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CUCKOO SEARCH ALGORITHM COST MINIMIZATION IN THE POWER SYSTEM: A NOVEL APPROACH WITH MULTI-FACTS DEVICES

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Abstract

The distributed generation has a presence in the power system as deregulation of the power system is one of the most recent demands of the power network. This causes network losses to be unpredictable. The appropriate placement of "FACTS" devices reduces power system losses. In this paper, it is described how installing two fact devices at once may significantly enhance cost and loss reduction. This analysis makes use of "FACTS" devices like SVC, UPFC, and TCSC. Here, TCSC with UPFC, SVC with UPFC, and SVC with TCSC are taken into consideration. They were all added at the same time to the unregulated environment. With regard to cost-effective FACTS system reduction, two FACTS devices were made possible. Here, 62 buses with India's utility bus system are deployed.

Keywords :CSA,optimal placement of FACTS deregulated SVC TCSC UPFC

I.INTRODUCTION

Integrating different types of FACTS devices allows you to reap the full benefits of each type.For example, some data uses three or four types of FACTS devices such as TCSC, TCVR, TCPST, SVC [1], [2], [3], [4]. In [4] and [5] UPFC was added to the other FACTS above.In this context, the modeling approach for types, locations and values of different FACTS devices is often sought. All FACTS devices except the UPFC are well located and offer excellent reviews.Based on the UPFC comparison, which will be summarized in the app, this device has three components. Unlike the first type study [4], [5], this book covers UPFC with three performance models and other cost-effective point devices. Some publications discuss the optimal number of FACTS devices in addition to the words above [6], [1.5], [7], [8]. Following these introductory comments, we will continue to provide a comprehensive overview of this document.MATLAB uses the FACTS machine, which uses the cucumber search algorithm to use it. The user must specify the password of the pulse algorithm. The use of CSA places this document in the first part of the dissemination method. Based on the second example, we will perform the same procedure simultaneously for two types of FACTS devices: SVC-TCSC, TCSC-UPFC, SVC-UPFC. The user has the opportunity to choose the desired number and type. The user must select the power in the range of Indian 62 utility bus system connections.The model will provide digital homes FACTS, which are more efficient and cheaper in the selection process. the program. electricity to reduce the cost of FACTS devices.

II.PROBLEM FORMULATION

Bidding cost is considered as the thermal system cost curve so the biding cost can be represented as ,

$$F_i(P_{gi}) = a_i + b_i P_{gi} + c_i P_{gi}^2 \ldots..(1)$$

The incremental cost can be represented as below,

$IC_i(P_{gi}) = b_i + 2c_iP_{gi}$….(2)

Deregulated power system optimal power flow equation is given below,

$Minimize$: $\sum_{i=1}^{n} F_i(P_{gi})$….(3)

$subjectedto$: $\sum_{P_{gi}}^{N_g} P_{gi} = P_d$…(4)

$P_{imin} < P_{gi} < P_{imax}$, $i \in [1, N_g]$…..(5)

When $\sum_{i=1}^{N_g} P_{imin} > P_d or \sum_{i=1}^{N_g} P_{imax} = P_d$, -no feasible solution,

When $\sum_{i=1}^{N_g} P_{imin} = P_d$, -every customer has a contract that is a minimum of his ability.
When $\sum_{i=1}^{N_g} P_{imin} < P_d$ and $\sum_{i=1}^{N_g} P_{imin} > P_d$-non-trivial case.

Here,

$$F_i(P_{gi}) - costofgeneratori$$
$$P_{gi} - Power\ in\ MWof\ i^{th}generator$$
$$a_i, b_i, c_i - constant\ \ co-ordinate$$
$$P_{imin}, P_{imax} - minimum\ and\ maximum\ limits\ of\ i^{th}generator$$
$$P_d - PowerdemandinMW$$
$$n, N_g - Numberofgenerators$$

Facts devices costs

$C_{TCSC} = 0.0015S_{TCSC}^2 - 0.713S_{TCSC} + 153.75$…(6)
$C_{SVC} = 0.0003S_{SVC}^2 - 0.3051S_{SVC} + 127.38$…… (7)
$C_{UPFC} = 0.0003S_{UPFC}^2 - 0.2691S_{UPFC} + 188.2$ …(8)

Here,

$$IC_{devices} - investmentcostofFACTS\ devices\ in\ Rs$$
$$C_{TCSC} - TCSCcost\ per\ KVAR\ installed \text{ in Rs}$$
$$C_{SVC} - SVCcost\ per\ KVAR\ installedin\ Rs$$
$$C_{UPFC} - UPFCcostperKVAR\ installedin\ Rs$$
$$S_{TCSC} - TCSC\ capacity\ in\ MVAR$$
$$S_{SVC} - SVC\ capacity\ in\ MVAR$$
$$S_{UPFC} - TCSC\ capacity\ in\ MVAR$$

Considering the above constraints entire cost function can be represented as below .

Case I:

$$minimizeTotalCost = \sum_{i=1}^{n} F_i(P_{gi}) + IC_{SVC+TCSC} \ldots (9)$$

Case II:

$$minimizeTotalCost = \sum_{i=1}^{n} F_i(P_{gi}) + IC_{TCSC+UPFC} \ldots (10)$$

Case III:

$$minimizeTotalCost = \sum_{i=1}^{n} F_i(P_{gi}) + IC_{SVC+UPFC} \ldots (11)$$

Here,

$$IC_{SVC+TCSC} = C_{svc} + C_{TCSC} \quad (12)$$

$$IC_{TCSC+UPFC} = C_{TCSC} + C_{UPFC} \quad (13)$$

$$IC_{SVC+UPFC} = C_{SVC} + C_{UPFC} \quad (14)$$

III.CUCKOO SEARCH ALGORITHM (CSA)

The cuckoo algorithm is based on the bird named as cuckoo behavior of its reproduction. The bird cannot build the nest. It is aimed for the other birds nest for laying eggs. But birds of the nest can't allow it. They can leave the nest or push the eggs of the birds. But the cuckoo is left free as a host, and if it happens to the peak chicks, it's like the sound of the host bird. And finding the best bird nest to make a great discovery is math.

The cuckoo algorithm is based on the animal cuckbehavior of hisimprovement. The cuckoo cannot build the nest. Depends on the host's reception and engagement socket. But the nest of the wounded bird is not allowed.It can get out of the nest or throw in the eggs of birds. But the Cuckoo lays eggs that resemble those of the host, and, when defined, the Cuckoo chicks uses the sound of this bird. Therefore, the discovery of the best possible catalyst for the health of the cathode provides good research, which is presented as the next step in mathematical mathematics.

i) The first rate of variation of X over n is random.
ii) A cuckoo are selected in the collection of a distributor and evaluate the production schedule for any product.
iii) Model the end of the sample by which the measurements are selected and determined. If the new game is compatible, replace the old cuckoo.
iv) Eliminate existing areas in the sidewalk area more effectively.
v) state the detection to have the best cuckoo
vi) increase awareness and take the second step.And repeat till termination

The proposed solution algorithm is described below.

Step 1: Initializes the line and pass information, liability information, all constraints and CSA cycle.

Step 2: Initialize the population of the test strip to the number and speed of any new decisions / decisions and change the location and measurement of the device TRUE NOTE.

Step 3: Set the information on index index = 0.

Step 4: The cuckoo displays the location and level of the FACTS device, enhancing the row in the Reactivity column and the column in the barrel. Determine the level of charge and power

of the equipment. Do TWO, including FACTS equipment for normal and emergency situations. Calculate the cost of operation and the required capacity of the machine for each country.
Step 5: calculate the cost and REQUIRED the actual use of price management of all related and potential costs. Calculate funding costs for equipment used (12/13/14).
Step 6: Applying the importance of the focus function (10/09/11), subject to any constraints. If some of the penalties for violating the restrictions are added to the price. The calculated value of the fitness function is served as a fitness value of a cuckoo.
Step 7: Each cuckoo value is optimized. If the price of the body is lower than the local best, set this price as the best local option and hold the cuckoo position for that best in the local.
Step 8: Select the lowest price of the best local ingredients as the highest quality and best, and record the packoo level to match this highest value.
Step 9: Update the update to anyone.
Step 10: If you get the highest number of repeats, the cuckoo is connected
now Global is the best solution. Otherwise, set ite = know + 1 and go to step 4. And repeat until done

IV.RESULTS AND DISCUSSION

The test system is 62 bus system solved CSA is taken here. As shown in the results the fitness value of CSA. As it is optimal power flow the losses also considered here.When a 19-generator system is used to operate efficiently, the cost of generation is reduced. we use the same 19 generation system as the test system and we implement the facts devices with inclusion of investment cost.

The FACTS devices considered here are SVC with TCSC, TCSC with UPFC and SVC with UPFC. SVC and UPFC models are taken as reactive power model and the TCSC is taken as reactance model.

The objective function discussed in equations (9/10/11) is taken as a fitness equation with voltage limit and power flow constraints. The well-known metaheuristic algorithm called CSA algorithms is used for testing the fitness function for without facts devices. The results obtained arediscussed below.

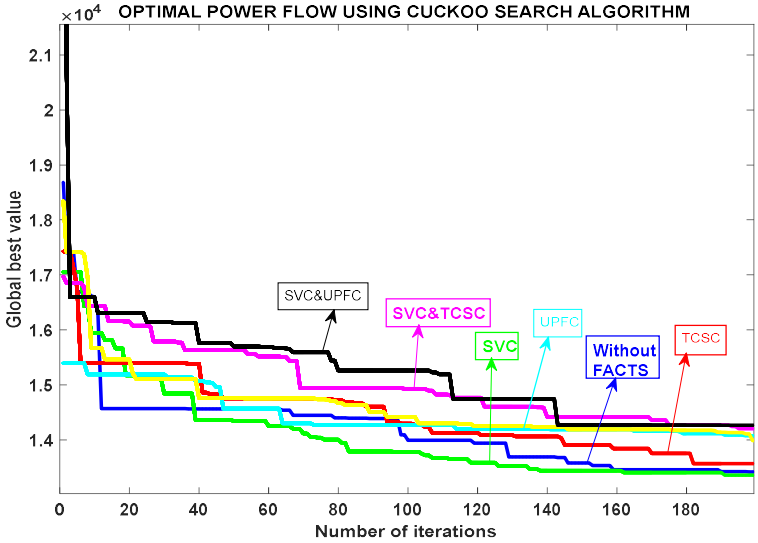

Fig.1 convergence curve for Indian utility 62 Bus System

Table I-Voltage in Pu for Indian utility 62 Bus System

Bus no.	WO	SVC	TCSC	UPFC	SVC&TCSC	TCSC&UPFC	SVC&UPFC
1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100
3	1.0088	1.0080	1.0080	1.0088	1.0084	1.0080	1.0080
4	1.0066	1.0047	1.0047	1.0066	1.0056	1.0048	1.0048
5	1.0200	1.0100	1.0100	1.0200	1.0100	1.0100	1.0100
6	1.0130	1.0094	1.0092	1.0129	1.0092	1.0091	1.0090
7	1.0138	1.0097	1.0095	1.0137	1.0096	1.0094	1.0093
8	1.0145	1.0099	1.0097	1.0144	1.0098	1.0096	1.0095
9	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100
10	1.0144	1.0128	1.0142	1.0150	1.0132	1.0150	1.0146
11	1.0170	1.0151	1.0169	1.0177	1.0152	1.0177	1.0170
12	1.0250	1.0229	1.0252	1.0257	1.0207	1.0257	1.0229
13	1.0129	1.0115	1.0130	1.0134	1.0111	1.0135	1.0127
14	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0042	1.0031	1.0031	1.0042	1.0065	1.0032	1.0032
16	1.0030	1.0028	1.0029	1.0033	1.0029	1.0033	1.0032
17	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18	1.0002	1.0002	1.0002	1.0002	1.0002	1.0002	1.0002
19	1.0012	1.0012	1.0012	1.0012	1.0012	1.0012	1.0012
20	1.0228	1.0218	1.0229	1.0226	1.0195	1.0230	1.0217

21	1.0079	1.0072	1.0076	1.0067	1.0025	1.0076	1.0077
22	1.0025	1.0021	1.0024	1.0021	1.0005	1.0024	1.0024
23	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
24	1.0072	1.0069	1.0085	1.0087	1.0088	1.0077	1.0088
25	1.0000	1.0100	1.0000	1.0000	1.0000	1.0000	1.0000
26	1.0022	1.0123	1.0022	1.0022	1.0022	1.0022	1.0022
27	1.0139	1.0209	1.0157	1.0159	1.0161	1.0145	1.0156
28	1.0028	1.0434	1.0028	1.0028	1.0028	1.0028	1.0028
29	1.0182	1.0240	1.0206	1.0209	1.0211	1.0191	1.0205
30	1.0239	1.0251	1.0270	1.0275	1.0277	1.0250	1.0280
31	1.0186	1.0191	1.0214	1.0219	1.0221	1.0196	1.0222
32	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
33	1.0200	1.0200	1.0200	1.0200	1.0100	1.0200	1.0200
34	1.0200	1.0200	1.0200	1.0100	1.0100	1.0200	1.0200
35	1.0014	1.0014	1.0014	1.0007	1.0007	1.0014	1.0014
36	1.0042	1.0042	1.0042	1.0042	1.0042	1.0042	1.0042
37	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200
38	1.0227	1.0227	1.0228	1.0179	1.0179	1.0229	1.0228
39	1.0206	1.0204	1.0215	1.0217	1.0218	1.0210	1.0218
40	1.0239	1.0243	1.0267	1.0272	1.0274	1.0250	1.0276
41	1.0219	1.0217	1.0245	1.0249	1.0251	1.0230	1.0252

42	1.0226	1.0223	1.0251	1.0255	1.0257	1.0237	1.0257
43	1.0247	1.0244	1.0272	1.0276	1.0278	1.0257	1.0278
44	1.0276	1.0272	1.0293	1.0299	1.0295	1.0287	1.0298
45	1.0194	1.0191	1.0220	1.0224	1.0226	1.0204	1.0226
46	1.0201	1.0200	1.0203	1.0201	1.0200	1.0202	1.0203
47	1.0197	1.0197	1.0197	1.0183	1.0174	1.0197	1.0198
48	1.0127	1.0127	1.0114	1.0126	1.0112	1.0114	1.0114
49	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100
50	1.0100	1.0100	1.0100	1.0100	1.0100	1.0100	1.0000
51	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200
52	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200
53	1.0232	1.0232	1.0234	1.0230	1.0233	1.0232	1.0233
54	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200
55	1.0208	1.0203	1.0219	1.0209	1.0142	1.0210	1.0151
56	1.0139	1.0139	1.0139	1.0139	1.0038	1.0159	1.0038
57	1.0200	1.0200	1.0200	1.0200	1.0100	1.0200	1.0100
58	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200	1.0200
59	1.0271	1.0268	1.0283	1.0289	1.0283	1.0280	1.0288
60	1.0230	1.0227	1.0233	1.0235	1.0226	1.0233	1.0233
61	1.0229	1.0230	1.0233	1.0235	1.0229	1.0232	1.0237
62	1.0157	1.0209	1.0162	1.0157	1.0153	1.0157	1.0198

Table II-Comparison of Transmission Loss & Cost with Facts devices for Indian utility 62 Bus System

	TL in MW	Cost in Rupees	Place	size in MW	size in pu of reactance
WO	12.984667	9402436.192149	-	-	-
SVC	19.4262591	**944364.757413**	28	57.1252163	-
TCSC	**1.63496829**	**959341.587358**	6	-	0.538594937
UPFC	22.1360396	995066.767513	2	17.2187173	0.396253084
SVC+TCSC	**1.03518198**	1004338.921922	15, 72	23.8132646	0.8
TCSC+UPFC	5.77819432	10780045.409133	79,56	41.4832152	0.0013,-0.5366
SVC+UPFC	11.3675433	1008471.705269	62,62	9.19423983	-0.8

Table III-The Power Generation Pattern for Indian utility 62 Bus System

Gen no.	WO	SVC	TCSC	UPFC	SVC+TCSC	TCSC+UPFC	SVC+UPFC
Pg1	52.59	10.62	44.27	56.49	40.37	67.33	64.68
Pg2	175.18	238.14	192.63	277.99	408.63	228.17	234.88
Pg3	312.76	157.91	198.21	344.39	236.17	228.22	246.80
Pg4	141.52	150.00	131.66	145.98	150.00	148.13	149.99
Pg5	74.99	162.90	194.23	286.24	59.11	224.35	299.64
Pg6	308.45	233.29	340.53	183.39	450.00	257.15	227.53
Pg7	75.22	127.18	128.61	122.48	116.21	50.45	171.67
Pg8	99.06	60.96	172.01	66.26	50.00	101.87	152.22
Pg9	226.62	257.83	142.80	62.11	44.35	214.88	109.71
Pg10	98.71	100.00	97.37	100.00	53.91	99.94	95.77
Pg11	150.00	150.00	123.51	91.13	128.61	148.78	150.00
Pg12	99.79	98.79	100.00	84.93	97.61	95.45	100.00
Pg13	294.49	299.65	187.31	300.00	283.66	166.51	237.08
Pg14	146.40	134.49	150.00	150.00	142.67	143.82	39.20

Pg15	111.16	139.68	108.67	178.95	171.20	207.52	153.14
Pg16	127.47	147.35	149.99	61.35	135.01	107.26	148.95
Pg17	99.93	99.92	79.05	96.51	99.70	94.73	69.07
Pg18	264.47	299.63	299.83	253.35	179.69	274.11	193.74
Pg19	111.99	108.86	118.75	118.37	111.94	104.90	125.10

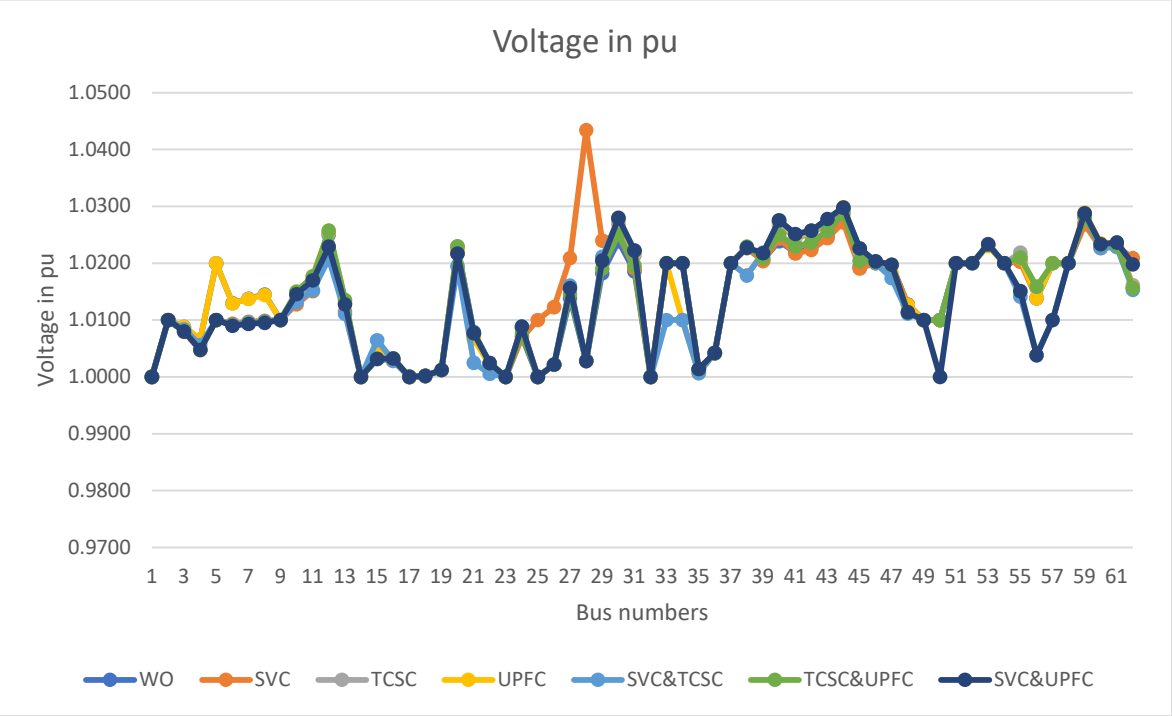

Fig. 2 Voltage profile for Indian utility 62 Bus System

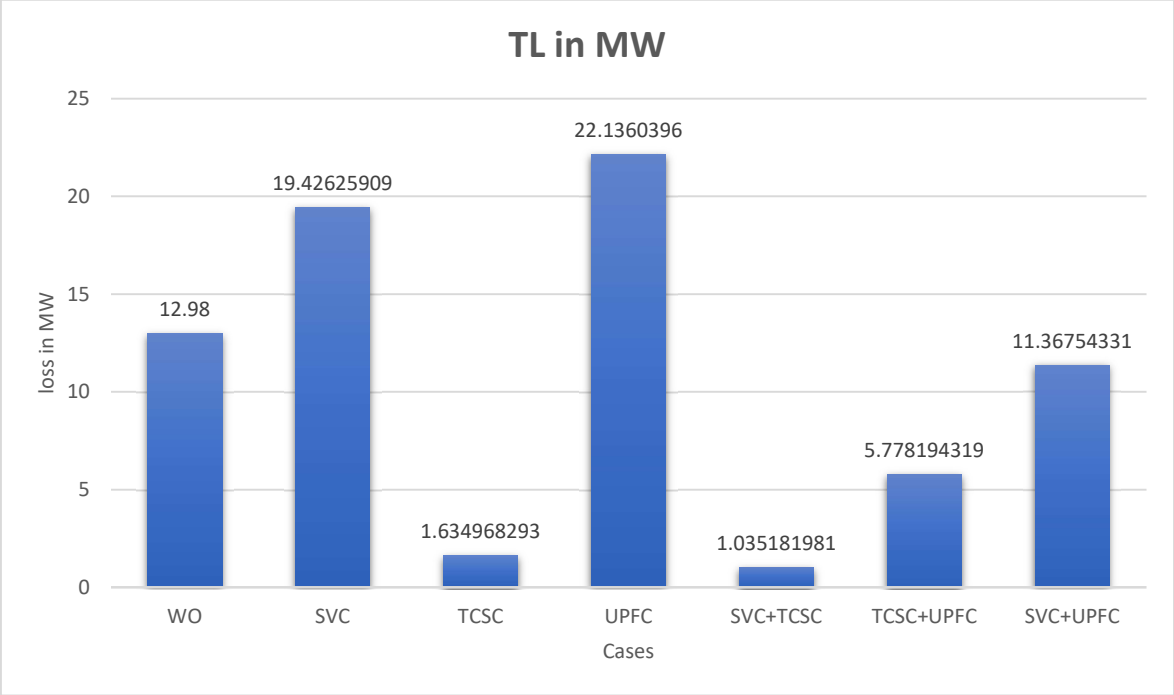

Fig.3 Total loss in MW in each cases for Indian utility 62 Bus System

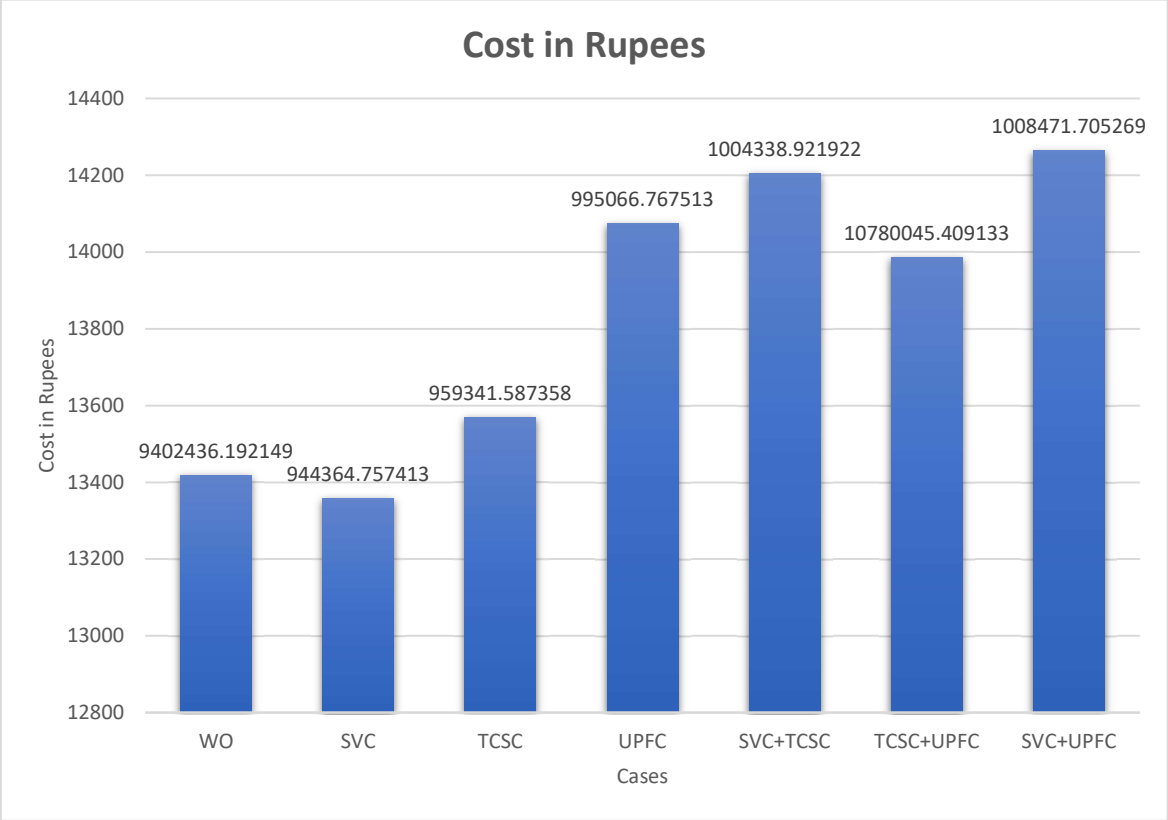

Fig.4 Cost in Rs for Indian utility 62 Bus System

The fig.1 shows the convergence curve. It can be seen that SVC gives lesser cost compared to SVC with TCSC and TCSC with UPFC. But loss is not minimized drastically from the single FACTS devices to multiple facts devices. Table II shows the comparison of the

loss cost and locations of the FACTS devices. The fig.2 shows the voltage profile. Here in all the cases the voltages are within limit. The voltage profiles are nearly equal. Fig.3 shows the power loss from the system after and before placement of SVC with TCSC, TCSC with UPFC and SVC with UPFC. Here the minimum loss generated by the SVC& TCSC case. And TCSC single also produces lesser loss. The loss reduction is drastic from 12.98 MW to 1.03MW. From table II it is evident that minimum cost is achieved when the SVC alone is placed. But minimum loss is achieved when combining the SVC & TCSC. But TCSC alone reduces loss as well as cost compared to other SVC with TCSC and TCSC with UPFC.

V.CONCLUSION

The combination of SVC with TCSC, TCSC and UPFC and SVC with UPFC is characterized by reduced operating costs and production costs over time. The cuckoo search algorithm is used here as the solution technique. And the Indian 62 utility bus, which is also is considered here for testing the performances. The comparison is provided in the results and discussion section. The TCSC performs better in cost and loss. SVC alone gives better cost. Combination of SVC&TCSC gives better loss.

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