9, which shows that this current is clearly clean of harmonics, unlike the load current. This is better illustrated by Fig.10 which shows the spectra of the load and net currents. It is seen that the net current is mainly constituted by a single component, situated in 50Hz. The higher frequency harmonics have well been suppressed.

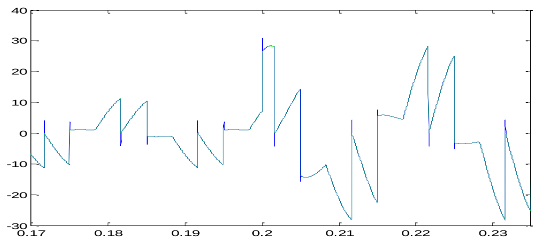

Fig.7: inner-loop tracking performances: $i_{f\alpha}$ current and its reference

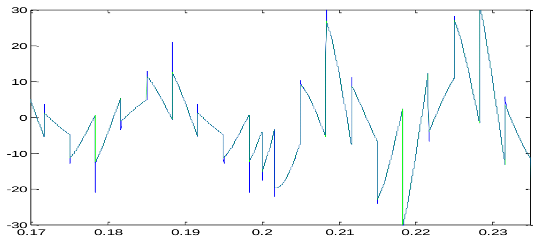

Fig.8: inner-loop tracking performances: $i_{f\beta}$current and its reference

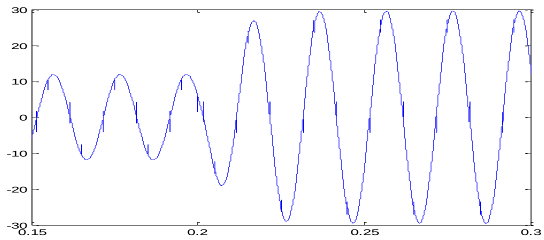

Fig.9: Network current shape with NLM-AC in time domain

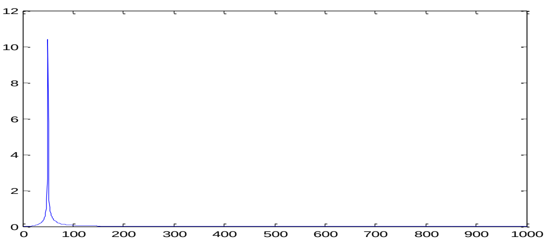

Fig.10: Network current with NLM-AC in frequency domain

5. CONCLUSION

We have considered the problem of controlling three-phase shunt active power filters when the operation conditions are such that the involved coils cannot be characterized by a constant inductance coefficient. This is particularly the case of high power coils operating in the presence of significantly changing conditions e.g. large variations of the converter load. The control objective is to achieve current harmonics and reactive power compensation, as well as tight voltage regulation at the inverter output capacitor. To this end, a new model of the three-phase SAPF is developed that accounts for the nonlinear nature of the coil magnetic characteristics. Using tools from the system averaging analysis theory, it is formally shown that the controller meets its objectives in the mean This formal result is confirmed by several simulations illustrating the performances of the proposed controller.

6. REFERENCES:

[1] Komurcugil, H. (2006) *"A new control strategy for single-phase shunt active power filters using a Lyapunov function"* IEEE Trans. on Industrial Electronics, vol. 53, pp. 305 – 312.

[2] Umamaheswari. M.G., G. Uma, (2013) *"Analysis and design of reduced order linear quadratic regulator control for three phase power factor correction using cuk rectifiers"* Electric Power Systems Research 96,1, 8

[3] Zaveri. N., A. Chudasama, (2012) *"Control strategies for harmonic mitigation and power factor correction using shunt active filter under various source voltage conditions"* International Journal of Electrical Power & Energy Systems, 42, 661–671

[4] Panda A.K., S. Mikkili (2013) "*FLC based shunt active filter (p–q and I_d-I_q) control strategies for mitigation of harmonics with different fuzzy MFs using MATLAB and real-time digital simulator*" international journal of *Electrical* Power and Energy Systems 47 (2013) 313–336

[5] Bin Liu, Ji Ju Wu, Jun Li, Ji Yang Dai (2013) "*A novel PFC controller and selective harmonics suppression*" Electrical Power and Energy Systems 44, pp. 680–687

[6] Mikkili. S., A.K. Panda, (2012), *"Real-time implementation of PI and fuzzy logic controllers based shunt active filter control strategies for power quality improvement"* International Journal of Electrical Power & Energy Systems, 43. 1114–1126

[7] Escobar, G., A.M. Stankovic, and P.Mattavelli, (2004). *"An adaptive controller in stationary reference frame for D-statcom in unbalance operation"* IEEE Trans. Ind. Electron., vol. 51, no. 2, pp. 401–409

[8] Rahmani, S., A.Hamadi, and K.Al-Haddad "A Lyapunov-Function-Based Control for a Three-Phase Shunt Hybrid Active Filter" IEEE Transactions On Industrial Electronics, Vol. 59, No. 3, pages:1418-1429, 2012.

[9] Djerioui, A., K. Aliouane, F. Bouchafaa (2014) "*Sliding mode direct power control strategy of a power quality based on a sliding mode observer*" international journal of Electrical of Power and Energy Systems 56 (2014) 325–331

[10] Krein P.T., J. Bentsman, R.M. Bass, and B. Lesieutre (1990). *"On the use of averaging for analysis of power electronic system"* IEEE Trans. Power Electronics, vol. 5, pp. 182-190.

[11] Tse, C. K. and M. H. L. Chow (2000). *"Theoretical study of switching converters with power factor correction and output regulation"*. IEEE Trans. Circuits & Systems I, vol. 47, pp. 1047–55.

[12] Subrahmanyam, V. (1994) *"Representation of magnetization curves by exponential series"*, IEEE Proceedings, 121, no 7, pp. 707-708.

[13] Leonhard, W. (1996) "*Control of Electrical Drives*", Springer-Verlag, 2nd edition, NY

[14] Ouadi H., F.Giri, A.Elfadili, L.Dugard (2010). *"Induction machine speed control with flux optimization" Control Engineering Practice 18.55-66.*

[15] Levi, E. (1996) *"Main flux saturation modelling in double cage*" IEEE Transactions on Energy Conversion, Vol. 11. No 2, pp. 305-311

[16] Akagi, H., Y.Kanazawa, and A.Nabae, (1984). "*Instantaneous reactive power compensators comprising switching devices without energy storage components"* IEEE Trans. Industry Applications, vol. 20(3), pp. 625-630