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by Alimuddin Alimuddin

Optimization Placement Static Var Compensator (SVC) Using Artificial Bee Colony (ABC) Method On PT PLN (Persero) Jawa-Bali, Indonesia

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Abstract*— Reactive power injection using Static Var Compensator (SVC) is one of the efforts that can be used to overcome the problem of transmission power loss and voltage drop caused by the increase of electrical load. Artificial bee colony (ABC) is an optimization method used to determine the position and capacity of SVC. The research purpose for knowing the location and optimal capacity of SVC in IEEE-30 Bus System using Newton-Raphson method and Artificial Bee Colony (ABC). The data to be used is primary data consisting of data bus, data channel, and data generator on Java-Bali transmission system 500 kV and data processing using software Matlab. Result and discussion First, SVC installation proved able to overcome the voltage problems so that the voltage level of all buses can meet the allowable voltage limits. Secondly, SVC installation is capable of reducing power line losses. Third, there is a decrease in active and reactive power loss by using ABC method at 100% loading and 80% loading. Fourth, There is a decrease in active and reactive power loss as well as the largest loss of power losses is when the maximum loading

***Keywords- ABC-SVC,* transmission power loss, voltage drop**

I. INTRODUCTION

The demand for electric power from year to year in big cities grew rapidly along with the increase of industrial loads, resulting in decreased power distribution capacity, voltage fluctuations, increased power losses, especially on transmission lines. Along with the growing demand for electric power, power electronics are also experiencing very rapid development, in particular the Flexible AC Transmission System (FACTS) equipment, Static VAR Compensator (SVC), which has been widely used in transmission systems since the late 1970s. SVC can improve the performance of power transmission and distribution systems in various ways of generating and absorbing variable reactive power by using a switch from a thyristor. Installation of SVC at one or more points on the transmission network can increase the capacity of power distribution and reduce power losses while maintaining the voltage profile [1].

Much research has been undertaken to apply SVC equipment in dealing with various issues related to the electricity system. Is used the Ant Colony Optimization method in determining the optimal SVC MVAR on the 500 KV Java-Bali transmission system [1].
As for the other research of using Artificial Bee Colony method in determining the optimal MVAR of SVC on 500 KV Java-Bali transmission system [2]. This research uses the Bacteria Foraging Algorithm method in determining the optimal SVC MVAR of the 500 KV Java-Bali systems [3]. This research is provided Newton-Raphson method power flow modeling with SVC injection to obtain better power flow results [4]. This research uses the Artificial Bee Colony method in determining optimal power flow with SVC [5]. Some of the studies mentioned indicate that FACTS can be used to improve power flow, including reducing power loss.
A common problem that occurs in a system is the determination of the optimal location and rating of FACTS equipment, which in this study is SVC, to be allocated in power systems. Based on this, the author tries to apply the Artificial Bee Colony (ABC) method for optimization of SVC placement on 500 kV Jamali Power System. The research purpose for knowing the location and optimal capacity of SVC in IEEE-30 Bus System using Newton-Raphson method and *Artificial Bee Colony* (ABC).

II. METHODE

The data to be used is primary data consisting of data bus, data channel, and data generator on Java-Bali transmission system 500 kV Research in using MATLAB software in analyzing system. The process of data analysis performed is as follows: *The first*, for 500 kV Java-Bali transmission system data that has been obtained is then processed and recalculated for inclusion into M-Files present in MATLAB software. *The Second*, For data has been entered into the M-File then simulated using Newton-Raphson power flow calculation method, *The third*, Simulation results obtained using Newton-

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Raphson power flow calculation is the value of voltage profile and power losses on each bus.*The Four*, for basing on the value of voltage profile from the previous simulation will be done simulation placement and capacity of SVC with method of Artificial Bee Colony (ABC) algorithm under different loading conditions. *The five*, in this simulation use three different types of loading, i.e. 100%. The result obtained is the value of voltage profile and power loss of each bus. *The six*, Simulations before SVC placement and after SVC placement were compared, whether with SVC placement could improve the voltage profile and be able to decrease the power losses in the 500 kV Java-Bali transmission system. The data used for this research is single line diagram, input data generator, channel, and load of Java-Bali transmission system 500 kV. Single line diagram of Java-Bali transmission system 500 kV shown in Figure 1

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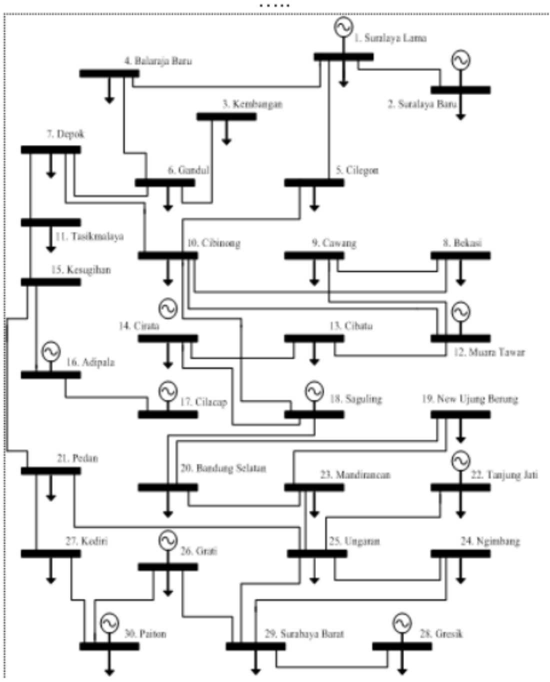

Figure 1. Single Line Transmission Diagram Jaw-Bali 500 kV.

The Jaw-Bali transmission image consists of 30 buses. The buses are classified as follows: Reference bus: Bus the old Suralaya.Bus generator: New Suralaya Bus, Muaratawar Bus, Bus Cirata, Adipala Bus, Cilacap Bus, Saguling Bus, Tanjung Jati Bus, Grati Bus, New Gresik Bus, and Paiton Bus. Bus load: Kembangan Bus, New Balaraja Bus, Cilegon Bus, Gandul Bus, Bus Depok, Bus Bekasi, Bus Cawang, Cibinong Bus, Tasikmalaya Bus, Cibatu Bus, Kesugihan Bus, Ujung Berung Baru Bus, South Bandung Bus, Pedan Bus, Mandirancan Bus, Ngimbang Bus, Ungaran Bus, Kediri Bus, and West Surabaya Bus. The power flow simulation consists of two experiments, before SVC placement and after SVC placement implemented using ABC algorithm using Software used is MATLAB 7.11.0 (R2010b). The data to be used is primary data consisting of data bus, data channel, and data generator on Jawa-Bali transmission system 500 kV.

III. RESULT AND DISCUSSION

Power Flow Analysis of Jawa-Bali Transmission System 500 kV. The result of power flow analysis from Java-Bali 500 kV transmission system is simulated using Newton-Raphson method. The power flow simulation results prior to SVC placement under 100% loading conditions are carried out in order to know the initial conditions on the 500 kV Java-Bali transmission line and then the results will be compared with the power flow after SVC placement. The parameter values used in Newton-Raphson are the base voltage of 500 kV, the base power of 1000 MVA, the accuracy of 0.001, the acceleration of 1.1 and the maximum iteration of 100. The result of running the power flow program prior to SVC placement at 100% loading using Newton-Raphson method with total active power load (P) of 12090.038 MW and total reactive power load (Q) of 4530,166 MVAR, and total active power generation P) of 12360.828 MW and total reactive power generation (Q) of 7324.03 MVAR. The voltage values on buses 8, 9, 13, 19, 20 and 23 are below the standard, 0.95 pu. After the simulation, the optimal location and capacity of SVC at 100% loading are as follows:

1. Bus 3 = 256.7307 MVAR
2. Bus 8 = 259.1591 MVAR
3. Bus 11 = 300 MVAR
4. Bus 13 = 267.9126 MVAR
5. Bus 19 = 195.7614 MVAR
6. Bus 21 = 300 MVAR
7. Bus 23 = 292.5550 MVAR
8. Bus 25 = 300 MVAR
9. Bus 27 = 295.2850 MVAR
10. Bus 29 = 160.8732 MVAR

Figure 2. shows the graph of bus voltage comparison before SVC placement and after SVC placement at 100% loading. From the graph it can be seen that after the placement of SVC using ABC algorithm the value of the bus voltage profile is critical changed to the value of the allowable voltage profile.

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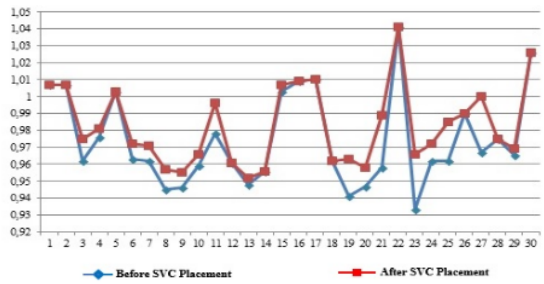

Figure 2. Comparison Graph of Each Bus's Voltage Before and After SVC Placement On 100% Charging

Figure 2 shows the power losses of each channel after SVC placement under 100% loading conditions and optimized using ABC algorithm method with total active power loss (P) of 252,7992 MW and total reactive power loss (Q) of 2602,2272 MVAR

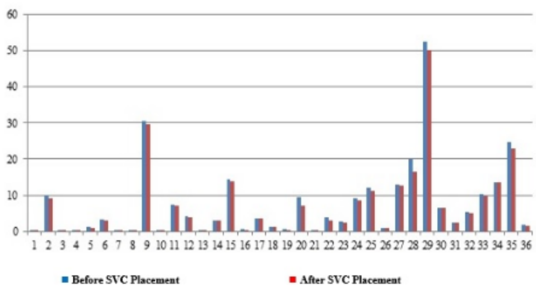

Figure 3. Graph of Comparison of Active Power Loss Channels Before and After SVC Placement.

Figure 3 shows the results of running the power flow program after optimized SVC placement using ABC algorithm method with total active power load (P) 7254,023 MW and total reactive power load (Q) of 2718.1 MVAR, and total active power generation P) of 7348,191 MW, total reactive power generation (Q) of 1738,72 MVAR and total capacity of SVC (Q) equal to 2283,222 MVAR.

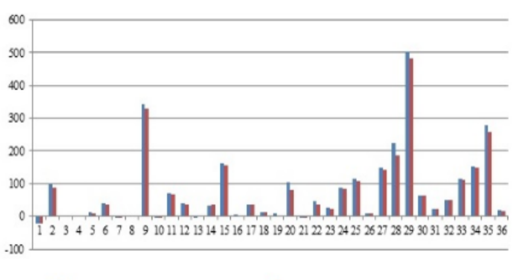

Figure 4 Comparison Reactive Power Loss Channels Before and After SVC Placement On 100% Charge.

Figure 4 shows the decrease of reactive power loss (Q) before SVC placement and after SVC placement at 100% loading of 191,6712 MVAR. It can be concluded that after SVC placement, the total power losses decreased by 17,9927 MW + j191,6712 MVAR, from the initial losses of 270,7919 MW + j2793,8984 MVAR to 252,7992 MW losses + j2602,2272 MVAR.

After the simulation, the optimal location and capacity of SVC at 80% loading, as follows:

1. Bus 3 = 182.4707 MVAR
2. Bus 8 = 256.2633 MVAR
3. Bus 11 = 252.4921 MVAR
4. Bus 15 = 287.3624 MVAR
5. Bus 19 = 233.8716 MVAR
6. Bus 21 = 300 MVAR
7. Bus 23 = 300 MVAR
8. Bus 24 = 300 MVAR
9. Bus 25 = 300 MVAR
10. Bus 27 = 224.5745 MVAR

Figure 5 shows a graph of bus voltage comparison before SVC placement and after SVC placement at 80% loading. From the graph it can be seen that after the placement of SVC using ABC algorithm the value of the bus voltage profile is critical changed to the value of the allowable voltage profile.

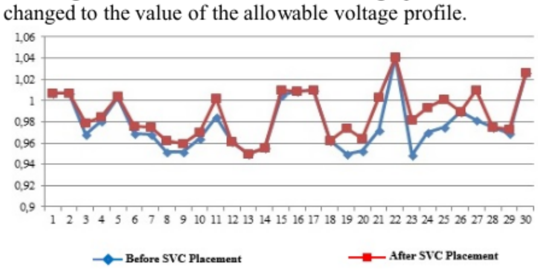

Figure 5 Graph of Comparison of Voltage of Each Bus Before and After SVC Placement On 80% Charging.

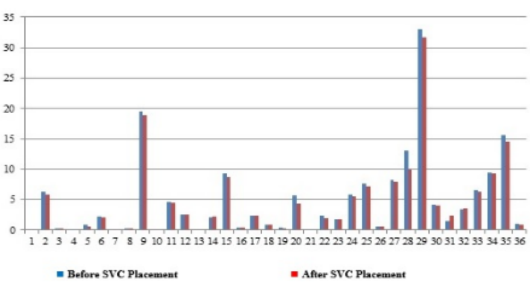

Figure 6 Graph of Comparison of Active Power Loss Channel Before and After SVC Placement On 80% Charging.

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Figure 6. shows the decrease of active power loss (P) before SVC placement and after SVC placement at 80% loading of 9.987 MW.

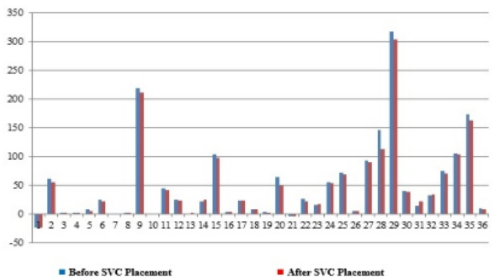

Figure 7. Chart Comparison of Reactive Power Loss Channels Before and After SVC Placement On 80% Charging.

Figure 7 shows the decrease of reactive power loss (Q) before SVC placement and after SVC placement at 80% loading of 108,694 MVAR. It can be concluded that after SVC placement, the total loss of power has decreased by 9,987 MW + j108,694 MVAR, from the initial loss of 172,691 MW + j1767,205 MVAR to loss of 162,704 MW + j1658,511 MVAR.

IV. CONSCULATION

From the research that has been done, obtained some conclusions as follows is : First, SVC installation proved able to overcome the voltage problems so that the voltage level of all buses can meet the allowable voltage limits. Secondly, SVC installation is capable of reducing power line losses. Third, There is a decrease in active and reactive power loss by using ABC method at 100% loading and 80% loading. Fourth, There is a decrease in active and reactive power loss as well as the largest loss of power losses is when the maximum loading.

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