MULTI-OBJECTIVE OPTIMIZATION OF DOUBLE-TUNED FILTERS IN DISTRIBUTION POWER SYSTEMS USING NON-DOMINATED SORTING GENETIC ALGORITHM-II

By

Eng. Mohamed Ahmed Mohamed Fahmy

A thesis submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE
In
Electrical Power and Machines Engineering

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Title of Thesis:

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Keywords:

Power quality, harmonics, singled-tuned filter, double-tuned filter, NSGA-II

Summary:

This thesis proposes an optimization method to find the optimal design of different filters' types to reduce harmonic distortion in electrical power systems, and thus improving power quality performance of these systems. Non-dominated sorting genetic algorithm (NSGA-II) has been employed and tested using MATLAB. In this thesis, the operating principles of the single and double-tuned filters and the design equations to calculate its parameters directly from the known power system data are presented. Further, a comparative analysis between multi-arm single-tuned filter and double-tuned filter to investigate the performance of both filters in mitigating harmonics and improving parameters of power quality is introduced. Then, a performance of two different configurations of damped double-tuned filter is investigated in reducing both the system's transmission line loss and filter's loss simultaneously, while maintaining the individual and total harmonic distortion limits stated in IEEE Std. 519

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LIST OF ABBREVIATIONS

CD	Crowding distance
DTF	Double-tuned filter
GA	Genetic algorithm
HVDC	High voltage direct current
MOEA	Multi-objective evolutionary algorithms
NSGA	Non-dominated sorting genetic algorithm
STF	Single-tuned filter

LIST OF SYMBOLS

f_m^{i+1}	m^{th} objective function value of solution number (*i*+1) in the set front
f_m^{i-1}	m^{th} objective function value of solution number (*i*-1) in the set front
f_m^{max}	maximum value of the m^{th} objective function in the set front
f_m^{min}	minimum value of the m^{th} objective function in the set front
C_f	Capacitance of the filter
C_1	1^{st} capacitance of the double-tuned filter
C_2	2^{nd} capacitance of the double-tuned filter
C_a	1^{st} capacitance of the multi-arm single-tuned filter
C_b	2^{nd} capacitance of the multi-arm single-tuned filter
$CIHD$	Individual current harmonic distortion
DPF	Displacement power factor
h_r	Order of the resonant frequency
i	Number of solution
i_{distance}	Crowded distance
i_{rank}	Non-domination rank
I_{sh}	Current passed through the impedance of the system
I_{Lh}	Harmonic current inserted into the system from nonlinear load
I_{Fh}	Harmonic current passed through the filter
I_h	Harmonic current
I_1	Rms current at the fundamental harmonic.

j	Total number of solutions in the set front
L_f	Inductance of the filter
L_1	1st inductance of the double-tuned filter
L_2	2nd inductance of the double-tuned filter
L_a	1st inductance of the multi-arm single-tuned filter
L_b	2nd inductance of the multi-arm single-tuned filter
m	number of objectives
m_p	Parallel resonance harmonic order
O	Mathematical notation that describes time complexity
P_t	Parent population
ΔP_L	Transmission line power losses
ΔP_F	Filter power losses
P_1	Fundamental harmonic active power
q	Quality factor
Q_f	Reactive power of the filter
Q_t	Offspring population
R_f	Resistance of the filter
R_t	Resulted population
S_1	Fundamental harmonic apparent power
$THDI$	Total harmonic distortion current
$THDV$	Total harmonic distortion voltage

$VIHD$	Individual voltage harmonic distortion
V_s	Line-to line rated voltage of the filter
V_{Lh}	Resulted harmonic voltage
Z	Population size
Z_f	Filter impedance
Z_L	Load impedance
Z_s	Source impedance
Z_{sh}	Source harmonic impedance
Z_{Lh}	Linear load harmonic impedance
Z_{Fh}	Filter harmonic impedance
Z_{FLh}	Parallel equivalent impedance of filter's impedance and the load impedance
ω_f	Fundamental harmonic angular frequency
ω_p	Parallel resonant frequency
ω_s	Series resonance angular frequency
ω_a	1st resonance angular frequency of multi-arm single-tuned filter
ω_b	2nd resonance angular frequency of multi-arm single-tuned filter
ω_1	1st resonance angular frequency of double-tuned filter
ω_2	2nd resonance angular frequency of double-tuned filter

LIST OF PUBLICATIONS

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