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Amended Firefly Algorithm for the Application of Congestion Management in Deregulated Environment

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Abstract **This present paper intends to confer a amended firefly algorithm based on firefly algorithm and nice improved by opposition based learning on the application of congestion management. Firefly algorithm (FA) was successfully developed by Xi-She Yang in 2007. It was based on the flashing patterns and its behavior of fireflies. Firefly algorithm is a metaheuristic method based on population. Fireflies' behavior was defined by the sky filled with the light of fireflies and it is a remarkable sight in the summer in the moderate temperature regions. There are nearly two thousand firefly species, and most of them generate short output and repeated flash. In competitor electricity market, Congestion is important for profit -making and safe. This paper presents reliable and systematic meta-heuristic based methods to solve congestion issue. These firefly algorithms are based to the light of other fireflies and also accomplish well on different numerical optimization issues. A balancing the firefly algorithm with amended firefly algorithm is conducted for standard benchmark function with the help of simulations. This refers to proposed methodology be allowed help in removing the congestion of rule with minimum rescheduling amount. The analytical results of modified IEEE 30- and 57-bus test power system can be summarized. The Congestion management model is produced on one objective function to reduce last price of capital planning**

Keywords — Firefly Algorithm, Opposition based Learning, Congestion management, Electricity Market.

I. INTRODUCTION

Electricity grid was typically operated by vertically integrated utilities prior to the reform of the power sector. One of the main issues that threatened system security in deregulated electricity market is congestion [1]. So, it is called congestion management. Congestion management is one of the most challenging tasks system operators. System operators try to manage congestion which otherwise increases the cost of the electricity and also threatened the system security and stability [2].

Deregulation a new example in the electric supply industry uses the transmission network as a common carrier. The open access causes congestion which occurs frequently in deregulated system where it is somewhat complex to manage. The main objective of congestion management is given as congestion is said to have occurred when system operator finds that all the transactions cannot be allowed on account of overload on the transmission network. So, it helps to- minimized interference of the transmission network in the market for electric energy, secure operation of the power system, improvement of market efficiency, manage power flow with existing transmission line. Congestion management features is gives as economic-efficiency, be robust, be transparent.

Congestion Management can be classify in two methods-

(1) Non-Market Method

(2) Market Method.

Types of Non-Market Method are –

a) Type of contract b) First come First Serve c) Pro rate Methods d) Curtailment

Types of Market Method are-

a) Explicit auctions b) Nodal Pricing c) Zonal Pricing d) Price Area e) Re-dispatch

f) Counter Trace

In market method is type (a,b,c,d) based on Pricing based and type (e,f) is based on Remedial based.

II. PROBLEM FORMULATION

a. Congestion Management [5]

In the days, the electricity market was under a monopoly. One large utility had the authority of generation, distribution

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as well as transmission usually known as vertically integrated utilities. This called for the need of restructuring the industry.

[3] Congestion management can be classified two part- Cost free method (ii) non-cost-free method

Cost free measures include which are apt to disposal of the transmission system operator (TSO). These employ modifying to topology of the network for transformer taps, Operation of Conventional Compensation devices eg. Phase-Shifters are use of flexible AC transmission system devices.

Non-Cost-free measures include generation rescheduling and Curtailment of load transactions. In the Conventional Congestion management method includes nodal pricing method, Price control theme, Congestion management through Genetic algorithm, fuzzy logic, Voltage Stability, nodal and zonal congestions.

A few congestions management through FACTS devices are market-based analogy.

Conventional methods of congestion management-

- Nodal Pricing Method
- ATC (Available Transfer Capability) based Congestion management
- Flexible AC transmission System

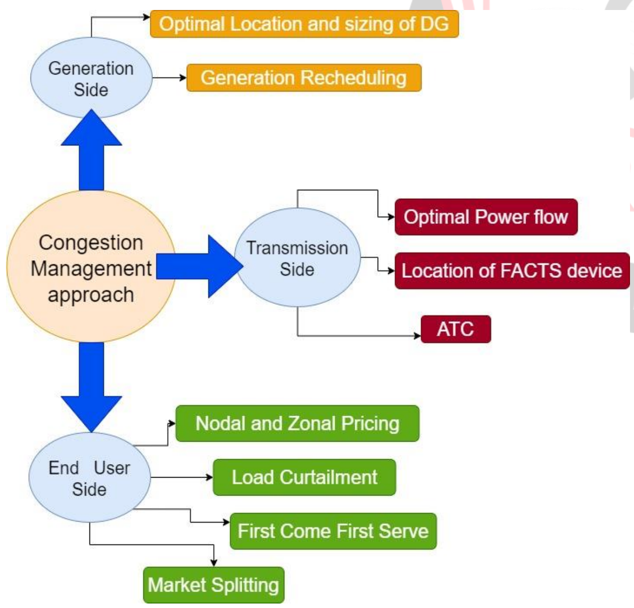

Figure 2. Schematic diagram of Congestion management methods in deregulated power System

1. Flexible AC transmission System:

There are two measures by which congestion could be managed. One is the cost-free measure and second is the non-cost-free measure. FACTS device can be classified into three categories: Series controller, shunt controller and combined series shunt controller. The series controllers like thyristor-controlled series compensator (TCSC), static synchronous series compensator (SSSC) and thyristor-controlled phase-angle regulator (TCPAR) are used in line overloads and increasing transfer capability by controlling power flow. The shunt controllers such as SVC (Static Var Compensator) and STATCOM (static synchronous compensator) can be employed reactive power at the low voltage buses. The combined series–shunt controllers such as UPFC (unified power flow controller) can be used in the system to release the power flow congestion.

2. Optimization techniques and expert system

Congestion management is fundamentally a non-linear program involving often of variables which could be solved using optimization algorithms. The most frequently used optimization techniques are categorized as Genetic Algorithm (GA) [8-9], Particle Swarm Optimization (PSO)[10], ALO [12].

III. PROPOSED METHODOLOGY

a. Firefly Algorithm

Optimization problem solver is given for some solution to find a practical region minimal or maximal cost of aim task. During optimization problem, metaheuristic designer stubble is based on data processing design a well-known optimizes problem by inter actively which tries into develop the result of an issue.

Within reach act various fundamentals properties of metaheuristic cases given as:

1) Metaheuristic remain strategic analyses such operation in the process of control counsellor for searching's case.

2) The objective scorer of metaheuristic act directed towards explosions the research field efficient market into finds capital or near-capital result.

3) Powerful simple way for local search method is given problem to solve by some technique used to complex number learning process analyses.

4) Metaheuristic algorithm is based on approximate solution and usually uses non-determinations. In last decadence, the inspiration of swarm intelligence (SI) used for optimization technique and develop into also in demand price with search company into explain the optimization problem. SA rule, swarm intelligence is alive formed at the top of an imputation system about operator such connect for any more for our environment effect. Effective inspirations of SI come taken away features, special measure the biological system position the algorithm simulate the act of swarms of social insects including ant colonies, bird flocking, animal herding, bacterial growth and fish schooling and SI approaches their business entities (security), flexibleness, distribute and self-methodized character references. Various

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signification algorithm have many continuation clauses are Genetic Algorithm (GA), Firefly Algorithm (FA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Levy Flight, Artificial Bee Colony Algorithm (ABC), Hunting Search (Hus), Simulated Annealing (SA) and many more. This paper gives powerful major reason for reviewing and shows the application of FA in optimization problem. Firefly Algorithm is inspiring the blinking behaviour of firefly's new solving issue. In the next section we will be discussing about FA behaviour and methodology. In Firefly Algorithm, fireflies flied beetles either insects such generates bright and blinking on night. The bright takes not inferred or but an ultraviolet oscillation that make them chemically created taken away the reduced belly act termed bioluminescence.

The Firefly Algorithm is given in the resulting surmise:

1) A firefly decision act attracted directed toward one another instead about its sex due to the act unisexual.
2) The brightness equivalent of their attractiveness where the lesser light firefly decision be attracted to the brighter firefly. When the attractiveness decreased then outpace about the final fireflies added on.
3) If the brightness of the two fireflies acts the equal, the fireflies design measure randomly. The formation of current result is attraction of the fireflies by random walk. FA advanced by Yang in late 2007 which obtain very capable procedure to determine constrained optimization problems. During researchers this technique is used to determine optimization problems of dynamic environment in FA (Firefly algorithm).

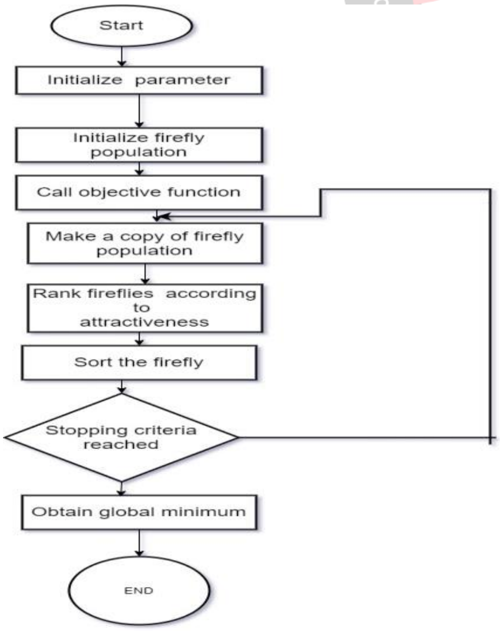

Figure 3.1 Process Flow of Firefly Algorithm

b. *The attractiveness of the firefly[6]*

Their brightness is used for their attractiveness, I of firefly i on the firefly j which is situated at the intensity of the brightness of the firefly i or also the length r_{ij} among the firefly i and the firefly j as given as Eq. 1.

$$I(r) = \frac{I_S}{r^2} \qquad (1)$$

(1) Let us consider in their operation n fireflies; and the result the firefly i corresponded to x_i. The light of the firefly i, the objective function f (xi) is associate member. The brightness I of a firefly is selected to reversions interest present simple area of its fitness value or objective function

$$I_i = f(x_i) \qquad (2)$$

The agreeable firefly is attracted to less bright side along with displaced to the brighter one; also the attractiveness value β certainties to each firefly. Although, the firefly is based on distance of the attractiveness and its value is given by β. The attractiveness function of the firefly is depicted in Eq. 3.

$$B(r) = \beta_0 e^{-\Upsilon r^2} \qquad (3)$$

Where, β0 is defined as firefly attractiveness value at r = 0 and γ is defined as the media light absorption coefficient.

The flow almost attractive firefly mentioned in sudden change of a firefly i at position xi moving to a brighter firefly j at position xj by Eq.4.

$$x_i(t+1) = x_i(t) + \beta_0 e^{-\Upsilon r^2}(x_i - x_j) + \alpha\varepsilon_i \qquad (4)$$

Where, $\beta_0 e^{-\Upsilon r^2}(x_i - x_j)$

Due to this attraction of firefly is given as xj and $\alpha\varepsilon_i$ are randomization parameter; so simple random movement turns out β0 = 0. The balance attractiveness of the new firefly position is given with the old one. If present position makes larger than attractiveness cost, the new position is changed to the firefly situation or the firefly unresolved in the current position. The finished benchmark of the FFA is placed on a random prearranged sum of repeat or predefined fitness value. Randomly moves of brightest firefly depicted in eq. 5

$$x_i(t+1) = x_i(t) + \alpha\varepsilon_i \qquad (5)$$

c. *Opposition-Based Firefly Algorithm*

A novel approach called opposition- based learning (OBL) suggested by Taizhou's has been applied with FFA. It has been successfully applied with several optimization algorithms like genetic algorithm, differential evolution algorithm, ant colony optimization and gravitational search algorithm. In OBL the candidate solution and its corresponding opposite solution are considered simultaneously. Let z

∈[x, y] be a real number, the opposite number of z is denoted as z` and is defined as:

$$z` = x + y - z \qquad (6)$$

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The above concept can be extended to the case of higher dimensions. Let Q (z1, z2,..., zm) be a m- dimensional vector, where i = 1, 2,..., m and zi ∈[xi, yi]. The opposite vector for Q is determine by Q` = (z`1, z`2,..., z`m), where z`i= xi + yi − zi .

The proposed algorithm applies OBL concept in two phases of optimization namely initializing the population and producing new generations.

d. Amended firefly algorithm

Firefly algorithm is based on optimization problems which uses metaheuristic algorithms. The firefly algorithm is motivated by behavior of flashing in the fireflies. In this algorithm brightness depends on their performance and objective function, these are considered as fireflies and their behavior is randomly generated [4]. In firefly algorithm firefly decision act captivate toward lighter firefly, furthermore in case that available act no brighter firefly, it design act randomly. Then it uses modified firefly algorithm. If we modified the indicated random change of the lighter firefly away develop random control latest line to find effective suitable control through that the brightness maximizes. In case that equivalent a control does not generate, it will unresolved in owned general situation. As well as the function of attractiveness is modified latest equivalent a action that the development of the objective function is maximized.

World best solution is based on brightest fireflies. In standard firefly algorithm it passes through randomly in brightest firefly. Brightness of firefly will be decreased, which depends on the direction. This leads to decrease of these algorithms and this term repeat. As well as it moves only brightest firefly whose brightness improves and brightness will not decrease in term of global best solution. To decide randomly generated brightest firefly is m unit vector called u1, u2,..., um. Then direction U is chosen in such a way that randomly develops m direction current that the brightness of the firefly increases in case that the firefly changes in that control. Therefore, the act of the brightest firefly is given as result:

$$X: =x+\alpha U, \qquad (7)$$

Where α is defined as random step length. In case that randomly generated solutions does not remain in the given direction than the brightest firefly remain in its present position. Instead of expansive A_0^i =1 for every firefly i, it is preferable to allow a source attractiveness that is based on the intensity of the firefly, which also count on objective function. There is one more act to allow the ratio of the intensity of fireflies. Let us assume firefly i, located at x' is brighter than a firefly j, which is placed at the given value of x. Finally, the value of x at which firefly is defined desire act almost firefly i, as follows: -

$$A_0=\frac{I'_0}{I_0} \qquad (8)$$

Where I'_0 is given as intensity at r =0 value for firefly i, also I_0=0 is given as intensity at r = 0 value for firefly j and when

$I_0 \neq 0$. For possible occurrence to remove the singularity occurrence, when the value of I_0=0 and A_0 can expressed as $e^{I'_0 - I_0}$. If we consider $A_0 = I'_0$ and if its intensity is more than the change of the firefly j almost, I may be extended. Although, based on the result field is preferred to amend A_0. In another occurrence it should be directly equal to the intensity at the given source i.e., I'_0.

IV. AMENDED FIREFLY ALGORITHM FOR SOLVE CONGESTION MANAGEMENT

a. Overview

Electricity grids were typically operated by vertically integrated utilities prior to the reform of the power sector. Both generating and transmission were under the authority of these utilities. It has become a problem for unconstrained entities, has become an obstacle because independent system operators (ISO) to run the method of synchronism [1]. Participants like transactions buy and sell power solely to increase net profit, forcing transmission networks to control their workable limits. Physical restrictions, such as temperature, voltage limits, defined limits that guarantee system reliability and dependability can be used as constraints [2]. In a deregulated context, an effective PSO approach was utilized for actual power rescheduling of generators to transmission CM (Congestion management). PSO improves voltage by utilizing distributed generating units for congestion management. In reference, the paper allocation of the FACTS device is used to apply PSO to optimize system general welfare which has bilateral auction market. Reference proposes use of a fuzzy-based genetic algorithm (GA) to optimize entire structure general welfare current a bilateral auction market to one side optimizing powerful location with size of FACTS devices.

Figure 4.1 Firefly Algorithm

Meta-heuristic technique is based on the Firefly algorithm (FFA) which depends on flashing behaviour of fireflies,

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along with personal use in nearly all fields of information and compute for optimization is fast expanding. In reference, FFA was employed to address a non-linear design challenge [11], [13-14].

b. Mathematical Problem Formulation

The CM's major goal is to reduce congestion costs while staying within network limitations. The CM problem is handled in this paper through rescheduling (raising and lowering) of the active power results of the generator.

This problem stated in eq (9)-

Minimize

$$C_c=\sum_{j\in Ng}(C_k\,\Delta P_{Gj}^{+} + D_k\Delta P_{Gj}^{-})₹/h \qquad (9)$$

Where C_c,C_k, D_k, ΔP_{Gj}^{+} and ΔP_{Gj}^{-} represent overall amount causes for alternating the active power results ($₹/h$), increasing cost bid agreed by GENCO ($₹/MWh$) decreasing cost bid agreed by, active power increased in alternator (MW) and operating energy decreases in generator (MW), vice versa.

1. Similarity constraints

Powerful similarity constraints of CM show the energy movement calculation in eq:-

$$P_{Gk} - P_{Dk}=\sum_j |V_j|\,|V_k||Y_{kj}|\cos(\delta_k - \delta_j - \theta_{kj})$$

$$j=1, 2\ldots N_b \qquad (10)$$

$$Q_{Gk} - Q_{Dk} = \sum_j |V_j|\,|V_K||Y_{kj}|\sin(\delta_k - \delta_j - \theta_{kj})$$

$$j=1, 2\ldots N_b \qquad (11)$$

$$P_{Gk}=P_{Gk}^{C} + \Delta P_{Gk}^{+} - \Delta P_{Gk}^{-};\quad k=1, 2\ldots N_g \qquad (12)$$

$$P_{Dj}=P_{Dj}^{c};\quad j = 1,2\ldots\ldots N_d \qquad (13)$$

Where P_{Gk} and Q_{Gk} the generated is active or reactive power in given bus k, consequently; P_{Dk} with Q_{Dk} act active and reactive power in given bus k, sequentially; V_j with V_k is voltage given in bus j and k sequentially δ_j with δ_k are bus voltage angles of bus j and k. sequentially; θ_{kj} is admittance angle of line joining k and j; N_b ,N_g and N_d are total number of buses, generator and loads, sequentially; P_{Gk} with P_{Dj} are operating power processed by alternator k along with operating energy absorbed by load bus j, sequentially, act achieved away powerful offer for sale clearing amount.

It is notable that eq. (10) with (11) active and reactive power has symmetry at each node eq. (12) with (13) represent net power as a function of market gap value.

2. Dis-similar constraints

In this dis-similar inequality constraints expresses the operating along with physical limit of every transmission lines, transformers and generator eq as follows-

$$P_{Gk}^{min} \le P_{Gk} \le P_{Gk}^{max}\,\forall k \in N_g \qquad (14)$$

$$Q_{Gk}^{min} \le Q_{Gk} \le Q_{Gk}^{max}\,\forall k \in N_g \qquad (15)$$

$$(P_{Gk} - P_{Gk}^{min})=\Delta P_{Gk}^{min} \le \Delta P_{Gk} \le \Delta P_{Gk}^{max}=(P_{Gk}^{max} - P_{Gk}) \qquad (16)$$

$$V_n^{min} \le V_n \le V_n^{max},\ \forall k \in N_i \qquad (17)$$

$$P_{ij} \le P_{ij}^{max} \qquad (18)$$

Where superscription represents minimal and maximal values of the respected fluid also N_i represents powerful total digit of limit.

V. SIMULATION RESULT AND DISCUSSIONS

AFFA is used for CM (Congestion Management) which is designed with the help of MATLAB R2017 a program at an entity and Intel Core i5 Processor running at 2.20 GHz and 4 GB of RAM in the current study. Many networks were proposed with the help of different techniques which were tested including a modified IEEE 30-bus system, a modified IEEE 57-Bus test system.

Table 5.1. Simulated test systems according test cases.

Test System	Test Case	Contingency Considered
Modified	1A	Draw a line in 1 and 2.
IEEE 30-bus	1B	Limit between 1 and 7 with load increase 50% at all buses
Modified	2A	Lines capacity reduction from 200 to 175 MW and 50 to 35 MW between 5–6 and 6–12
IEEE 57-bus	2B	Line capacity reduction from 85 to 20 MW between lines 2 and 3

Table 5.1.1 Congested line flow for various test systems: Congestion management

Test Case	Congested Lines	Line Flow, MW	Specified Line Limit, MW

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		Before CM	After CM	
1A	1–7	147.57	130	130
	7–8	140.23	123.54	130
1B	1–2	314.01	130	130
	2–8	97.86	61.46	65
	2–9	103.66	64.39	65
2A	5–6	188.69	168.47	175
	6–12	49.53	16.85	35
2B	2–3	36.60	16.78	20
3	16–17	209.24	97.65	175
	30–17	580.29	496.80	500
	8–30	363.52	143.08	175

Improved IEEE 30-bus test system has 41 transmission lines, 6 generator buses, and 24 load buses. 283.4MW is overall real power of measuring system and value of reactive power have being 126.2 MVAR. F or the given test system 2 different examples are used i.e., Case 1A and Case 1B for analysing the suggested method. In Case 1A example when line between bus 1 and 2 is considered down, traffic is generated in the system Congestion develops in lines 1–7 and 7–8 which result end of the line outage. Table 5.1coveys the specifics of the quantity of line flow. Corrective steps are made to relieve these overloaded lines for safe operation. For the purpose of minimizing congestion costs, the suggested Amended FFA algorithm is used. In Table 5.2, the suggested AFFA method's optimal congestion cost values are compared to those published in the literature, including firefly algorithm (FA) and particle swarm optimization (PSO). Using the suggested Amended FFA, the best overall congestion cost was found to be 421.58 $/h.

Table 5.2 Comparison of modified IEEE 30-bus test power system, SA: simulated annealing; (PSO); FA; AFFA: Amended firefly algorithm.

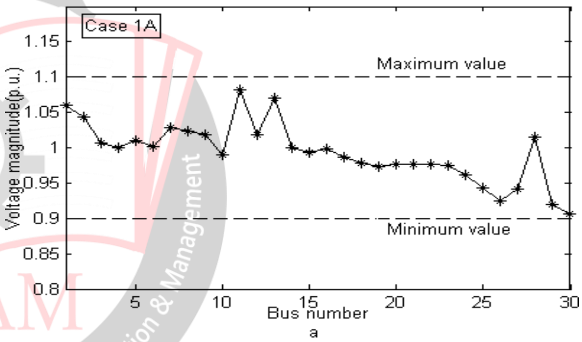
Variables	PSO [8]	FA [22]	AFFA [Proposed]
Case 1A			
TC, $/h	539.96	512.867	422.61
ΔP_{G1},MW	-8.7789	-8.7783	-8.59617
ΔP_{G2},MW	15.0008	15.0008	7.57019
ΔP_{G3},MW	0.1068	0.1068	0.35246
ΔP_{G4},MW	0.0653	0.0653	1.056891
ΔP_{G5},MW	0.1734	0.1734	0.56891
ΔP_{G6},MW	-0.6180	-0.6180	0.52286
TRRG,MW	22.93	24.7425	18.70758
Case 1B			
TC, $/h	5335.5	5314.40	5238.93
ΔP_{G1},MW	NIL	-8.5789	-9.00148
ΔP_{G2},MW	NIL	75.9961	62.90304
ΔP_{G3},MW	NIL	0.0581	34.24745
ΔP_{G4},MW	NIL	42.9952	2.05959
ΔP_{G5},MW	NIL	23.8319	29.45485
ΔP_{G6},MW	NIL	16.5151	23.47373
TRRG,MW	168	167.981	161.14013

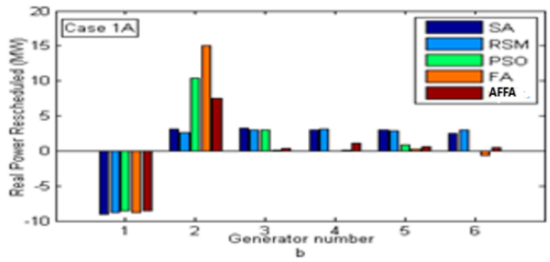
TRRG—total real-power rescheduling generators;

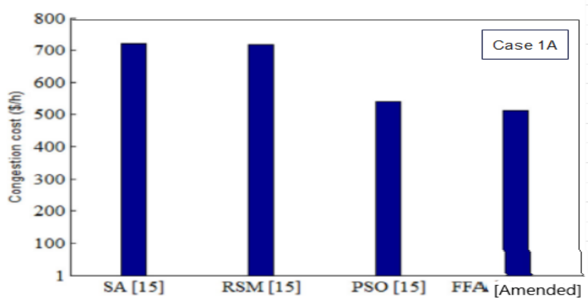
TC— total cost of the congestion;

NL— not given in the literature;

Figure 1A depicts the voltage magnitude achieved after CM using MFFA. The voltage magnitude is reported to be within limits between 0.9 and 1.1 after CM. Figure 1B shows a graphical depiction using different methods of congestion cost and real power rescheduling. After the CM, value of actual energy cost is decreased against 16.13 MW to 12.665 MW.







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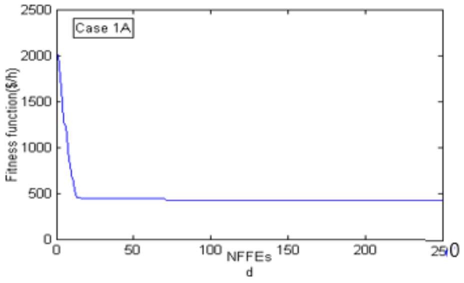


Figure 5.2. Image output now Case 1A.

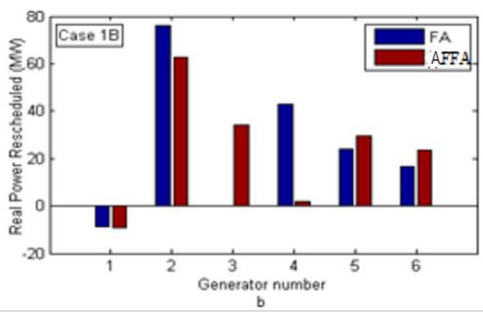
(**a**) Potential degree defined smart p.u.;

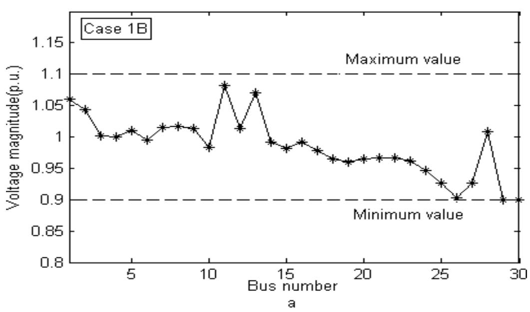
(**b**) variation in actual-Energy given in MW;

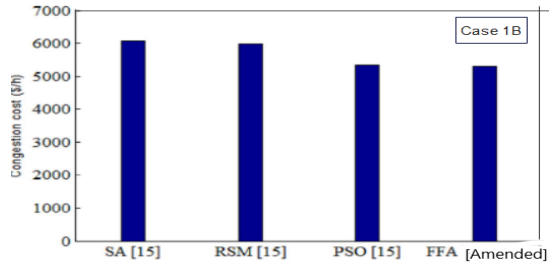
(**c**) congestion cost defined as $/h;

(**d**) Convergent figure.

In this Case 1B, a line outage between 1 and 7, combined with a 1.5-fold increase on demand, generates overloading in lines 1–2, 2–8, and 2–9. In this scenario, Table5.2 depicts the overloaded lines and line flows. In Table 5.2 depicts results of congestion amount minimization and variation of generator actual power. Figure 2B depicts a visual comparison about sudden difference new generator actual-energy also overall congestion cost. The suggested AFFA technique has a lower cost for CM than the other comparable methods. Furthermore, firstly system loss is 37.24 MW, but decreased to 14.59 MW after CM. After CM, Figure 1A displays the suggested AFFA, results of voltage of all buses using method-based fluctuation.







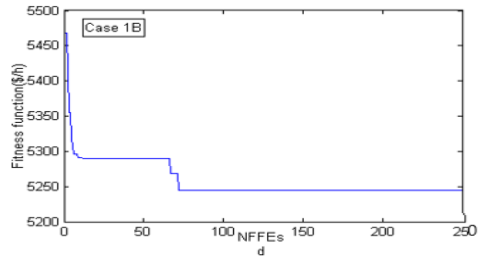


Figure 5.2. 1 Simulation output as Case 1B.

(**a**) Potential degree defined usual p.u.;

(**b**) Variation in actual-energy given in MW; (**c**) congestion cost defined as $/h;

(**d**) Convergent figure.

Improved IEEE 57-bus test system has 80 transmission lines, 50 load buses, and 7 generator buses. Overall actual energy of testing network is given as 1250.8 MW or reactive-power is 336 MVAR. Table 5.3 shows power double unequal scenarios examined for Cases 2A and 2B image.

In the scenario of Case 2A, instead of 200 MW with 50 MW line limitations from lines 5 to 6 and 6 to12 were decreased to 175 MW and 35 MW.

Table5.3 shows the specifics flow before and after CM of congested line. Lines 5–6 and 6–12 become overloaded as a result of the congestion, and the total power violation rises to 28.22 MW. The suggested MFFA algorithm's optimal value for generator real-power rescheduling entirely eliminates disturbance caused due to overloading lines. In Table 5.3 compares at least costly attained by the suggested AFFA technique from these previous methods. Figure3a shows that AFFA is based on method-based bus voltages and given by following approach of CM, which is acceptable. Graph 1a, compares the proposed AFFA methods of actual-power rescheduling and congestion amount of given existing methods. In convergent profile is shown in Figure 6.6. Before the CM, the overall system loss was 69.64 MW; after the CM, it was reduced to 24.558 MW.

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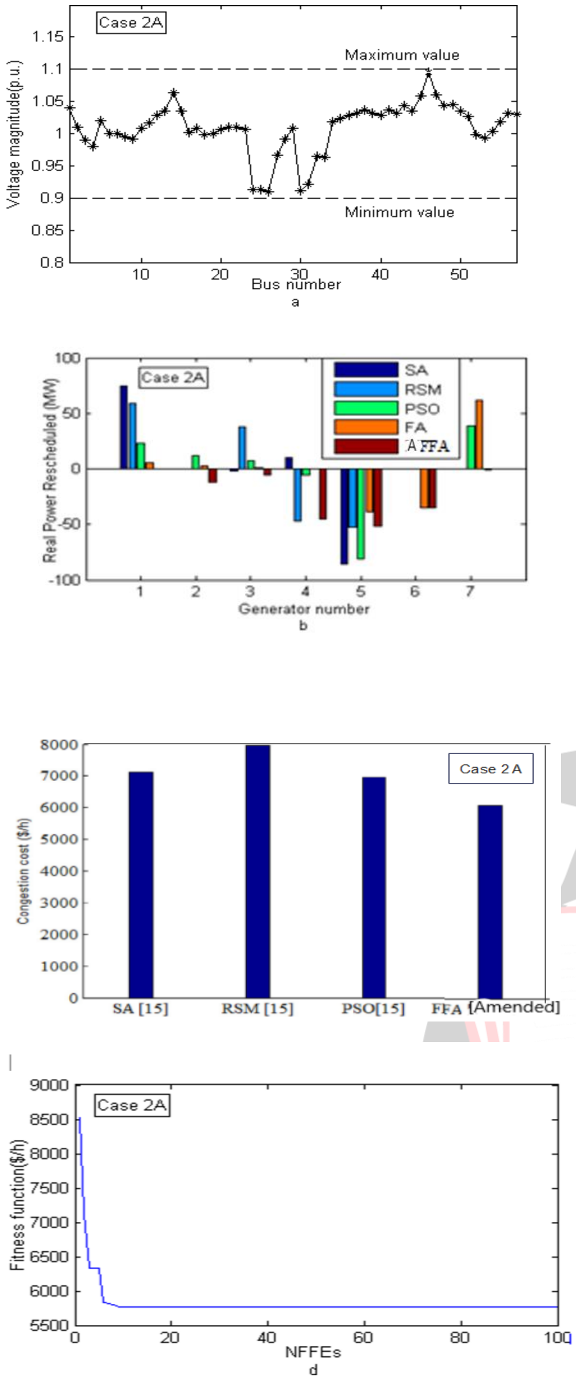


Figure 5.3. Simulation output for Case 2A.

(**a**) Potential degree given in p.u.;

(**b**)Variation in actual-energy given new MW;

(**c**) Congestion cost defined as $/h;

(**d**) Convergent figure.

Table 5.3 Balancing about image outputs for modified IEEE 57-bus test power System.

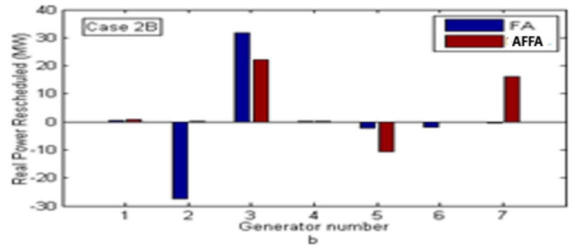
Variables	PSO [9]	FA [23]	MFFA[Proposed]
Case 2A			
TC, $/h	6951.9	6050.1	5773.27
ΔP_{G1},MW	23.13	5.6351	-0.05437
ΔP_{G2},MW	12.44	2.5230	-11.72790
ΔP_{G3},MW	7.49	0.5098	-5.81154
ΔP_{G4},MW	-5.38	0.107	-45.26118
ΔP_{G5},MW	-81.21	-39.1514	-51.32093
ΔP_{G6},MW	0	-35.1122	-34.86761
ΔP_{G6},MW	39.03	62.1938	-0.53486
TRRG,MW	168.78	145.227	144.57839
Case 2B			
TC, $/h	3117.6	2618.1	2084.78
ΔP_{G1},MW	NIL	0.3704	0.76179
ΔP_{G2},MW	NIL	-27.5084	0.08662
ΔP_{G3},MW	NIL	31.6294	22.04924
ΔP_{G4},MW	NIL	0.3308	0.17019
ΔP_{G5},MW	NIL	-2.2549	-10.50832
ΔP_{G6},MW	NIL	-1.9354	-0.00000
ΔP_{G7},MW	NIL	-0.5101	16.00743
TRRG,MW	76.314	64.5393	49.58359

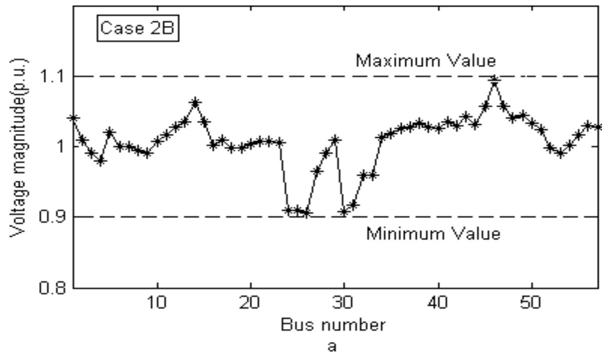
TC—total cost of the congestion;

NL—not given in the literature:

TRRG—total real-power rescheduled generators;

Case 2B, depicts Table5.1, to create line overloading line limitation is used by line 2–3 that is decreased from 85 MW to 20 MW. The characteristic of limit discharge input or CM act given in Table 5.2. Powerful output reach later implementing the suggested AFFA and different approaches are given in Table5.3 clearly shows that the cost incurred for CM is only 2084.78 $/h for the proposed AFFA method, which is the lowest among all the costs obtained so far. Comparative congestion amount offers unlike algorithms and proposed AFFA approaches are shown in Figure 2A. During congestion system minimizes the losses from 28.22 MW later CM in the act of related into 78.23 MW. Figure 5.3.1 shows the proposed-AFFA method gives the best results after CM compared with others Algorithms.





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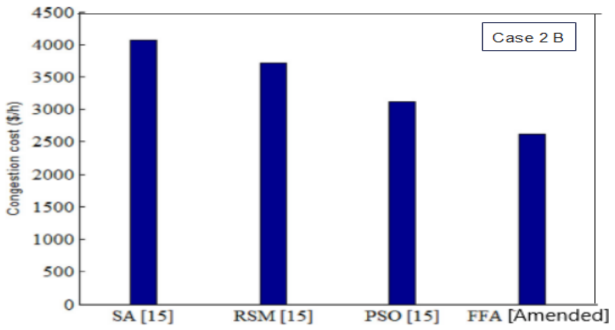

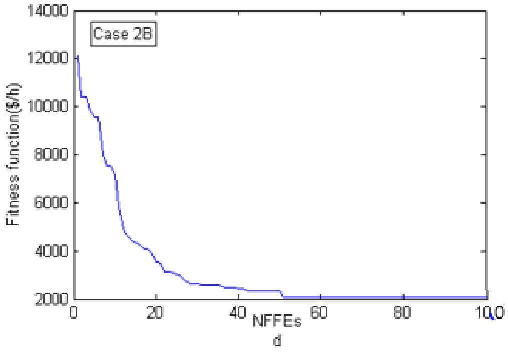

Figure 5.3.1. Output after Case 2B.

(**a**) potential degree defined latest p.u.;

(**b**) Real-power defined into MW changes;

(**c**) congestion cost shown as $/h;

(**d**) convergent figure.

VI. Conclusion

This Paper concludes that how we can solve the CM (Congestion Management) issue in open access electricity market using a unique optimization method. To get effective output from AFFA (Amended firefly algorithm) we reduce the rescheduling cost in order to remove traffic congestion. In this research we analysis occurrence of line disturbance or high-speed load change. This result shows the given technique which is differentiated from random search method, simulated annealing, and PSO (Partial Swarm Optimization) operating modified IEEE 30- and IEEE 57-bus technique. AFFA implies effective reduce congestion with rescheduling price demanded which attains remarkable reduce cost and its starting cost declares different powerful new methods. Likewise, final load is smaller than rescheduling and losses. As we have seen different process of AFFA which has feasible technique for answering a non-linear and multimodal issue. On the other hand, optimization methods such as FFA (Firefly algorithm), PSO and AFFA have included benefits of faster optimal value generation, random reduction and automated subdivision between fireflies. Separately present space includes self-improvement, the AFFA also checks out correction inside its own space from earlier steps. It is practicable to conclude that AFFA is a powerful and robust technique to solving optimization issues, resulting in the most dependable, cost effective and secure operating conditions. Future study effort might focus on using sensitivity analysis to choose participating generators as well as rescheduling. For several additional power engineering optimization applications, AFFA may be recommended as an effective optimization technique.

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