Improvement of Power Quality with the Use of FACTS Devices

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Abstract*: The research examines the use of Flexible AC Transmission System devices to address problems with power quality. The use of SVC, STATCOM and UPFC as part of FACTS helps manage power flow, adjust voltage levels and address difficulties caused by transients, harmonics and voltage sags. By connecting the two systems, their stability, usefulness and reliability are greatly improved. Today's networks benefit from FACTS solutions which bring together renewable energy and handle increasing demand while providing consistent and reliable performance.*

Keywords*: Capacitor, Thyristor Controlled Series, Thyristor Controlled Reactor, MATLAB/Simulink, Facts Controller*

I. Introduction

Maintaining a high-power quality in today's power systems helps ensure both that the grid stays steady and that electrical devices perform properly. Voltage sags, swells, flickers, harmonic distortion and interruptions can all damage delicate industrial systems, cause equipment breakdowns and result in big losses for companies. With more energy needing to be supplied and an increase in renewable energy and because systems are growing more intricate, supplying stable and high-quality power is now a bigger challenge.

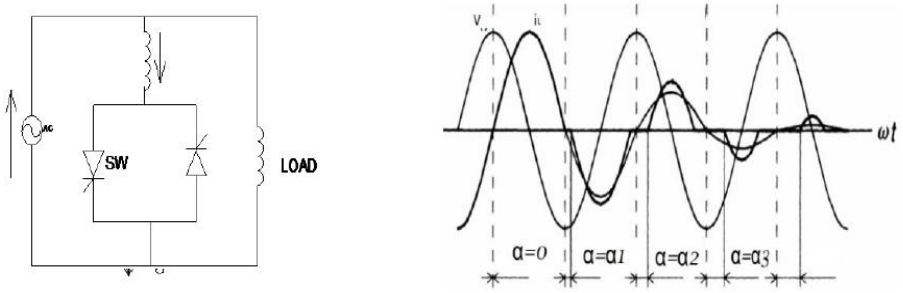

Fig 1: Basic Thyristor-controlled reactor (TCR) firing Delay Angle Control and operating waveform

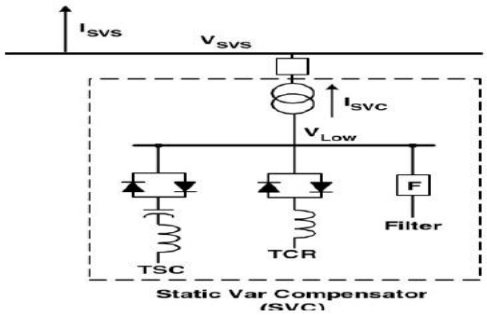

Fig 2: Basic configuration static var compensator

Today, flexible AC Transmission Systems are implemented to handle these challenges. Thanks to FACTS, it is simpler to control the transmission of AC electricity and boost the capacity of grids. To increase voltage stability, decrease losses during transmission and prevent power disturbances, text power systems use the Unified Power Flow Controller, Static VAR Compensator and Static Synchronous Compensator. The ways that FACTS devices help to improve power quality are investigated in this research. This information demonstrates how using these technologies strengthens, improves and boosts the effectiveness of power system infrastructure.

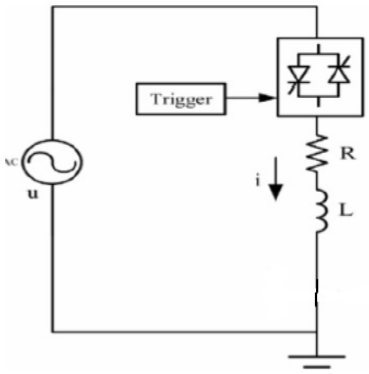

Fig 3: Basic structure of TCR

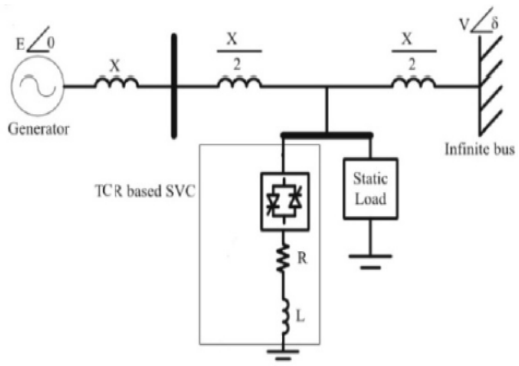

Fig 4: SMIB system with a TCR based SVC

A Thyristor Controlled Series Capacitor, a FACTS device, controls power flow stability and impedance by being connected in series with a transmission line. The main part of the system is a thyristor-controlled reactor that alternates a group of capacitors in series. Thyristor firing angles and the total capacitive reactance of the TCSC can both modify TCR reactance. The dynamic control offered by TCSC enables more power to be moved safely and improves transmission performance and stability by reducing oscillations and sub-synchronous resonance.

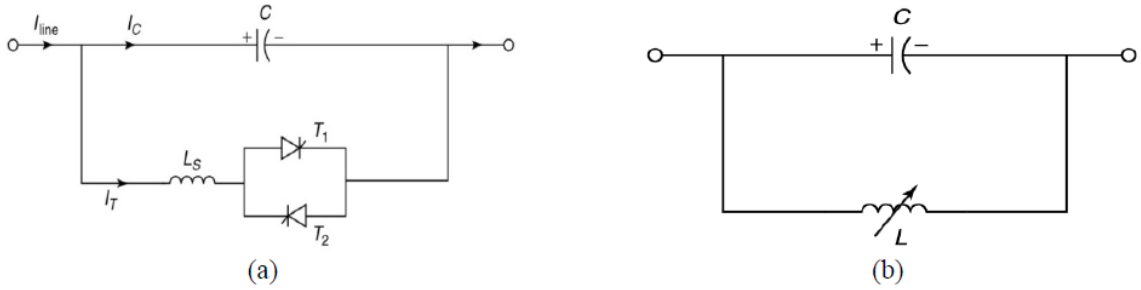

Fig 5: TCSC Module (a) Basic module and (b) A Variable inductor connected in shunt with FC

II. Simulation Results

Mostly applied in power systems to help control and balance reactive power, the Shunt Connected Thyristor Controlled Reactor is a fundamental component of the Flexible AC Transmission System. Two anti-parallel thyristors make up the TCR, which runs a reactor linked in parallel to the system. Thyristor firing angle variation in the circuit alters the reactive power picked up from the system.

Usually, most simulation applications including MATLAB/Simulink and PSCAD model TCRs by using appropriate switches and a reactor. The intended reactive power is obtained by varying the thyristor gating signals with a firing angle controller and following the system voltage with a phase-locked loop.

One can investigate the behavior of the TCR in several load conditions and disturbances thanks to the simulation. It shows that the TCR can quickly solve reactive power imbalances, lowers voltage fluctuations, and supports constant voltage. Design and optimization of power system operations as well as monitoring the real-time FACTS device performance depend on the model.

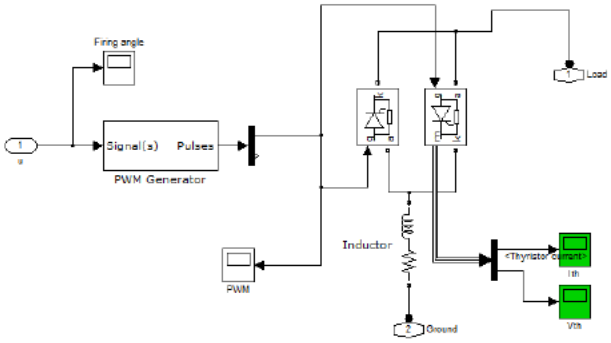

Fig 6: Design Model of TCR

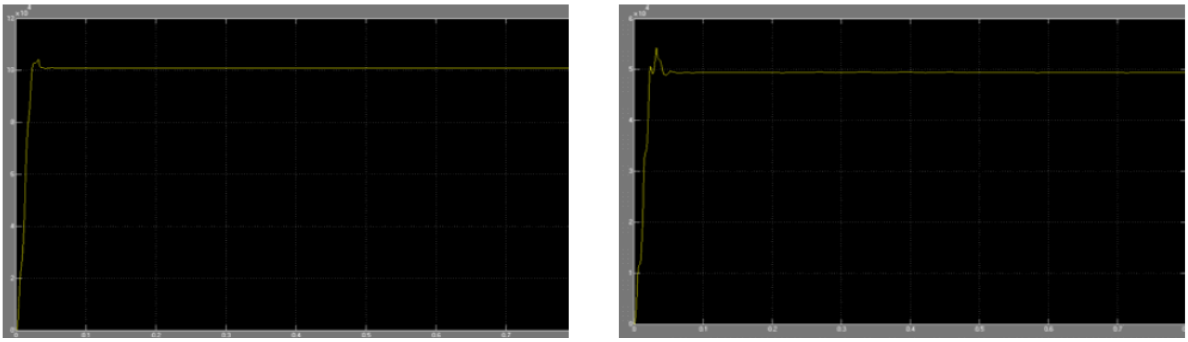

Fig 7: Load Power in RMS

III. Conclusion

Simply put, FACTS technologies are needed to improve the reliability and quality of electricity in today's electrical systems. With SVC, STATCOM and TCSC, these devices can supply reactive power, control voltage levels in real-time and monitor the correct flow of power. Because of these devices, the system is more reliable when it meets problems like sags, harmonics and power instability. With FACTS devices, you can still keep power quality steady even as power networks adjust to new demands and the use of renewables. More use of these technologies will improve the dependability, effectiveness and lifespan of power systems.

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