A Combination of Shunt Hybrid Power Filter and Thyristor-Controlled Reactor for Power Quality

ABSTRACT:
This paper proposes a combined system of a thyristor-controlled reactor (TCR) and a shunt hybrid power filter (SHPF) for harmonic and reactive power compensation. The SHPF is the combination of a small-rating active power filter (APF) and a fifth-harmonic-tuned LC passive filter. The tuned passive filter and the TCR form a shunt passive filter (SPF) to compensate reactive power. The small-rating APF is used to improve the filtering characteristics of SPF and to suppress the possibility of resonance between the SPF and line inductances. A proportional–integral controller was used, and a triggering alpha was extracted using a lookup table to control the TCR. A nonlinear control of APF was developed for current tracking and voltage regulation. The latter is based on a decoupled control strategy, which considers that the controlled system may be divided into an inner fast loop and an outer slow one. Thus, an exact linearization control was applied to the inner loop, and a nonlinear feedback control law was used for the outer voltage loop. Integral compensators were added in both current and voltage loops in order to eliminate the steady-state errors due to system parameter uncertainty. The simulation and experimental results are found to be quite satisfactory to mitigate harmonic distortions and reactive power compensation.

KEYWORDS:
1. Harmonic suppression,
2. Hybrid power filter
3. Modeling
4. Nonlinear control

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5. Reactive power compensation
6. Shunt hybrid power filter and thyristor-controlled reactor (SHPF-TCR compensator)
7. Thyristor-controlled reactor (TCR)

SOFTWARE: MATLAB/SIMULINK

BLOCK DIAGRAM:

Fig. 1. Basic circuit of the proposed SHPF-TCR compensator.

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EXPECTED SIMULATION RESULTS:

Fig. 2. Steady-state response of the SHRC-TCR compensator with harmonic generated load.

Fig. 3. Harmonic spectrum of source current in phase 1. (a) Before compensation. (b) After compensation.

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Fig. 4. Dynamic response of SHPF-TCR compensator under varying distorted harmonic type of load conditions.

Fig. 5. Dynamic response of SHPF-TCR compensator under the harmonic and reactive power type of loads.

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Fig. 6. Harmonic spectrum of source current in phase 1. (a) Before compensation. (b) After compensation.

Fig. 7. Steady-state response of the SHPF-TCR compensator with harmonic produced load.

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CONCLUSION:

In this paper, a SHPF-TCR compensator of a TCR and a SHPF has been proposed to achieve harmonic elimination and reactive power compensation. A proposed nonlinear control scheme of a SHPF-TCR compensator has been established, simulated, and implemented by using the DS1104 digital realtime controller board of dSPACE. The shunt active filter and SPF have a complementary function to improve the performance of filtering and to reduce the power rating requirements of an active filter. It has been found that the SHPF-TCR compensator can effectively eliminate current harmonic and reactive power compensation during steady and transient operating conditions for a variety of loads. It has been shown that the system has a fast dynamic response, has good performance in both steady-state and transient operations, and is able to reduce the THD of supply currents well below the limit of 5% of the IEEE-519 standard.

REFERENCES:

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