

Impact Investigation on Each Method of Removing Load Imbalance in Distribution Network

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Abstract

By the expanding utilization of innovation and mechanization in different fields of present day life, the electrical outage has turned into a noteworthy effect to complete the necessities in the day by day life of most segments like modern, financial and even recreational. It is, along these lines, important to approach a reliable electrical framework to continuity of customer electric consumption. So, load imbalance in distribution networks causes to increase electric energy loss in addition to unreasonable occupation on network or equipment capacity. By adding equipment in order to improve load imbalance and load balance of low voltage distribution networks, in addition to huge prices of investment to buy equipment, the reasons to repair and keep added equipment are prepared. So, it seems if the author can act toward the load balance and at last balance the feeder load via keeping available establishments without adding any equipment, the author will have an effective step to decrease the loss equipment, and they will have an effective step to decrease the loss of electrical energy in distribution networks. Therefore, in the research paper, some available methods to balance the load are presented and the effectiveness of each one is compared to improve the load imbalance in distribution networks.

Keywords: load balance, phase balance, distribution network, loss.

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1. Introduction

The frameworks' future in the world is the change intelligent frameworks [1-3], including the electrical power system and distribution systems. An innovative technology can be put to delete numerous issues in the framework, incorporating an imbalance in voltage and current, just as the unbalance load distribution on the network's three phases prompting one of its appendages surpassing the reasonable load. The dangers of unbalancing are much, involving drop of voltage or glitch of transformers (trances) and increment the likelihood of the breakdown. Just as the energy losses are expanded because of unbalancing. The imbalance electric distribution system antagonistically influences the procedure of power creation regarding expanding loss of the

system. Also, increment the operation and maintenance expenses of the trans' system hardware, circuit breakers and others, which named the inquiry for, balance components to lessen the impacts of the unbalancing issue. Numerous ways can be utilized to tackle this issue, however some are costly, for example, redistribution and move of electrical trances, utilizing Scott trans and Steinmetz, connect circuit breakers and capacitors, utilizing Static-VAR-Compensators (SVC), feeder reconfiguration feeder, and stage swapping of phase [4-7].

On the other hand, precedence of electricity industry, in fact, the problems and troubles in this phenomenon is very old but what caused to continue

this problem as a discussion in electricity engineering society has economical results and huge amount of money paid for this [8]. The most reliable statistics from loss amount is 23.3% from all levels of the electricity system of the country such as manufacturing (producing), transferring and distributing of distribution part and 55 percent of this amount is 12.9% of the loss. So, it's the way that the amount of available loss in levels of generation and transferring is almost inevitable [9]. But this matter isn't finished here because power loss which is related to transit load square from system parts in the time of load peak is much more than average amount of power loss. It means that in the hardest situation it means in the time of load peak, we'll have the most power loss. Basically in distribution network which has the various industrial, domestic and business loads and organizes main portion of single phase loads, getting to balance is difficult and even impossible load imbalance has two forms of static and dynamic.

Static imbalance is related to fixed impedance loads which is always a clear and known manner but dynamic imbalance is related to collective manner of mixing loads. The feeder loads of low voltage distribution networks is from collective and mixing load kind which have been made because of random and a synchronized single-phase user on one hand and non- even distribution of them between different phases of origin in appearing load imbalance and flow in phase lines that cause to increase the loss, give electricity to null point of lattice, warm electrical engines and trances and reach saturation of magnetic nucleus and other samples. Planning power systems is according to symmetrical action and asymmetrical action makes flow components of zero and negative sequence. These components make unpleasant effects in network.

Meanwhile, existence of non-linear loads causes to make harmonic load and decrease power coefficient. In distribution networks, asymmetrically of load and phases is clear and inevitable which causes to occupy line capacity, increase loss and casualties, increase voltage loss and finally impose financial damage, so it's important to give suitable ways to solve the

problems caused by load asymmetry and phase imbalance.

So, in this paper, some available methods to balance the load are presented and the effectiveness of each one is compared to improve the load imbalance in distribution networks.

As well, the paper is organized as follows: the reasons to make load imbalance in distribution networks in section two; section three shows methods of load distribution on triple phases in distribution network, and practical solutions of order to decrease the effects of load imbalance in addition to above methods is discussed in section four. Finally, the conclusion will be in section five.

2. The reasons to make load imbalance in distribution networks

If we want to divide the factors of making imbalance into two main groups, we can point to two factors of function and structure [10]. structure factor of networks refers to structure and arrangement of networks in which in most of items, asymmetrical arrangement of one system causes the imbalance that geometrical asymmetry in line impedance and cables because of imperfect transposition of lines, imbalance in wiring of transformers, trans banks of open triangle and open star which trances zero components of the primary system voltage to negative components in secondary, eroded phases and capacitor banks, and etc. are pointed.

The second factor is to make the imbalance of functional factor in network and infect the imbalance loads of system. This factor mostly is related to distribution networks. Imbalance caused by structure factors is mostly very small and solvable. What makes the imbalance problem double is function factors such as single-phase or two- phase or three-phase loads for example electrical arc furnaces and imbalance equipment like connections having high impedance like destroyed contacts and torn contactors, rotation number of imbalanced wiring of inductive engines or asymmetry caused by their incorrect repair of asymmetry in rotor or stator of this group of engines [11].

In addition, we can name the malfunction of equipment of power coefficient correction and error of connecting single [12]. Phase to the ground uneven and anisotropic distribution of different domestic, official and industrial single phase users between line phases can cause the load imbalance [13]. The random and asynchronous manner of single-phase loads has role in imbalanced load in fact if single-phase loads are distributed almost evenly between phases, there is possibility of occurring imbalance because of random and a synchronized manner of them specially when kind of single-phase loads are different from each other. Sing-phase users in low voltage distribution networks of 400 volts is the main source of causing load imbalance in these lattice that because of lack of correction, it's possible to spread to 20kv lattice or even higher.

3. Methods of load distribution on triple phases in distribution network

In order to solve the imbalance occurred, we can use load balanced methods or phase balance method. In load balance way, in addition to injecting suitable flows active filters compensate the load imbalance and in phase balance method which has attracted company's attention to itself is that voltage is balanced in each point of feeder. Changing phases is a common way to balance phase and its main idea is to find a suitable phase exchange plan to balance the feeder with the lowest cost.

A. Phase balance

In phase balance, voltage of each bar point is balanced in feeder. Phase balance make the distribution system able to improve electricity quality and decrease costs. Phase balance is possible in two phases of repairing feeder in system level again and replacing phases in feeder level. Repairing the feeder again in these decades has been considered while replacing phases has been ignored. As repairing feeder is planned to balance load along the feeder, phase balance is considered as a target to repair feeder and in fact repairing feeder to get the phase balance has limitations [14].

Up to now, engineers have used phase replacing method to balance the phase according to experience

and trial and error method which is a time-consuming and trouble-making method.

Phase replacing problem is the issue of optimum distributing load. For example, price function should minimize the energy loss.

B. Load balance

All kinds of methods are as following:

C. Load balance by using participators conventional power

In this method, subscribers on feeder are balanced by using the kind of use conventional power so, conventional power of subscribers are brought on feeder and then load balance is done in a way that the sum of conventional powers on three-phases is divided equally although this method seems a simple method and rational, it's not a suitable method to balance the load because of difference in real amount of subscriber use from conventional power size [17].

Advantage: being simple and no need to use extra equipment.

Disadvantages: The difference in real amount of subscriber use with conventional power amount and low accuracy.

D. Balancing load with using subscriber- counting method

By using this method, it's necessary to clear the number of subscribers and there is no need for use kind, conventional power and amount of subscribers' use. In order to perform this method, the number of subscribers' use. In order to perform this method, the number of subscribers on one feeder is divided on three-phases in a way that on each phase there is equal number of subscribers. Although this method needs less information in comparison with other methods, it's not considered a good way because subscribers on a feeder have different use and they can't be put in one level.

Advantage: almost simple and need less data and information.

Disadvantages: considering the material and amount

of using subscribers equal and in fact low accuracy.

E. Balancing load by using pave method

In this method, basis of calculations is based on power by subscribers. The rate of average power from the amount of subscribers' use brought in bill's information is gained. In this method, we should have the information of subscribers numbers on feeder, usage kind and usage amount of each subscriber. So, this is the way that in comparison with previous methods it needs vast information. But in distribution network, load imbalance has dynamic and different nature with time because of random and a synchronized manner of single – phase subscribers in this method, we try to load each three phase equally.

Advantage: The actual use of customer operation basis, so this method is more accurate than previous methods.

Disadvantages: needing to more information of subscribers and coping with almost a lot of data, lack of availability of all subscriber's information in all places.

F. Balancing load by using active filters

Active filters are used in imbalanced distribution nets to balance the load, improve power coefficient and delete the flow harmonics, in algorithm imbalance situation, improvement for compensation reference flow is performed orbit related to placing active filter in net

Advantage: accuracy and efficiency higher than previous methods

Disadvantages: almost more expensive than other methods and it needs more equipment.

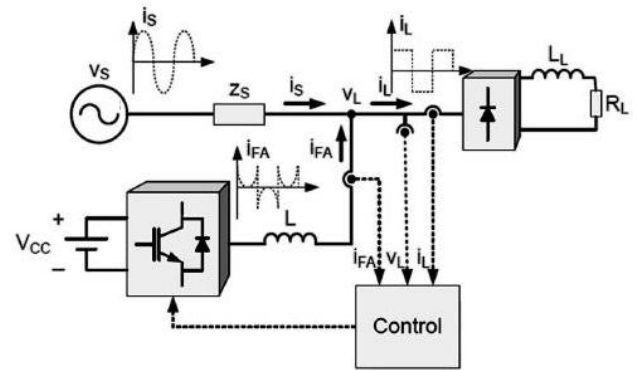


Figure 1. Basic diagram of the shunt active power filter in the system

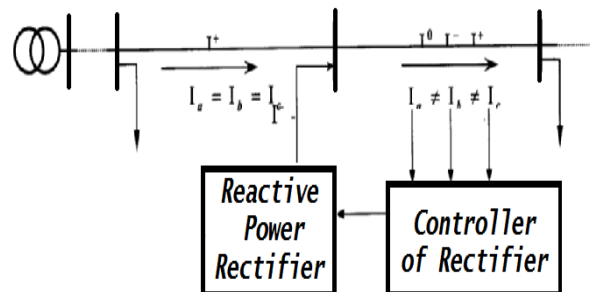


Figure 2. Reactive power controller performance

G. Balancing load by helping of reactive power control

The rules of balancing load [15] in this method because one of important features of imbalanced three-phase flow is presence of zero and negative sequence components of flow, so, the basis of balancing load with the aid of compensating reactive power is to delete available zero and negative sequence components in feeder flow.

The figure two is conceptual diagram of function of on compensator of reactive power in balancing feeder flow, as we saw, in any time (adjustable), by measuring pharos, three-phase flows and their processing by compensator controller and amount of load imbalance are measure according to zero and negative components and based on this, reactive power compensator is controlled in a way to be able to inject flows equal to phase difference to considered shin.

The orbit related to the function of reactive power controller the result of compensator function causes to delete or neutralize the sequence components of zero and negative f the flow and finally balancing three-phase flows will be resulted. Also by suitable controlling the illusive part of flow positive component, compensator is able to control and adjust the coefficient of feeder flow power in above process, operation of compensator control in order to balancing load can be done in interfaces for example every one hour once during the day. By using optimum compensation of reactive power in weak pressure distribution fadders, we can improve the load imbalance and its power coefficient ideally [17].

Advantage: more accurate control in comparison with previous methods and also improving coefficient of orbit power.

Disadvantages: a pretty expensive method and needing different controlling equipment.

H. Balancing imbalanced loads with SVC

A flexible alternating current transmission system (FACTS) tools are used to improve power coefficient, voltage loss and voltage oscillations to remove or decrease load harmonic crooked ness in addition to balancing imbalanced load. Having positive features in SVC caused to be used move in compensating imbalanced loads:

- 1) proportion of function (efficiency) to more cost in proportion to other FACTS tools.
- 2) Simple ness of its control orbit.
- 3) Availability.

Also about working rules of SVC:

SVC is one of the most applicable FACTS tools that has two main following features:

- 1) Despite all composing elements (capacitor, reactor, trans) are reactive, it's able to distribute active power between three-phases (balancing imbalanced load).
- 2) While the elements are composed of fixed impedance, it's able to make change able impedance.

The main component of transitive flow of SVC reactor is controllable via Tristor fire angles this process makes the producing of changeable impedance by it.

4. Practical solutions of order to decrease the effects of load imbalance in addition to above methods

To be more illustrate, this part divided ten following sections:

4-1- Giving code or special number to any trans and forming a separate file to each trans in which after annual recording in the time of load peak, each phase amperage would be written in it and in the case of adding a new subscriber, its ampere would be added to this statistic. After recording, if the percentage of trans load is getting higher, trans should be changed with higher capacity or else they should separate the net and add another trans to the network.

4-2- Observing standards of development and installation of distribution network [17].

4-3- Absolute and robust fight against robbers of network electricity or other people who manipulate counters and threaten stability of web and decrease trans life.

4-4- Using ring networks of low voltage in order to be used in the case of dropping voltage in some places or damaging trans by fastening jumpers from adjacent trances.

4-5- Finding weak points of distribution network (in places where voltage decreases more than normal) and if necessary, 50 volt capacitors would be installed [18].

4-6- Having suitable ground-system while a null wire has repeated wire to decrease the danger of cutting null wire and through increasing number of grounds, total resistance will decrease and as a result in addition to decrease the contact voltage, the number of power loss will be decreased in null wire.

4-7- Using the maneuver of changing tap in trances (distribution and power) if it's possible in summer the trans taps will increased and in winter, it'll decreases

[8].

4-8- Choosing suitable fuses of cutting extra load according to the capacity of trans and annual recording.

4-9- Controlling industrial loads of network and they should feed according to the demands.

4-10- Choosing wires with suitable sectional level in network in which null wire has the same section with phase wires and in the network under the trans (low voltage part) copper wire with sectional level of 70 mm is used [19].

Conclusion

As a word, getting to the balanced situation is very difficult of even impossible. In this research paper, all methods of removing load imbalance are mentioned and they're all compared because of cost, accuracy in function and equipment.

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