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Multi Objective Evolutionary Algorithm for Designing Energy Efficient Distribution Transformers

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Abstract--This paper has solved the transformer design optimization problem using Multi-Objective Evolutionary Algorithms based on Decomposition with Dynamical Resource Allocation (MOEA/D-DRA). For lesser computation burden, the existing design techniques merely employ few Standard Design Variables (SDV), satisfying only a few performance constraints, resulting in an approximated design, without any focus on an energy efficient transformer. The proposed methodology minimizes four sets of conflicting design bi-objectives, subjected to 27 constraints, incorporating three crucial design variables with SDV to ensure energy efficient transformer design with lesser losses, total life time cost (TLTC), green house gas emission, and failure rate. Different cases are analysed on a sample 1500kVA transformer, which is designed by existing technique and the proposed multi objective optimization problem formulation approach and the performances of the competing transformers are compared. To prove the effectiveness of Iterative Chaotic map with infinite collapses assisted MOEA/D-DRA (ICMDRA), NSGA-II has also been successfully applied to solve the problem. When tested in all three different rating transformers, the simulation results have proved that the proposed methodology saves energy, cost, and material, with ICMDRA rather than NSGA-II. This paper identifies ICMDRA as a superior algorithm for transformer design, in terms of diversity and convergence. Also, the core loss calculation of the transformer designed using the proposed methodology is validated by 3D-FEM assessment and experimental prototype setup for a 200kVA transformer.

Index Terms- Multi objective transformer design optimization, NSGA-II, MOEA/D-DRA, TLTC, crucial design variables, GHG emission.

Nomenclature

ABBREVIATION:
CDV               CDV               Crucial Design Variables
FEM               FEM               Finite Element Method
GHG               GHG               Green House Gases
HV                HV                High Voltage
ICMIC             ICMIC             Iterative Chaotic Map with Infinite Collapses
ICMDRA            ICMDRA             Chaos with MOEA/D-DRA
KBS               KBS               Knowledge Based Systems
LV                LV                Low Voltage
MOEA/D-DRA        MOEA/D-DRA       MOEA based on Decomposition with Dynamical Resource Allocation
MOEA              MOEA              Multi-Objective Evolutionary Algorithm
MOTDO             MOTDO             Multi Objective TDO
NSGA              NSGA              Non-dominated Sorting Genetic Algorithm
SDV               SDV               Standard Design Variables
TDO               TDO               Transformer Design Optimization
TLTC              TLTC              Total Life Time Cost
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