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THE COMPARATIVE STUDY OF STATCOM WITH FC-TCR AND SSSC

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Abstract:
The Flexible Alternating Current Transmission Systems (FACTS) device deals with the control of power flow, alternating current of transmission line and immediately respond towards the stability problems of the system. The present paper show that how the FACTS devices enhance the different parameter of the power systems like power transfer capacity of line, system stability etc. In MATLAB a simplified transmission system is modeled and the resultant power (PQ) and voltage profiles are studied as an uncompensated system. Now the same transmission system is simulating with FACTS device i.e. Static Synchronous Series Compensator (SSSC), Fixed Capacitor Thyristor Controlled Reactor (FC-TCR) and Static Synchronous Compensator (STATCOM). The result obtained after simulation provide the power and voltage profiles, are analyzed as a compensated system. Finally we found that a compensated system have better voltage profile and power flow w.r.t. an uncompensated system.

Keywords:
Flexible AC Transmission Systems (FACTS), STATCOM, FC-TCR, SSSC, Voltage Stability, Active and Reactive power.

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1. INTRODUCTION

A well-designed power system gives a good quality of reliable supply. In present the power systems have large, interconnected hundreds of generators and thousands of buses.

To meet increases load demand a new power system is added and this system has new generating station, transmission line, distribution system, which affect economically as well as environmentally and also take duration of long time. This decreases the security of power system as well as reduces power quality of the system.

When the on load system is faulted, reactive power increases sharply than the problem of voltage instability starts and it causes voltage collapse. This situation comes when system voltage become down to a level from which it can't be recover. This voltage collapse interrupts power system either partial or full and voltage instability gives a variation in reactive power demand.
The Flexible Alternating Current Transmission Systems technology or shunt capacitor is placed at appropriate locations in the system compulsory to alleviate some but not all of these difficulties.

These technologies have property of controlling power and enhancing the capacity of present power system. The advantages of apply FACTS are improvement in load ability and line capacity of the system, increment in power flow capability through the transmission line, less active and reactive power loss, voltage and power profile improvement, power quality improvement, voltage regulation and efficiency of power system operation improvement, voltage stability and security improvement, steady state power flow improvement, loss minimization, dynamic and transient stability improvement, voltage margin improvement.

FACTS device is static equipment used for the AC transmission of electrical energy. It means to enhance controllability and increase power transfer capability. Generally it is power electronics based device. The FACTS devices can be divided in following groups, dependent on their switching technology: mechanically switched, thyristor switched. While the phase shifting transformer (PST) and the static VAR compensator (SVC) are well known and already used in power systems, power electronics research and control have extended the application range of FACTS.

Fixed Capacitor Thyristor Controlled Reactor (FC-TCR) –

A thyristor based SVCs has a FC-TCR as a main part. Although it can be used alone, it is more after employed in conjunction with fixed capacitors to provide fast, continuous control of reactive power over the entire range. A thyristor switched capacitor scheme of a capacitor bank split up into appropriate sized units each of which is switched on or off using thyristor switches. Each single phase unit consists of a capacitor in series with bidirectional thyristor switch and small inductor. The purpose of inductor is:-

- To limit switching transients
- To prevent resonance
- To dump inrush current

Static Synchronous Series Compensator (SSSC) –

This device has a voltage source converter serially connected to a transmission line through a transformer. A SSSC is capable to communicative exchange active and reactive power with the transmission system. For reactive power compensation the controllable parameter is voltage and voltage vector forms 90º degrees with the line intensity. Now here the line current leads the injected voltage.

In static synchronous series compensation the inductive reactance of a line is compensates with a capacitor is connected in series with the transmission line and these is based on Voltage Source Converter. This device has better power flow and handling capacity, and also good transient stability.

Static synchronous compensator (STATCOM) –

GTO based shunt connected FACTS device represents a STACOM. It works as a static synchronous generator which can inject lagging or leading VAR into the system and compensate.

The advantage of STATCOM is that it has no rotating parts, so its response is very fast, no problem as loss of synchronism and less maintenance. Voltage conversion is done by the voltage source converter using GTO. The converter supplies lagging VAR to the transmission line when the output of VSC is more than the line voltage and absorbs lagging VAR from the system if line voltage is more than then converter. If both the voltages are equal the STATCOM neither supplies nor absorbs the reactive power. This condition of the STATCOM is known as floating condition.

The STATCOM is generally used with a system has poor power factor and poor voltage regulation.

2. METHODOLOGY

A simple circuit of power system is simulated in MATLAB with and without FACTS device.

Input Data –

Source impedance = $0.01 + j0.001\ \Omega$

Line impedance = $10 + j0.028\ \Omega$

Load = 30 MW

Inductor (L) = 150 mH

The simulation can be done with different values of capacitor to check the performance of the device. The simulation diagram with or without FACT device can be shown below:

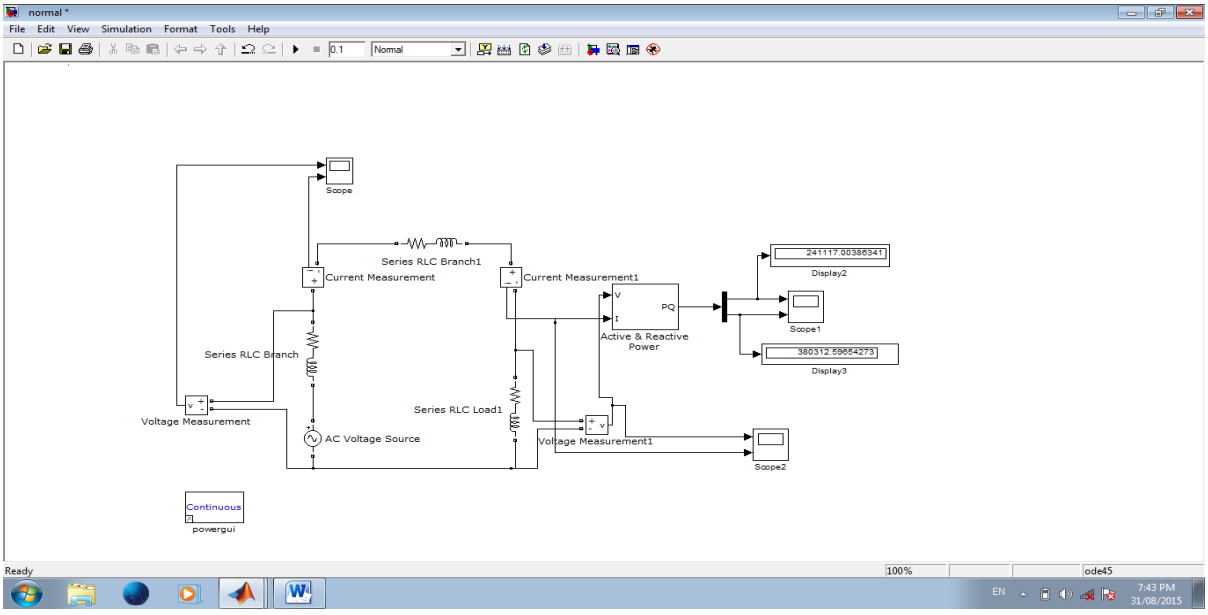

Figure 1: Without FACT device

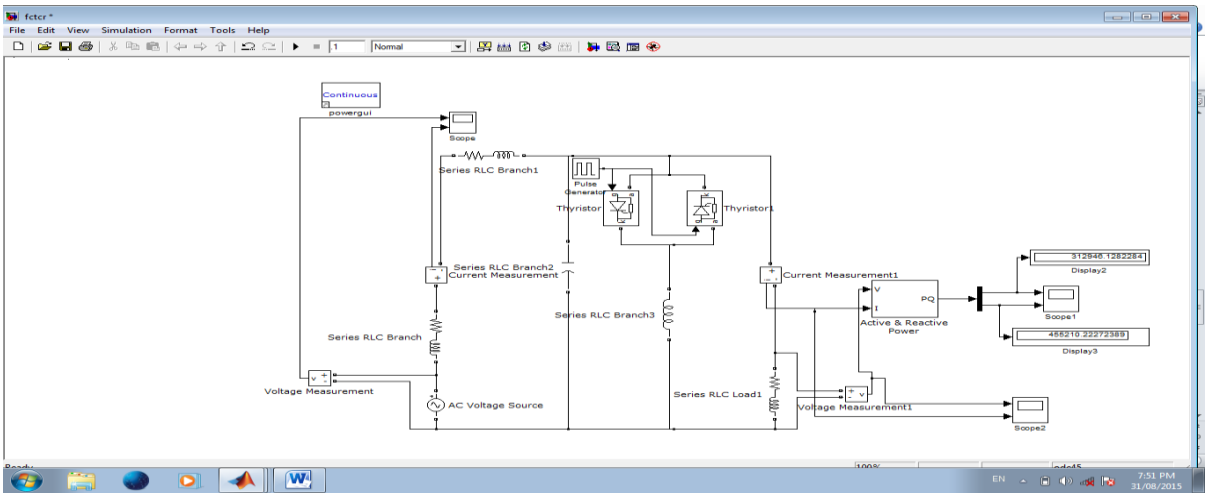

Figure 2: With FC-TCR

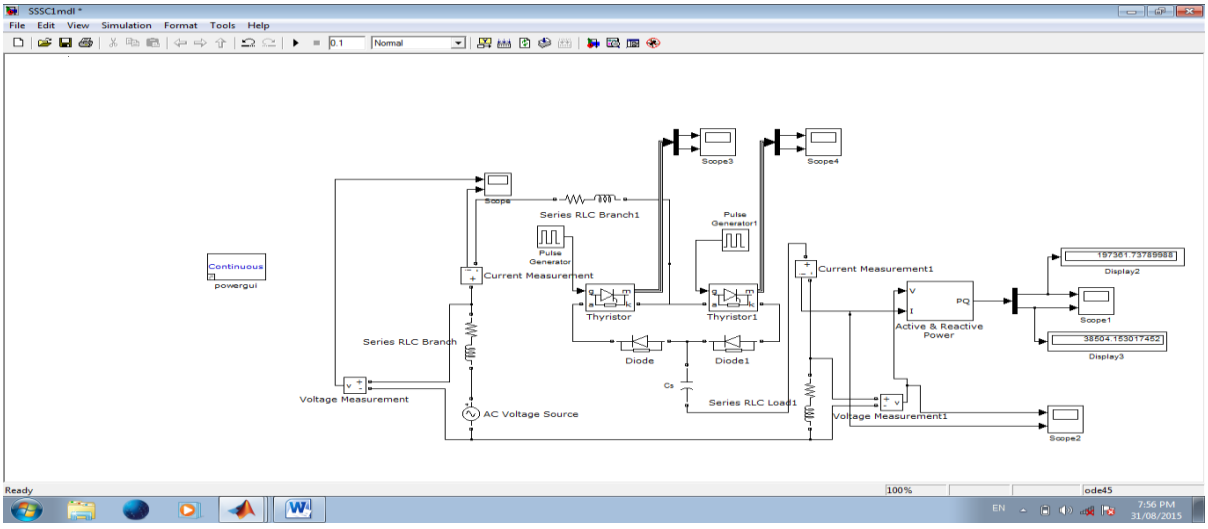

Figure 3: With SSSC

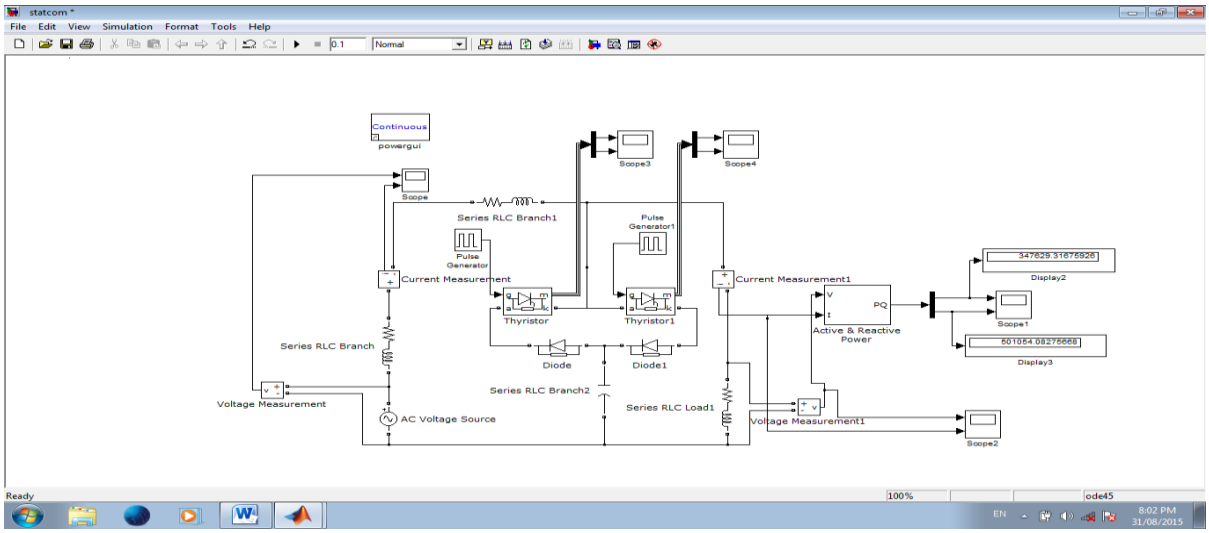

Figure 4: With STATCOM

3. RESULTS

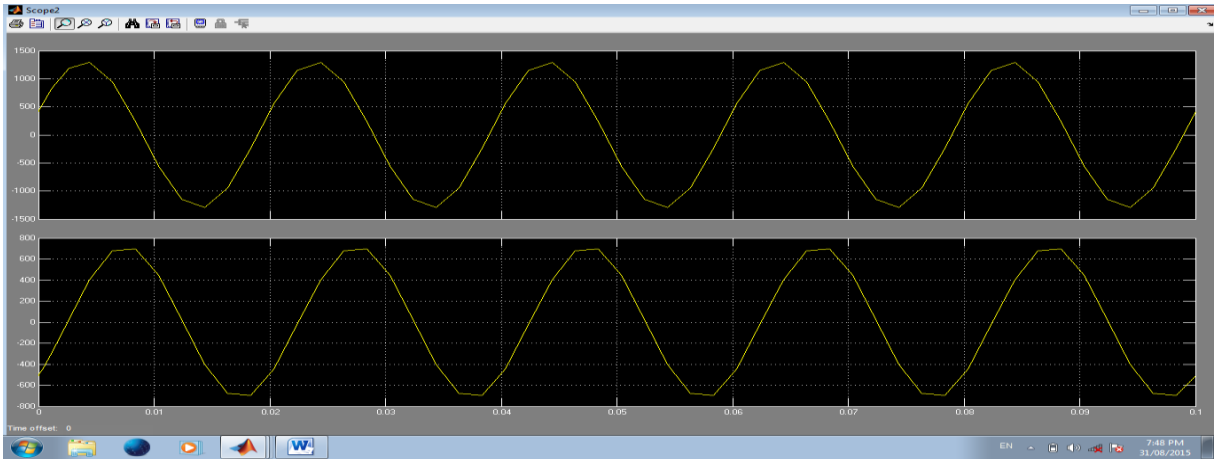

Figure 5: Output Voltage and Current (Without FACT device)

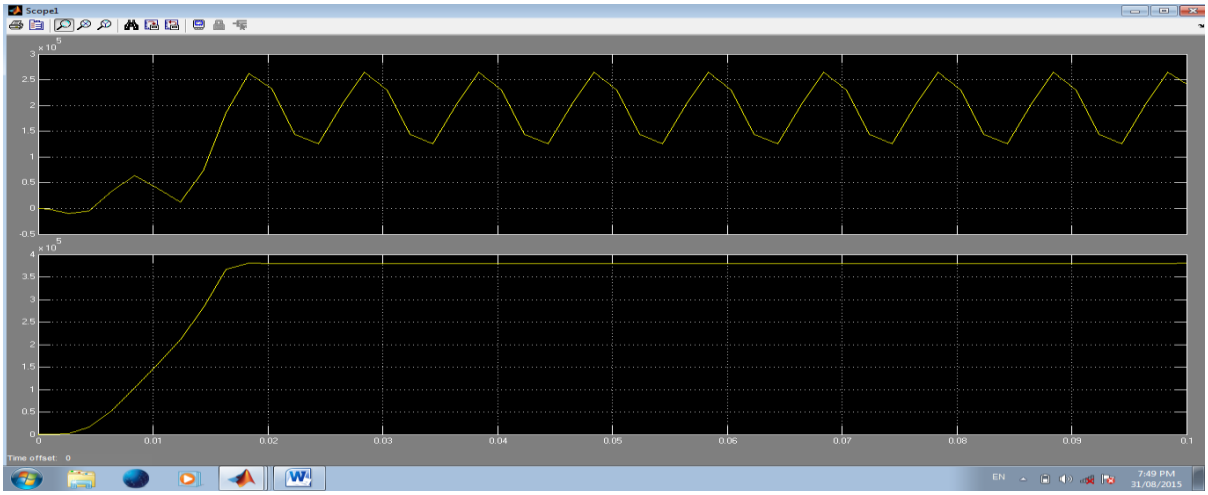

Figure 6: Active and Reactive Power (Without FACT device)

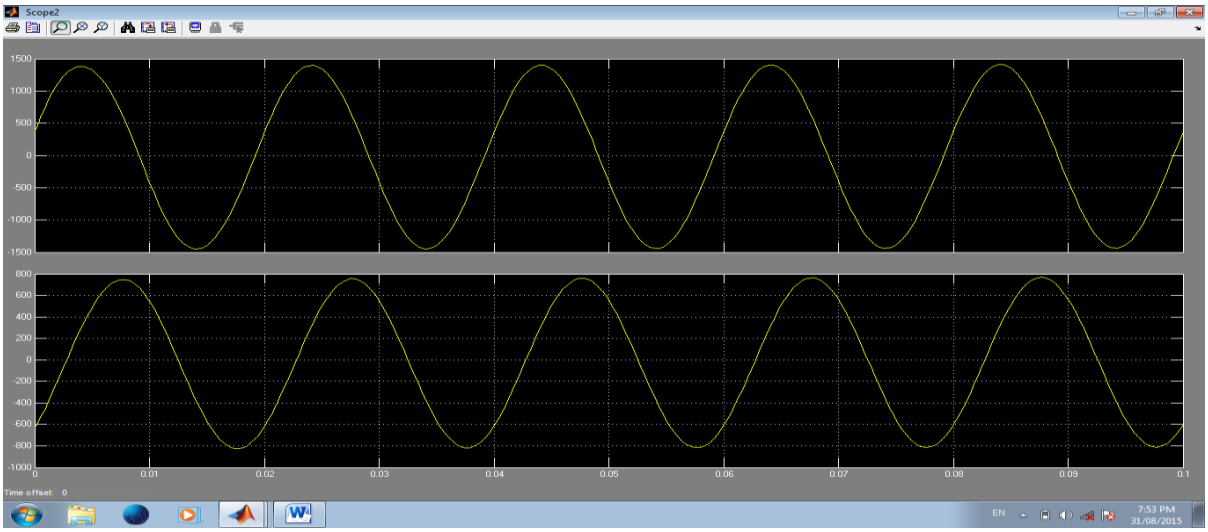

Figure 7: Output Voltage and Current (With FC-TCR)

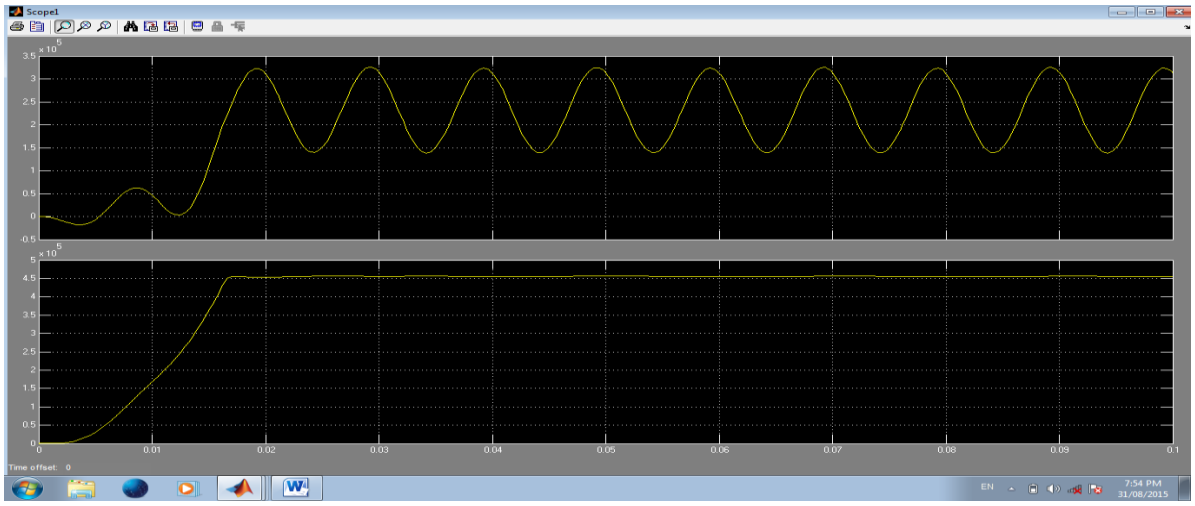

Figure 8: Active and Reactive Power (With FC-TCR)

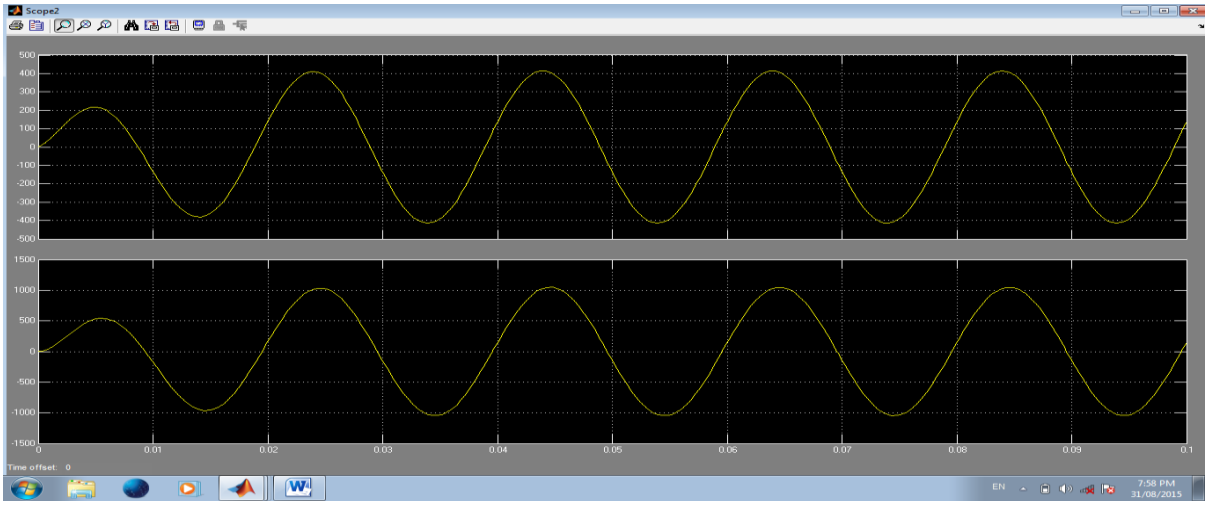

Figure 9: Output Voltage and Current (With SSSC)

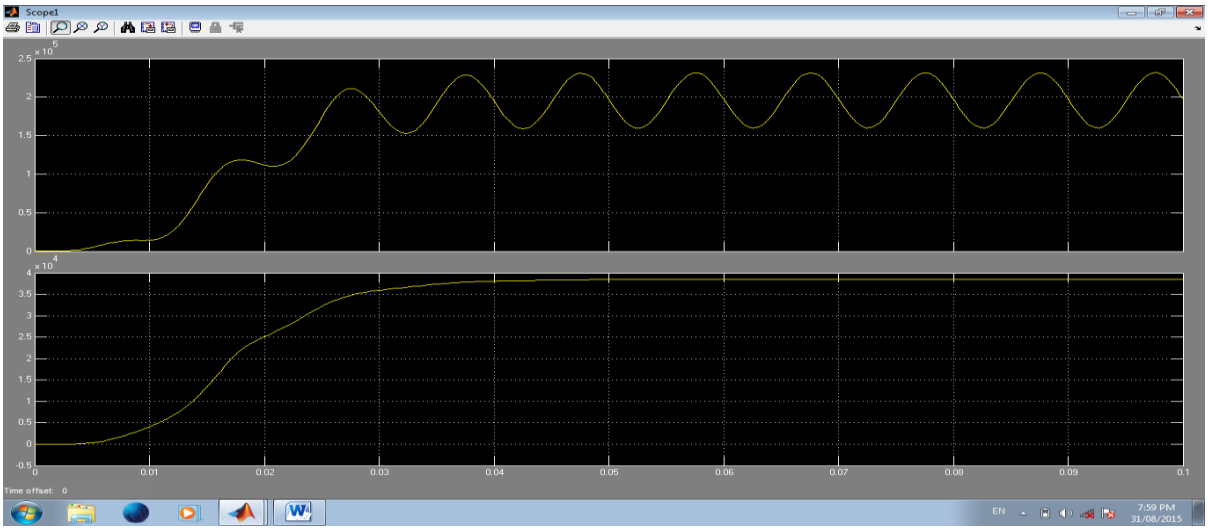

Figure 10: Active and Reactive Power (With SSSC)

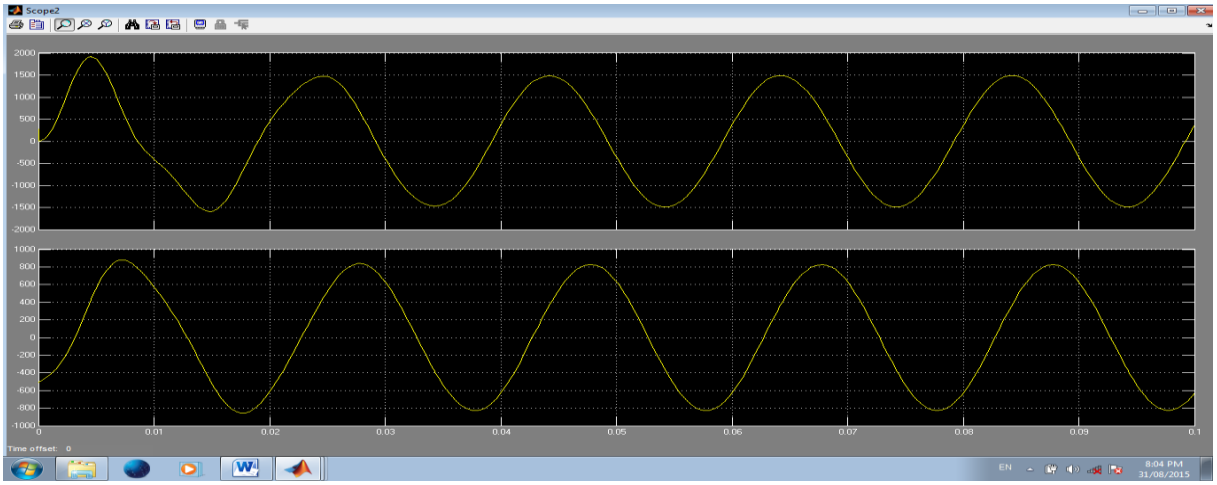

Figure 11: Output Voltage and Current (With STATCOM)

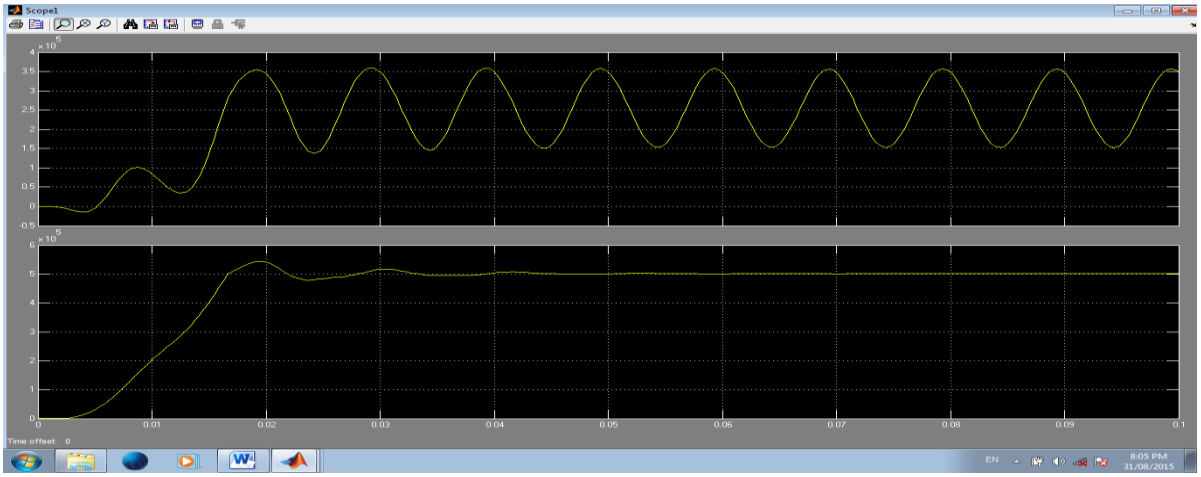

Figure 12: Active and Reactive Power (With STATCOM)

Comparative table with different values of capacitance:-

With 300μF Capacitance		
FACT Device	**MW**	**MVAR**
SSSC	0.211	0.039
FC-TCR	0.312	0.455
STATCOM	0.347	0.501
With 700μF Capacitance		
FACT Device	**MW**	**MVAR**
SSSC	0.194	0.032
FC-TCR	0.477	0.674
STATCOM	0.523	0.748
With 1100μF Capacitance		
FACT Device	**MW**	**MVAR**
SSSC	0.172	0.028
FC-TCR	0.719	1.01
STATCOM	0.784	1.12

4. CONCLUSIONS

From the above experiment we conclude that the FACTS device improve the performance of power system. The FACT device STATCOM provides best result among the FC-TCR, SSSC. The value of capacitance enhances the output result at a certain limit.

5. ACKNOWLEDGMENT

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