World Academy of Science, Engineering and Technology
International Journal of Electrical and Computer Engineering
Vol:8, No:04, 2014

Optimal Harmonic Filters Design of Taiwan High Speed Rail Traction System

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Abstract : This paper presents a method for combining a particle swarm optimization with nonlinear time-varying evolution and orthogonal arrays (PSO-NTVEOA) in the planning of harmonic filters for the high speed railway traction system with specially connected transformers in unbalanced three-phase power systems. The objective is to minimize the cost of the filter, the filters loss, the total harmonic distortion of currents and voltages at each bus simultaneously. An orthogonal array is first conducted to obtain the initial solution set. The set is then treated as the initial training sample. Next, the PSO-NTVEOA method parameters are determined by using matrix experiments with an orthogonal array, in which a minimal number of experiments would have an effect that approximates the full factorial experiments. This PSO-NTVEOA method is then applied to design optimal harmonic filters in Taiwan High Speed Rail (THSR) traction system, where both rectifiers and inverters with IGBT are used. From the results of the illustrative examples, the feasibility of the PSO-NTVEOA to design an optimal passive harmonic filter of THSR system is verified and the design approach can greatly reduce the harmonic distortion. Three design schemes are compared that V-V connection suppressing the 3rd order harmonic, and Scott and Le Blanc connection for the harmonic improvement is better than the V-V connection.

Keywords : harmonic filters, particle swarm optimization, nonlinear time-varying evolution, orthogonal arrays, specially connected transformers
Conference Title : ICEME 2014 : International Conference on Electrical and Mechanical Engineering
Conference Location : Venice, Italy
Conference Dates : April 14-15, 2014