Reactive and Harmonics Compensation in a Medium Voltage Distribution Network With Active Filters

V.F.Corasaniti, M.B.Barbieri, P.L.Arnera
IITREE-LAT - Facultad de Ingeniería
Universidad Nacional de La Plata
La Plata, Argentina
Email: fcorasaniti@iitree-unlp.org.ar,
bbarbieri@iitree-unlp.org.ar, pla@iitree-unlp.org.ar

M.I.Valla
LEICI - Facultad de Ingeniería
Universidad Nacional de La Plata and CONICET
La Plata, Argentina
Email: m.i.valla@ieee.org

***Abstract*— This paper presents the design of a shunt active filter to compensate reactive power and harmonics in the medium voltage level of a power distribution system. Reconfiguration of the power delivery network imposes new constraints in a distribution substation so that the reactive compensation should be increased. The alternative of shunt active filter compensation connected to the 13.8 kV level is analyzed. Two alternatives are proposed, the first one considers full compensation with the active filter while the second one uses the existing capacitor bank and builds the complementary compensation with the active filter. In the last case, the capacitor bank is modified to make a 5th harmonic filter to avoid system resonances. Both proposals show very good performance.**

I. INTRODUCTION

The increase of non-linear loads and equipments in the power systems has been demanding the compensation of disturbances caused by them. Voltage distortion, due to current harmonics, has become a major problem for the utilities at distribution levels. Utilities frequently encounter harmonic related problems, such as higher transformers and line losses, reactive power, and resonance problems, de-rating of distribution equipment, harmonic interactions between the utility and loads, reduced system stability and reduced safe operating margins [1] [2].

The use of traditional compensation with capacitor banks and passive filters gives rise to harmonic propagation. That is harmonic voltage amplification due to resonance between line inductances and shunt capacitors. So, alternative active solutions have been continuously analyzed in the last years. One of the most popular topologies employed in harmonic compensation is Shunt Active Power Filter (SAPF) [2] [3]. It basically functions as a harmonic current generator feeding the needed harmonics and/or reactive currents at a certain point of the network. Several control strategies have been proposed for the SAPF, being those based on the generalized theory of the instantaneous reactive power the most popular [4-6].

The particular problem of a power distribution network is considered in this paper. Reconfiguration of the network imposes new constraints in different distribution substations (DS). Harmonic studies were performed considering the future configuration of the network. Voltage distortions in different points of the network and the working conditions of the capacitor banks were verified by means of harmonic flows [7]. A preliminary proposal suggested increasing the existing passive compensation with capacitor banks from 3 MVAr to 6 MVAr, but this solution introduced resonances near the 5th and 7th harmonics resulting in unacceptable distortion levels. So, the alternative of an active compensation is proposed here.

The paper is organized as follows. The network configuration and the harmonic problems are described in section II. The shunt active power filter is analyzed in section III. Section IV presents two compensation alternatives. Finally conclusions are drawn in Section V.

II. NETWORK DESCRIPTION

Fig. 1 shows a map of the transmission network of the electric distribution utility. The 132 kV network, where the DS under study are connected, works meshed and connected to the 500 kV high voltage transmission system through two points. In the future, it will be necessary to work in a radial network only connected to one 500 kV point of the system. The requirement to enhance the voltage profile at 132 kV level demands for new compensation in the different substations [7].

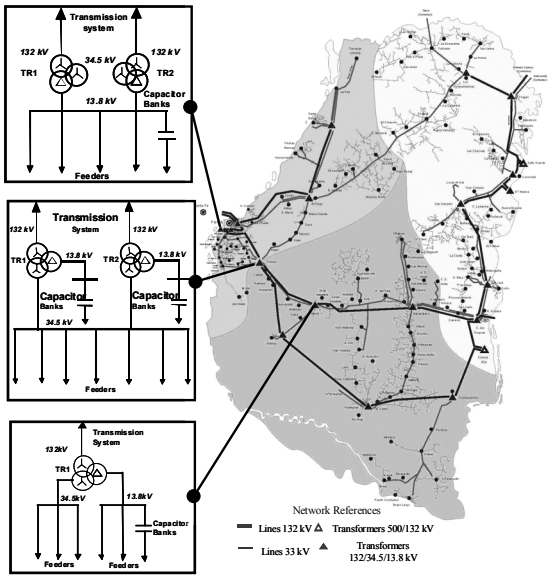

Fig. 1. Electric distribution utility power network.