A Power System Connected Fuel Cell Based On Instantaneous P-Q Theory

Rachid. Dehini
University of Bechar , Algeria,
Department of Electrical Engineering, Faculty of Technology,Postal address1, B.P 417 Bechar, Algeria, E-Mail1: dehini_ra@yahoo.fr
Berbaoui Brahim
Centre de Developpement des Energies Renouvelables, Unité de Recherche en Energies Renouvelables en Milieu Saharien, Adrar, Algiers, b_berbaoui@yahoo.fr, ORCID: https://orcid.org/0000-0003-1655-9768

***Abstract* – A leading factor in the evolutionary change of fuel cells is the need to reduce green house gas emissions (especially CO2), less polluting means of energy production are searched, such as fuel cells that are highly energy efficient. The Proton-exchange membrane Fuel cells (PEM) are more and more involved in various applications, the primary objective of this work is to present the uses of (PEM) in supplying the active compensator. The use of instantaneous p-q theory as a control system of the inverter results the multi-operation inverter, such as harmonic elimination, reactive power control and uninterruptible power supply will be achieved. The system consisting of Fuel cells, connected to a diode rectifier feeding a parallel active power filter. The simulation results prove the efficiency of using the proposed method for power quality improvement and Feed-in of Fuel cells -generated electricity into the public grid.**

Keywords – PEMFC cells energy, voltage source inverter, , PAPF, current harmonics, p-q theory.

I. INTRODUCTION

Energy and fuel exigency is rapidly increasing with time, and the fossil fuel time is getting missing. At the same time energy cost is also continuously rising. So as to overcome these anxieties we can use renewable resources at our disposal from which energy can be tapped; a fuel cell converts chemical energy to direct electric energy [1]. This alternative source is the clean energy, without any harmful emissions to the environment, and has high power density [2]. One of the most popular fuel cell is the Proton Exchange Membrane (PEM).it has been researched and developed, that they have gradually been recognized to work in a comparatively high efficiency and low temperature condition [3-4-5].

The harmonics injected by the non-linear loads have several impacts on the utilities grid and loads connected to system [6]. To solve these power quality problems, Parallel active power filter (PAPF) is extensively used in the system. This device is a power converter utilized to compensate current disturbances (harmonics, reactive power and unbalance) [7].Several topologies have been introduced in the literature and in commercial implementations for this filter that highlight different aspects of its compensation tasks. The most common topology of the shunt active power filter is shown in fig. 1. Its main components are voltage source inverter, DC bus (in our situation is a capacitor or fuel cell), output passive filter and a control system. The most important objective of the PAPF is to compensate the current harmonics generated by non linear loads. The reference currents consist of the harmonic components of the load currents which the active filter must supply [8-9]. These reference currents are fed through a controller to generate switching signals for the power switching devices of the voltage source inverter (VSI). Finally, the AC supply will only need to provide the fundamental component for the non linear load.

In this paper, the analysis are focused on the system configuration with a direct coupling between the (PEM) fuel cells and the shunt active power filter employed to inject the fuel cell power into the utility grid under fixed fuel cells power conditions. The proposed design is not only able of delivering the chemical power to the grid, but will also act as a parallel active power filter (PAPF) to mitigate the current harmonics and regulate reactive power injected by the non-linear loads. In order to reduce the impact of harmonic currents and strengthen the overall capacity of the proposed system ; a 100KW fuel cells power with shunt active power filter connected to a three-phase power grid feeding non-linear load was simulated in MATLAB / SIMULINK environment.

II. PEM FUEL CELL GENERATOR MODELING

Electrical energy needs are still increasing over these last years but production constraints like pollution and global warming lead to development of renewable energy sources, particularly chemical energy. Fuel cells (FCs) are static energy conversion devices that convert the chemical energy of fuel