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| **Title:** | THE SUPERIORITY OF FEASIBLE SOLUTIONS-MOTH FLAME OPTIMIZER USING VALVE POINT LOADING | | |
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| **Published Journal Name:** | Results in Control and Optimization | | |
| **Type of Publication:** | Journal | | |
| **Volume:** | Online | Issue |  |
| **Publisher:** | 2024 Published by Elsevier B.V.  This is an open access article under the CC BY-NC-ND license(http://creativecommons.org/licenses/by-nc-nd/4.0/) | | |
| **Publication Date:** | 09 Sep, 2024 | | |
| **ISSN:** | ISSN 2666-7207 | | |
| **DOI:** | https://doi.org/10.1016/j.rico.2024.100465 | | |
| **URL:** | [https://authors.elsevier.com/sd/article/S2666-7207(24)00095-X](https://kwnsfk27.r.eu-west-1.awstrack.me/L0/https:%2F%2Fauthors.elsevier.com%2Fsd%2Farticle%2FS2666-7207(24)00095-X/1/0102019223523863-9055168e-5713-4537-82d0-f00d3b59f9db-000000/ZRTNfKpHmKPkeC90aVgZvAYv54g=392) | | |
| **Other Related Info.:** |  | | |
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| **Abstract:** |  |
| **Abstract- The optimal power flow (OPF) problem deals with large-scale, nonlinear, and non-convex optimization challenges, often accompanied by stringent constraints. Apart from the primary operational objectives of an energy system, ensuring load bus voltages remain within acceptable ranges is essential for providing high-quality consumer services. The Moth-Flame Optimizer (MFO) method is inspired by the unique night flight characteristics of moths. Moths, much like butterflies, undergo two distinct life stages: larval and mature. They have evolved the ability to navigate at night using a technique called transverse orientation. This article presents a methodology for determining the optimal**  **energy transmission system configuration by integrating power producers. The MFO, Grey Wolf Optimizer (GWO), Success-history-based Parameter Adaptation Technique of Differential Evolution - Superiority of Feasible Solutions (SHADE-SF), and Superiority of Feasible Solutions-Moth Flame Optimizer (SF-MFO) algorithms are applied to address the OPF problem with two objective functions: (1) reducing energy production costs and (2) minimizing power losses. The efficiency of MFO, SF-MFO, SHADE-SF, and GWO for the OPF challenge is evaluated using IEEE 30-feeder and**  **IEEE 57-feeder systems. Based on the collected data, SF-MFO demonstrated the best performance across all simulated instances. For instance, the electricity production costs generated by SF-MFO are $845.521/hr and $25,908.325/hr for the IEEE 30- feeder and IEEE 57-feeder systems, respectively. This represents a cost savings of 0.37% and 0.36% per hour, respectively, compared to the lowest values obtained by other comparative methods.** | |