PERFORMANCEOF GEOGRAPHIC INFORMATION SYSTEM (GIS) IN ORDER TO REDUCE LOSSES OF DISTRIBUTION NETWORK OF SISTAN AND BELUCHESTAN PROVINCE: A CASE STUDY(ASPEECH FEEDER)

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ABSTRACT

Using GIS technology is one of the most important issues in the studies and design of power networks by which the weaknesses of the system are identified and suitable solutions for future planning and optimal operation of the studied network are proposed. As electric energy distribution networks is one of most suitable cases regarding studies by GIS knowledge, the study evaluated power network in distribution level. In this thesis, the suitable basis of calculations of distribution systems is based on using spatial and descriptive information by GPS system and in the next stage, its implementation is done in ARC GIS software and finally information transfer to Digsilent software for losses calculations operation to entrance parameters. A the beginning of this method, distribution network losses was evaluated in the level of a sample feeder and then by optimization solutions and system correction, we consider the followings: 1- Capacitor placement, 2- Increasing the area level of branching levels, 3-Increasing the area of the main branch, 4- Reduction of feeder length and prediction of constructing new station at the beginning of feeder to reduce losses. The present study aimed to present required solutions to present the required planning regarding reduction of losses and satisfying the power users of Sistan Baluchistan province. Besides, case study is done on Aspich feeder of Saravan town.

Key words: *GPS-GIS, Distribution Networks, Losses reduction*

Introduction

Increasing development of power industry and not eliminating the shortcomings of electricity distribution networks from the view of consumers and technological deprivation had some problems in distribution system of electric energy (Goodchild, 2009). As 25% of power industry investment is dedicated to distribution section (Wei et al., 2010) and the lack of correct design, system guiding without planning and determining the goals without projects control made national capital at loss, energy loss and dissatisfaction and pessimism of the users were considered (Mohantaet al., 2010). Thus, the necessity of education and transferring technical knowledge, innovation, observing technical points and standards, supervision, control and evaluation in distribution systems (Saeedi, 2010). The distribution networks can transfer electricity from production places to consumption and the networks with lower reliability have high disconnections and losses and thus this issue, undistributed or sold energy is increased and using GIS management for planning and prevention of achieving critical point and the increase of the number of disconnections and the increase of undistributed energy and losses and costs are increased (Barband, 2012).

The routine issues involved in distribution industry of electric energy are including:

- The inconsistency of conductors current with users current (Maet al., 2011)
- Non-engineering design of distribution networks as non-standard (Duan et al., 2011)
- Unallowable robbing of distribution networks wires (Linget al., 2012)
- The effects of flooding and thunder
- Imbalance of load and current from zero conductor
- Unsuitable distribution of transformersload
- Unsuitable operation coefficient transformers
- Low power coefficient
- The lack of station in load gravity center
- Long ray of station feed
- Construction of network with high current and single phase

- Loose connections
- High resistance of earth
- The lack of maintenance of network equipment
- Leakage of current of collision of tree branches with the network lines
- The wrong application of common connections to networks (Wang & Wang, 2004).

Network wear out and the increase of transformers life (Dong-minget al., 2009).

In the past, traditional methods of descriptive spatial information collection are including various problems:

Inaccuracy, lack of information control, lack of rapid access to information, complexity of synchronization of information, complexity of storage of information and finally the above problems and needs caused that power industry organizations mechanized their activities and moved to optimal management in this industry. Thus, implementation of GIS system was done to manage spatial-descriptive information and identification of barriers and needs and solving the problems by traditional method. The present study based on the spatial and descriptive information collected in GIS environment and based on the instructions of TavanirCompany, showed the effect and efficiency of the information in doing various analyses on an average pressure feeder in Sitan and Beluchestan province with the main goal of reducing the losses.

Research methodology

To do the study, at first, the needs were identified and information layers (spatial and descriptive) of average pressure network of the province were identified. To provide the required layers, all the existing codes in paper maps were transferred to Urban 2000 maps. The average pressure network layer of electricity distribution by DWG format was distributed from the company and was used in GIS environment. TO provide descriptive data of network (bases, material of the average pressure lines, area of lines, network arrangement and etc.), the existing documents, field visit and etc. were used.

The present study was done in some stages: First stage: Ground making; second stage-receiving and investigation of information, third stage: correction of information of average pressure network of the province, fourth stage: updating the information of average pressure networks province, Fifth stage: Implementation of corrected and update information in the required software.

Results

The collection if power distribution networks based on GIS is of great importance from two views of spatial and descriptive information. Thus, most of the common software in power industry for network analysis can recall information from GIS environment. One of the software is DIgSILENT and it is used in our country as the main software of power networks analysis.

To do this, the information is transferred from GIS environment to DIgSILENT software environment. This aim is including spatial and descriptive information. It is obvious that good accuracy of information of network (e.g. length, lines area, location and capacity of distribution stations) guarantee the results of load distribution calculations.

Here, case study was done on Aspich feeder in Saravan town (figure 1, Table 1).

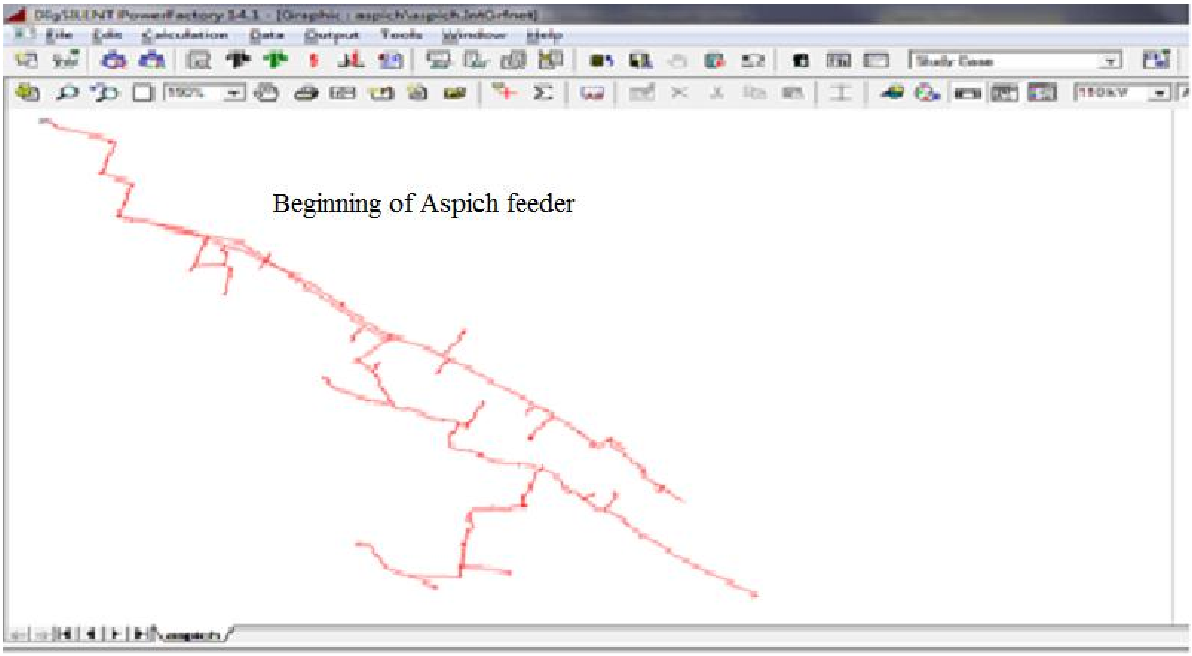

Figure 1- Aspich feeder of Saravan town

Table 1: Aspich feeder specifications of Saravan City

The length of the main branch of feeder	about 13,km
The length of feeder	about 32,km
Feeder load in peack	2.5 mega watt
The type of use of Feeder loads	Residential
Loads power coefficient	0.8 post phase
The number of distribution posts	54 systems
Capacity of distribution posts	7.21 mega volt ampere

Based on the special conditions of the region in terms of load dispersion, long feeder that is with severe voltage loss and their losses reduction percentage is high, the losses of the network calculation power in existing condition is exceeding 388.17 kilowatt. At first the existing condition of Aspich feeder (technical features of network) is updated, all the technical parameters including the bases location, conductors area in all distances, transformers capacity, maximum load of posts (loading of posts) and other collected data and its implementation was done in GIS environment. Then, by GIS intermediary software to Digsilent, the data entered the software. Finally, the load distribution calculations were done before and after capacitor placement and the results of the calculations were as followings:

Case study 1: The investigation of the effect of capacitor placement on reduction of losses. The method of calculations: In this example, by two sensitivity analysis methods and Tabu search method, capacitor placement calculations were done.

In the first method: By defining the index of efficiency of losses reduction changes, the reduction of losses for adding capacitor to each terminal is calculated. Doing this for all the points and defining the reduction of losses in each point and place with the highest influence of identification and capacitor are used. This trend continues for remaining points to the time benefit criterion is responsive to the costs. In the second method: Based on the definition of costs function (investment plus the losses) and by Tabu search method, the good points for capacitor placement are identified to make the target function minimized. The results are shown in Figure 2. One of the important points in solving this problem is identification of good and executive places to place capacitor and the data are collected from GIS environment (Figure 3 , 4). Table 2: compare the losses before and after capacitating and calculations in Digsilent.

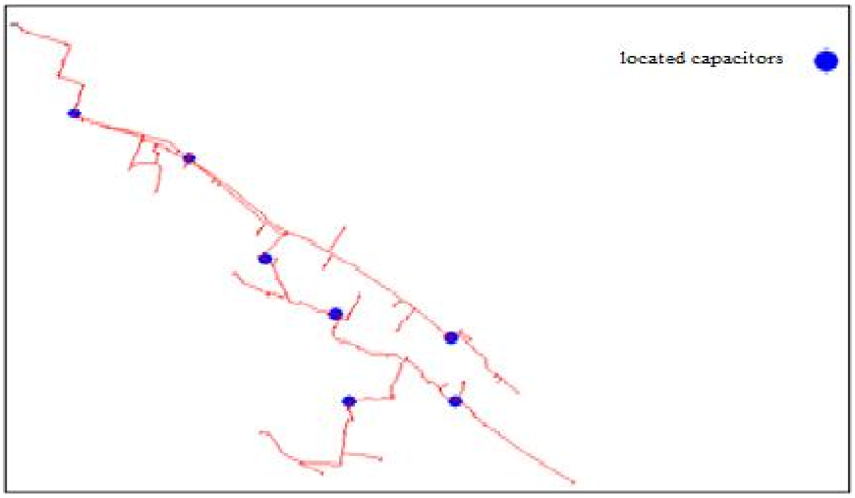

Figure 2: Capacitor placements using sensitivity analysis in Digsilent

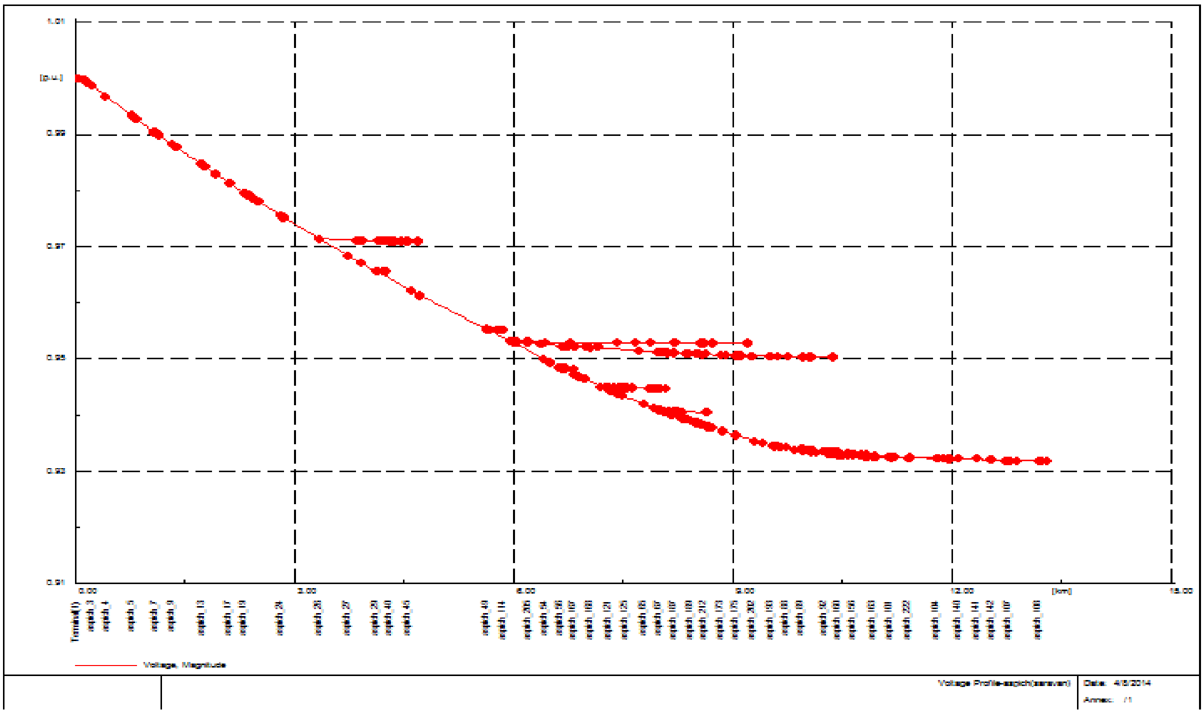

Figure 3: Voltage profile before capacitating

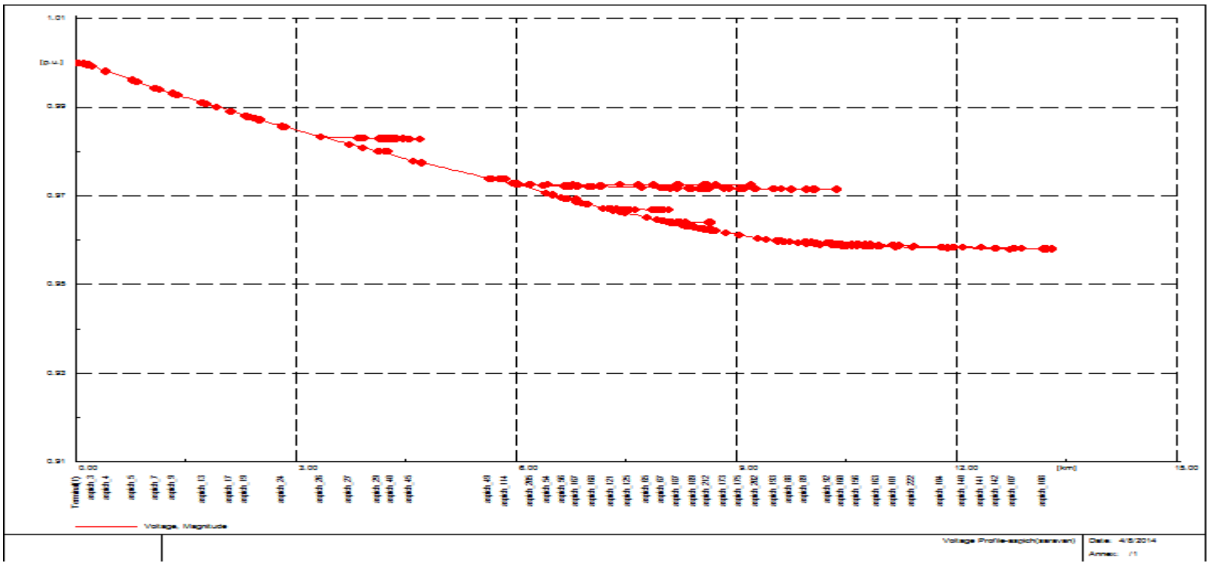

Figure 4: Voltage profile after capacitating

Table 2: comparison of losses before and after capacitating and calculations in Digsilent

Aspich	feeder
Before capacitor placement- Losses of power	388.17 kilowatt
After capacitor placement- the losses of power	280.45 kilowatt

As is shown in the results, capacitor placement reduced the losses to 27.75%.

Case study 2: The study of the effect of increasing area in sub branches on reduction of the Aspich feeder losses

Regarding the increase of area as the resistance is reduced, voltage is also reduced and power loss is reduced. Thus, loss power in cable is reduced. The Aspich feeder length is about 40km, of which about 13 km is the length of main feeder and the rest is the length of branches. Thus, by considering the losses of power before and after the increase of area of conductors, the following results are achieved. It can be said that conductors' area with the length considered via GIS software and existing Geographical coordinate of the feeder is as shown in Table 3.Table 4 shows a comparison of losses before and after increasing the cross section of sub branch and calculations in Digisilent

Table 3- The summery of the features of the applied conductor in sub branches of Aspich feeder

Conductor	Arrangement	Number of circuits	Length	X	Y
Name: MINK, Area :70	Parallel horizontal	Single circuit	487.9119	436392	3026097
Name: FOX, Area :50	Parallel horizontal	Single circuit	66.12866	435930	3026008

Table 4: comparison of losses before and after increasing the cross section of sub branch and calculations in Digisilent

Aspich	Feeder
Before correcting the area-losses of power	388.17 kilowatt
After correction of area-losses of power	366.19 kilowatt
5.66%	Reduced losses (%)

As is shown, the conductor area of sub branches includes FOX:50mm^2,MINK:70mm^2 and reduction of the losses of above conductors area was corrected to FOX:70mm^2,MINK:95mm^2

and the results of the calculations of load distribution showed reduction 5.66% of losses and the losses reduced from 388.17 kilowatt to 366.19 kilowatt.

Case study 3: The study of the effect of increasing area in main branch on reduction of the losses of Aspich feeder

As is shown in Table 5, the area of main branch conductors of feeder includes DOG:120mm^2 and the losses of the above conductor area as DOG:150mm^2 was corrected and the results of the calculations of load distribution showed the reduction 22.34% of the losses reduction.Table 6 shows a comparison of losses before and after increasing the cross section of main branch and calculations in Digisilent

Table 5- The summary of the features of the conductors applied in the main Aspich feeder branch

Conductor	Arrangement	Number of circuits	Length	X	Y
Name: DOG, Area :120	Parallel horizontal	Single circuit	38.38519	435739.8	3026442
Name: DOG, Area :120	Parallel horizontal	Single circuit	31.40064	434054	3028339
Name: DOG, Area :120	Parallel horizontal	Single circuit	337.0415	436373	3026061

Table 6: comparison of losses before and after increasing the cross section of main branch and calculations in Digisilent

Aspich	Feeder
Before correction of area-The losses of power	388.17 kilowatt
After correction of area-The losses of power	301.43 kilowatt
22.34%	Reduced losses (%)

Case study 4: The study of the reduction of feeder length on reduction of the losses of Aspich feeder of Saravan town (adding the above station of new distribution at the beginning of the mentioned feeder).

As is shown in Table 7, the results of the calculations of load distribution, it can be said that due to the prediction of construction of the above station of new distribution at the beginning of Aspich feeder and reduction of Feeder length, the losses are reduced to 41.18%. Finally, the losses are reduced from 388.17 to 228.32 kilowatt.

Table 7: comparison of losses before and after adding the new bulk power substation and calculations in Digisilent

Aspich	Feeder
Before reduction of feeder length-the losses of power	388.17 kilowatt
After the reduction of feeder length- the losses of power	228.32 kilowatt
41.18%.	Reduced losses (%)

Conclusion

The review and supervision on disconnection factors of electricity users including (industrial, commercial, agricultural and home) and its solution are the most important duties of the power distribution companies and as possible the disconnections of the electricity of the users arising from losses should be reduced. The errors occurred in the distribution and transfer lines lead to the harmful events and severe damage and in some cases unavoidable damages to the network equipment and users. By the investigation of the fault occurrence factors in power networks, required solutions to identify and eliminate the faults in the network, we can increase the reliability of the network to global standard. To do this, to have adequate information of the network, the existing installations statistics, network graph and other facilities, we required advanced tools and now this need is eliminated by GIS.

The weaknesses of distribution network including high voltage loss in average pressure feeder and the increase of losses in MV feeder and its sub branches by spatial and descriptive information of the network and its graph drawing in the GIS (Arc Gis) related software are identified and by calculations in various calculations software including Cyme and Digsilent, we can identify the weaknesses of network and improve these points for optimal use of the networks and reduction of the distribution losses.

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