THYRISTOR CONTROLLED REACTOR (TCR) BASED ON FUZZY LOGIC CONTROLLER FOR POWER FACTOR IMPROVEMENT

By

Eng. Fathy Hamed Hussein Awad

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements of the Degree of
MASTER OF SCIENCE
in

Electrical Power and Machines Engineering

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Title of Thesis:

THYRISTOR CONTROLLED REACTOR (TCR) BASED ON FUZZY LOGIC CONTROLLER FOR POWER FACTOR IMPROVEMENT

Key Words: Power factor, Harmonics, TCR, FLC, Hybrid

Summary:

This thesis introduces the Thyristor Controlled Reactor (TCR) as a reactive power compensator. The design of TCR is introduced to compensate the varying load from the full inductive to the full capacitive. The techniques of the reduction harmonics are introduced. Also, the comparative study for the three types (i.e. star, delta, and hybrid) is introduced. The reactive power calculation is based on the d-q frame to be fed as an input to the controller.

The Fuzzy Logic Controller (FLC) is designed to control the TCR system.

The simulation of three topologies of the TCR systems is presented. The simulation results cover the open loop and the closed loop (FLC). The results of different loads which are controlled by FLC are given.

The FLC controller proved a very good behaviour in both transient and steady state for controlling the TCR system. Finally, the hybrid TCR system proved a better solution for the THD in the most controlling range.

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Eng. Fathy Hamed Hussein Awad

Dedication

TO

My parents, my brothers, my sister, my wife for their encouragement, and finally to my sons: Tasnim, Zeiad.

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List of Symbols

$PF1=\cos\phi_1$	Initial power factor
$PF2=\cos\phi_2$	Target power factor
V_S	System voltage
T1	Thyristor of the positive cycle
T2	Thyristor of the positive cycle
$\beta_{TCR(\alpha)}$	Susceptance of TCR
βc	Susceptance of the Capacitor
X_{SVC}	Reactance of SVC
X_C	Reactance of Capacitance
X_{TCR}	Reactance of TCR
L	Inductance of the reactor
S	Apparent Power
P	Active Power
Q_x	Reactive power at point x
C	Capacitance of the capacitor
KVA	The unit of Apparent Power
KV	The unit of the Voltage
Hz	The unit of the frequency (f)
PW	The unit of power
KWH	The unit of electrical energy
Kvar, Mvar	The unit of the reactive power
R,S,T	Three phases
HP	The unit of power = 0.764 Watt
N	Binary steps
I_L	Maximum demand load current
$i_{th1,2}$	Current through the thyristor1,2
$v_{th1,2}$	Voltage through the thyristor1,2
$Q_{TCR(\alpha)}$	Total reactive power of the TCR
$I_{TCR(\alpha)}$	Total current through the TCR branch at a firing angle α.
$V_{a,b,c}$	Phase voltage for phase a,b,c
$I_{a,b,c}$	Phase current for phase a,b,c
i_{ds}	Direct current for stationary frame
i_{dr}	Direct current for rotating frame
i_{qs}	Quadrature current for stationary frame
i_{qr}	Quadrature current for rotating frame
v_{ds}	Direct voltage for stationary frame
v_{dr}	Direct voltage for rotating frame
v_{qs}	Quadrature voltage for stationary frame
v_{qr}	Quadrature voltage for rotating frame
$v_{d\,(Average)}$	Average Direct voltage
$v_{q\,(Average)}$	Average Quadrature voltage
$i_{d\,(Average)}$	Average Direct current
$i_{q\,(Average)}$	Average Quadrature current