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# Simulation of Fuel Cell in Power System and Study For Electric Vehicles

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***Abstract*** *– Now a days, maximum industrial devices are mainly supported electronic devices like programmable logic controllers and electronic drives. The electronic devices are really sensitive to disturbances and subsided tolerant to power quality problems like voltage sags, swells and harmonics problems . Voltage dips are thought of to be one in each of the foremost severe disturbances to the industrial equipments. Another power electronic resolution to the voltage regulation is that the use of a dynamic voltage restorer m(DVR). DVRs are a class of custom power devices for providing reliabledistribution power quality. Power Quality problems comes as an outsized vary of disturbances like voltage sags/swells, flicker, harmonics distortion, impulse transient, and interruptions.*

***Keywords:*** **electric vehicle; Power system of vehicle; Fuel cell vehicle; Solar vehicle**

## I. INTRODUCTION

In current scenario , industrial devices are mainly based on electronic devices like programmable logic controllers, scada and electronic drives for getting the target. The electronic devices are very sensitive to disturbances and subsided tolerant to power quality problems like voltage sags, swells and harmonics. Voltage dips are thought of to be one in each of the foremost severe disturbances to the industrial equipments [1].

**Power Quality Problems**

Power distribution systems, ideally, have to be compelled to provide their customers with associate uninterrupted flow of energy at smooth sinusoidal voltage at the narrowed magnitude level and required frequency however.

The power disturbances occur on all electrical systems, the sensitivity of today’s refined electronic devices makes them lots of risk of the quality of power provide. for some sensitive devices, in a brief disturbance can cause disorganized knowledge, interrupted communications, a frozen mouse, system crashes and failure etc. an influence voltage spike can damage valuable components. Power Quality problems embody an outsized vary of disturbances just like voltage sags/swells, flicker, harmonics distortion, impulse transient, and interruptions.

**Voltage dip:** A voltage dip is utilized to raise short reduction in voltage of lessthan half a second.

**Voltage sag:** Voltage sags can occur at any instant of it slow, with amplitudes ranging from 10 – 90th and period lasts for half a cycle to 1 minute.

**Voltage swell:** Voltage swell is made public as an increase in rms voltage or current at the power frequency for durations from 0.5 cycles to 1 min.

**Voltage 'spikes', 'impulses' or 'surges':** These are terms accustomed describing abrupt, very temporary can increase in voltage value.

**Voltage transients:** they are temporary, undesirable voltages that appear on the power supply line. Transients are high over-voltage disturbances (up to 20KV) that last for a very short time.

**Flickers:** Visual irritation and introduction of the numerous harmonic components at intervals the supply power and their associated sick effects.

## II .THEORY OF FUEL CELL

### FUEL CELL

A fuel cell is an electrochemical device that produces electric power in the form of D.C by converting chemical energy present in the fuel . A fuel cell is a device that generates electricity by a chemical reaction. Every fuel cell has two electrodes called, respectively, the anode and cathode. The reactions that produce electricity take place at the electrodes

Every fuel cell also has an electrolyte, which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes.

Hydrogen is the basic fuel, but fuel cells also require oxygen. One great appeal of fuel cells is that they generate electricity with very little pollution–much of the hydrogen and oxygen used in generating electricity ultimately combine to form a harmless byproduct, namely water. One detail of terminology: a single fuel cell generates a tiny amount of direct current (DC) electricity. In practice, many fuel cells are usually assembled into a stack. Cell or stack, the principles are the same.

## III. METHOD

### SYSTEM MODELING

The whole system is developed with the help of MATLAB software. In this system we are using fuel cell as a STATCOM in power system . Figure 4.1 shows the Simulink model of 150 km long transmission line with fuel cell. The major component of the model are fuel cell, power grid and three phase load. The main purpose of the fuel cell is to improve the transient response of the system.

### MODELING OF FUEL CELL

For fuel cells, the electrochemical process starts on anode side. At the anode side, flowplate channels gets $H_2$ molecules. Catalyst in anode separates hydrogen on protons H+ through membrane that proton travel to cathode and over external electrical circuit the electrons that travel to cathode. By using of catalyst at the cathode, oxygen is correlate with hydrogen protons and electrons for formation of $H_2O$ and heat.

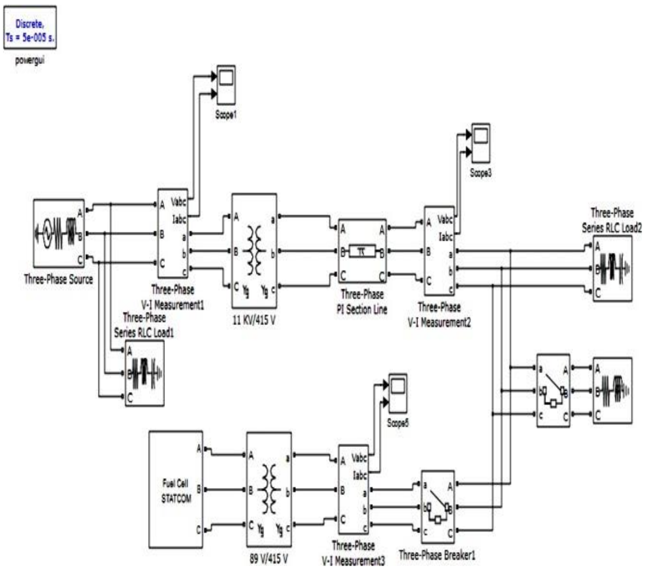
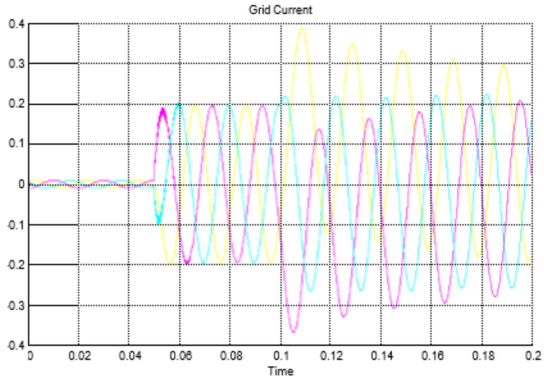



Figure 1 Simulink Model Of Fuel Cell Based Statcom

Electron-proton chemical bonds formation and breaking are the result by Cathode and anode




activation losses, at zero current through membrane hydrogen proton migration is caused by the parasitic electrochemical reactions. Te fuel cell voltage drop is expressed as:

$$V_{act} = V_0 + V_a\left[1 - e^{-c_1 i}\right] \qquad 4.5$$

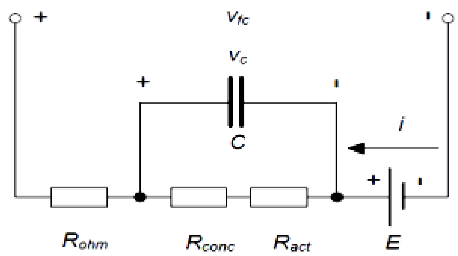



Figure 2 Fuel cell equivalent electrical circuit diagram

So from the equivalent circuit

$$V_{fc} = E - V_c - iR_{ohm}$$

Figure 3 shows the Simulink model of the PEMFC used for makingfuel cell STATCOM. As shown we used 8 PEMFC of rating 6 kW, 45 Vdc to form fuel cell.

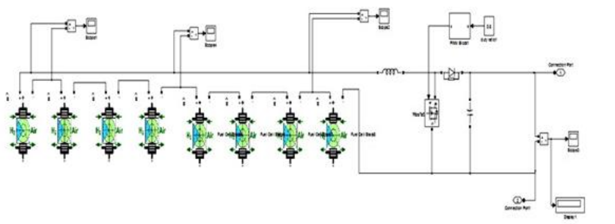
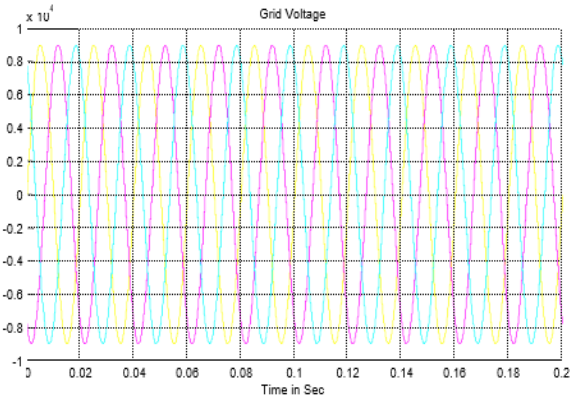


Figure 4 MATLAB Simulink model of Fuel Cell Stack

## IV. RESULT

The result generated by the used model. Figure 4 shows the grid voltage. we can see that the grid produce constant voltage.



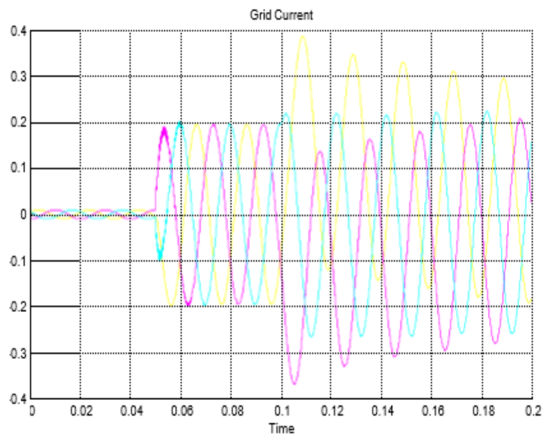




Figure 4 Grid Voltage of the power

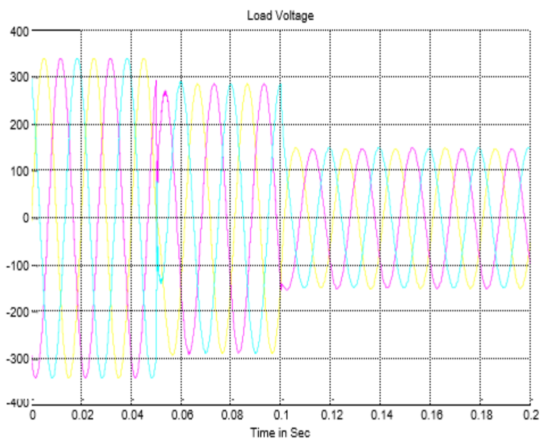



Figure 5 Result generated at Load side voltage

From the figure 5 shows that the voltage having flicker due to load variation at time t=0.05s after connecting of fuel cell the voltage get stabilized at t=0.1s. Hence here fuel cell works as STATCOM. The main role of the STATCOMEis to stabilize the voltage.

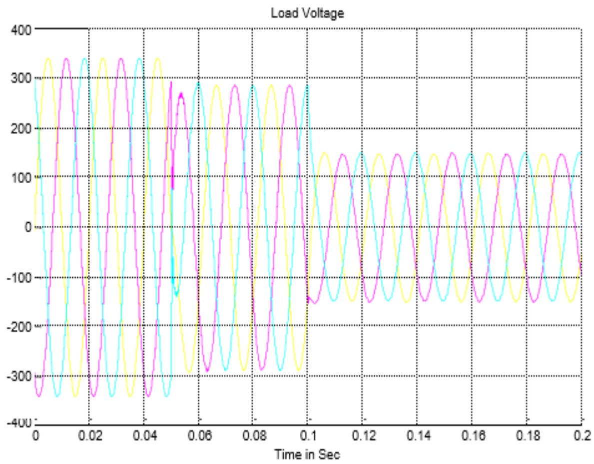



Figure 6 Result generated at Load side current

From the figure 6 shows that the voltage having flicker due to load variation at time t=0.05s after connecting of fuel cell the voltage get stabilized at t=0.1s. Hence here fuel cell works as STATCOM. The main role of the STATCOMEis to stabilize the voltage

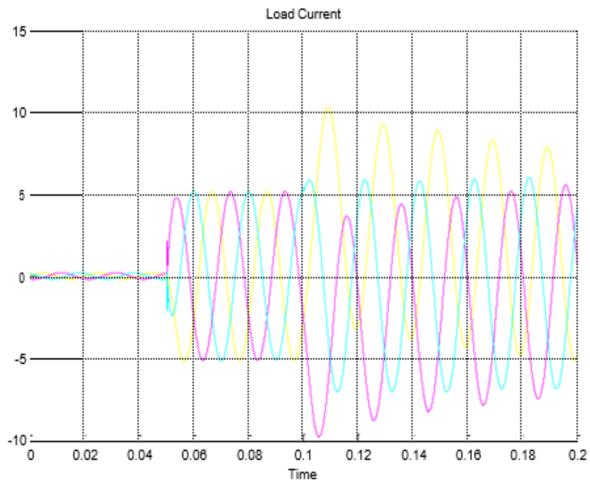



Figure 7 Result generated at Load side current

From the figure 7 the current profile is also change. At t=0.05 the load is sudden connect to the system so the current build up which get stabilize after connection of fuel cell at t=0.1.

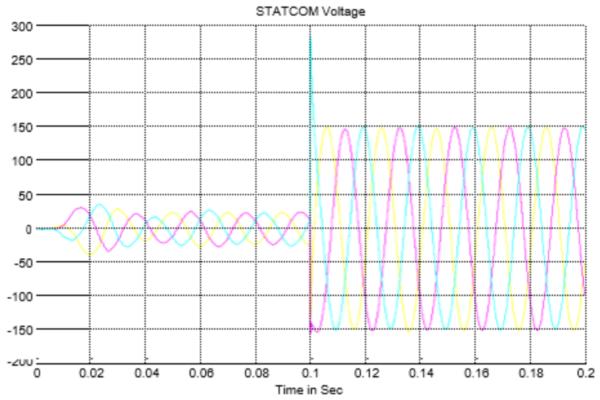



Figure 8 Result of STATCOM voltage at load side

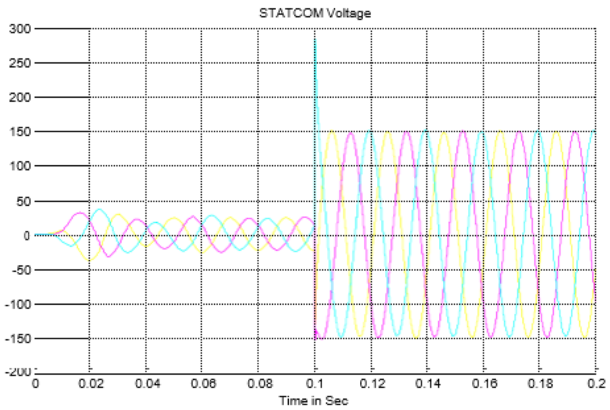



Figure 9 Result of STATCOM Current at load side

From the figure 5.5 and 5.6 it is clear shows that the output voltage and current of the STATCOM at the load side to compensate the voltage and current at load side.

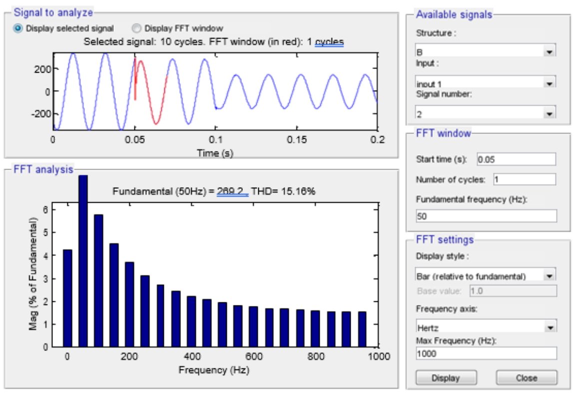



Figure 10 FFT analysis of the load side voltage at t=0.05 without STATCOM

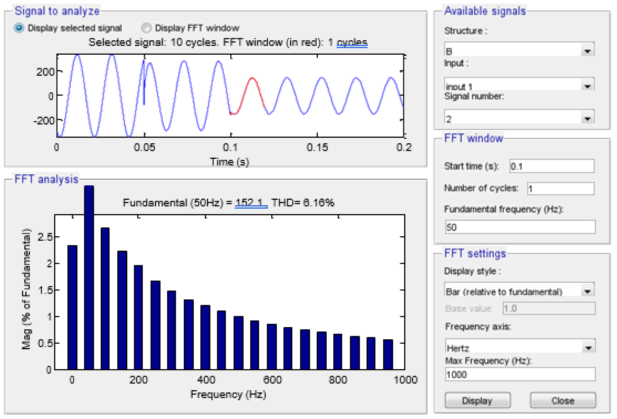



Figure 11 FFT analysis of the load side at t=0.1 with STATCOM

above shows that THD of the system is reduced by implementation of the STATCOM in power network.

## V. CONCLUSION

As per our result we get that the use of fuel cell is very useful in power system.fueled cars have some advantages over EVs. They can run for 300 miles, and fueling up takes 10 minutes. EVs can go about 200 miles, take 45 minutes. EVs not work properly in cold weather.Disadvantages of fuel cellDue the high cost of catalysts (platinum) Lack of infrastructure to support the distribution of hydrogen. A lot of the currently available fuel cell technology is in the prototype stage and not yet validated

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