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Reactive Power Control Using FC -TSR - TCR

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Abstract: This paper deals with the simulation of fixed capacitor Thyristor switched Reactor Thyristor controlled reactor (FC-TSR-TCR) system. The FC-TSR-TCR system is simulated using MATLAB and the simulation results are presented. The power and control circuits are simulated. The current drawn by the FC-TSR-TCR varies with the variation in the firing angle. Stepped variation of current can be obtained using thyristor switched reactor. The simulation results are compared with the theoretical results.

Key words: Facts, FC-TSR-TCR, MATLAB, simulink and reactive power

INTRODUCTION

In the control of Electric Power Systems, systems and procedures are used to compensate dynamically the detrimental effects of non-linear loads. The compensation process should be carried out without important alteration of source signal quality. Some benefits are expected using compensation reduction of losses in distribution lines, harmonic content minoration, and power factor improvement. The dynamic behavior of industrial loads requires the use of compensator that can be adapted to load changes. Unfortunately, the techniques frequently used for compensation are based on circuit controllers that alter the waveform of the signal subjected to control. Such is the case of the *static compensator* (Miller, 1982; Narain G Hingorani, 2002), which must perform harmonic cancellation, reactive power compensation, power factor correction, and energy saving. Although the static compensator is commonly used and studied under sinusoidal voltage conditions, waveforms corresponding to the controlled current present high harmonic content.

This paper focuses on the fixed capacitor Thyristor switched Reactor Thyristor controlled reactor (Lee S.Y. *et al.,* 1992). as shown in Fig 1. Compensation with FC-TSR-TCR consists of controlling the current in the reactor L from a maximum (thyristor valve closed) to zero (thyristor valve open) by the method of firing delay angle control. The fixed capacitor (FC) and TCR constitute a basic VAR-generator arrangement (FC-TCR). The constant capacitive VAR generation of C is opposed by the variable VAR absorption of the TCR. The Simulink circuit model of FC-TSR-TCR system is shown in Fig 2.

Calculation of the firing angle can be made in the time domain (Karady,1992) or in the frequency domain (Gomez, *et al.*, 1992; Gutierrez J. 1993), using different approaches. Assuming the supply voltage to be sinusoidal, calculation of the firing angle is obtained with minimum complexity (Miller, 1982; Montafio J.C. *et al.,* 1993).,The variation of α from π / 2 to π, produces increasing distortion of the current in the FC-TSR-TCR branch, and consequently that of line current. It increases the RMS value of the line current and the THD, and deteriorates the power factor. Effect of voltage harmonic distortion in TCR type compensators on supply voltage is given by (Montafio, *et al.,* 1994).

MATERIALS AND METHODS

Past work deals with the simulation of TCR system using PSCAD / EMTP. The literature (Miller, 1982) to (Haung , *et al.*, 2001) does not deal with the simulation of FC-TSR-TCR system. An attempt is made in the present work to simulate FC-TSR-TCR system using MATLAB Simulink.

FC-TSR-TCR System: The FC-TSR-TCR system is modified by introducing TCRs. The TSR system gives stepped variation of current and TCR gives smooth variation of current. Thus the range of control of reactive power can be increased by using TSR. The TSR system consists of three reactors and three IGBT 's . Three different amplitudes of currents can be obtained by using three switches. The FC-TSR-TCR system is best suitable for dynamic loads

Simulation Results: The simulation circuit of FC-TSR-TCR system is shown in Fig2.The scope-1 is used for indicating the switching pulses for the controlled reactors. The scope-2 represents the current through the load.Scope-3 indicates the voltage across the load. Scope-4 is used to indicate the real and reactive powers.Scope-5 represents the source current. The input current is shown in Fig 3. The pulses given to the gates of S_1 and S_2 are shown in Fig 4. The voltage across the tapped reactor is shown in Fig 5. The pulses given to the IGBT's across the reactors are shown in Fig 6. Four different switching combinations are used as shown in Fig 6. The current through TSR is shown in Fig 7. The load current is shown

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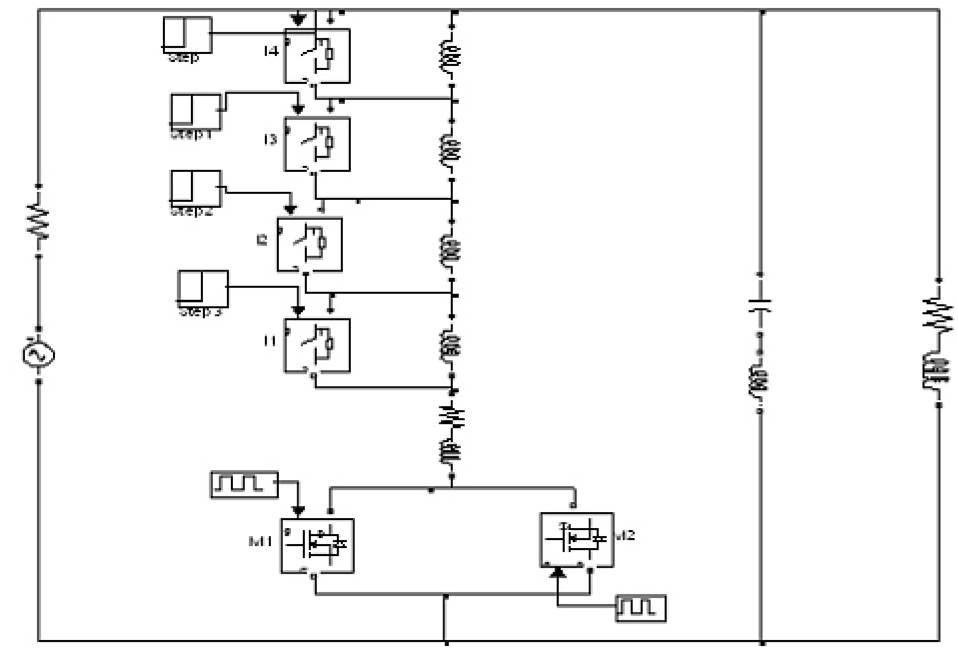

Fig 1: Basic Circuit Diagram of FC-TSR-TCR

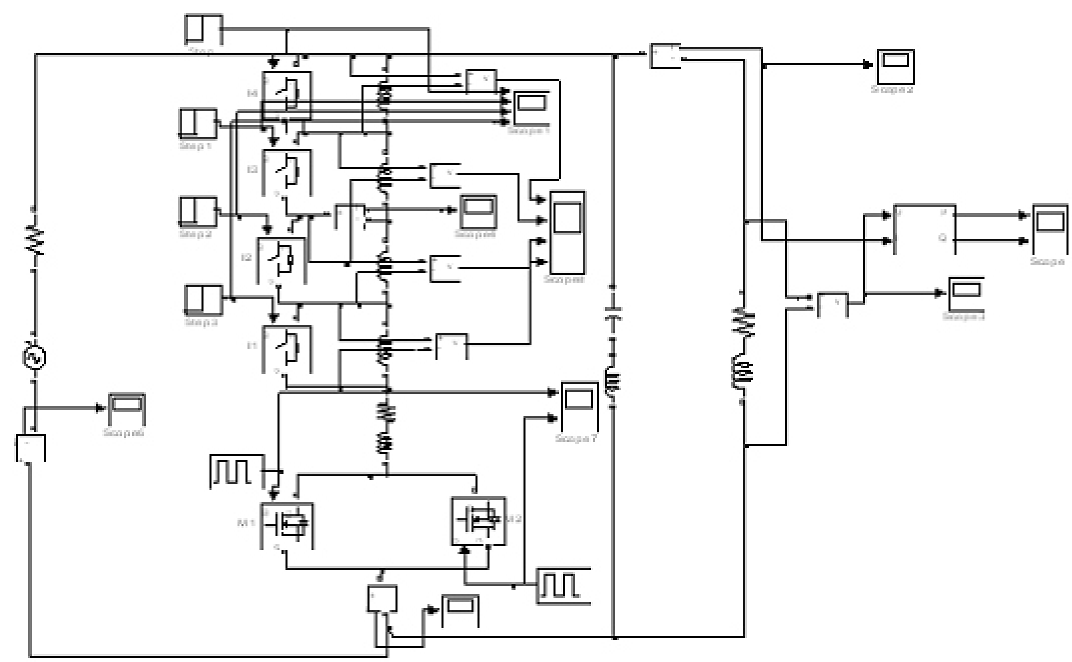

Fig 2 :Simulink Circuit Diagram

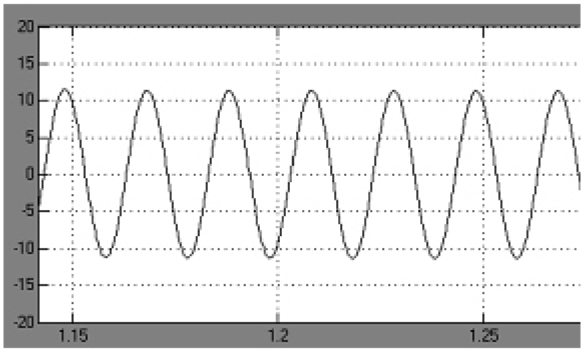

Fig 3: Source Current

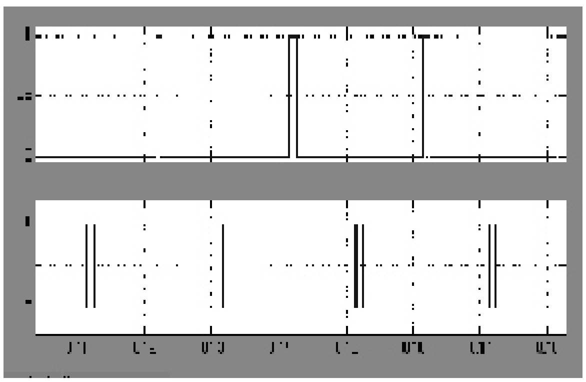

Fig 4: Switching Pulses for S_1 & S_2

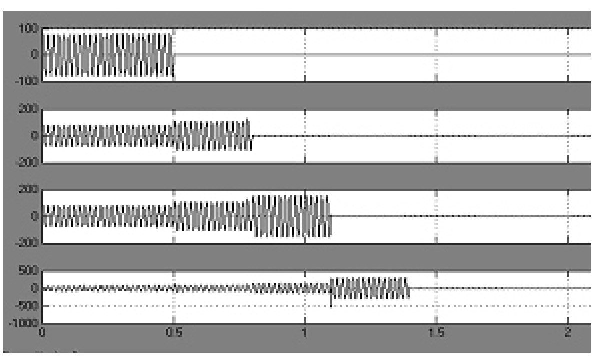

Fig 5 Voltage Across Tapped Reactors

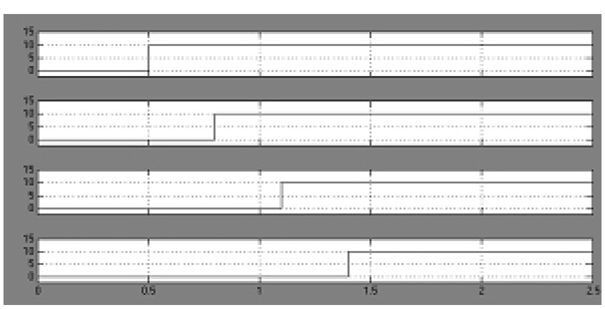

Fig 6: Switching Pulses for Shunt Switches

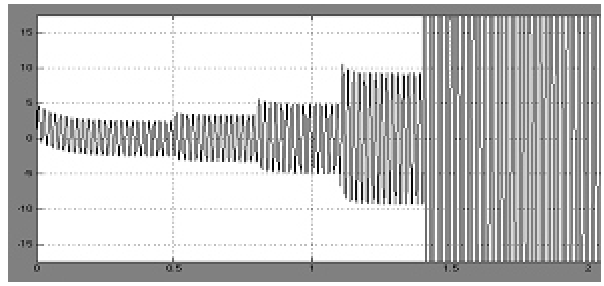

Fig 7: Current Through TCR

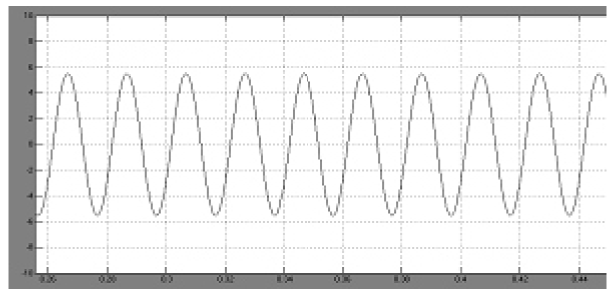

Fig 8: Output Current

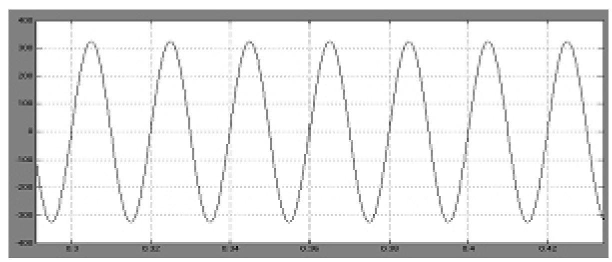

Fig 9: Output Voltage

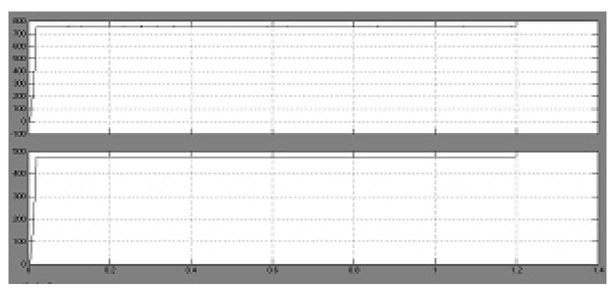

Fig 10: Active and Reactive Powers in the Load

in Fig 8. The voltage across the load is shown in Fig 9. The active and reactive powers are shown in Fig 10.

CONCLUSION

The variation of reactive power using tapped inductor FC-TSR-TCR is analyzed. The variation of reactive power with the variation in the firing angle is studied. The range of reactive power control can be increased by using the combination of thyristor controlled reactor and fixed capacitor system. The circuit model for FC-TSR-TCR is obtained and the same is used for simulation using Matlab Simulink. From the simulation studies, it is observed that reactive power variation is smoother by using FC-TSR-TCR system. The simulation results are almost similar to the theoretical results.

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