International Journal of Scientific Research & Engineering Trends
Volume 8, Issue 1, Jan-Feb-2022, ISSN (Online): 2395-566X

Review on Power Transmission and Distribution Losses - A Modal Based on Available Empirical Data and Future Trends for all Countries Globally

M.Tech.Scholar Sadre Alam, Prof. Lokesh Shukla
Department of Electrical Engineering
SORT People's University,
Bhopal, MP, India

Abstract- In this paper an attempt is made to reduce the power losses in practical distribution system. Power System faces a big problem of distribution losses. In this paper technical, non technical and administrative losses are calculated of local city. Analysis of various types of distribution losses of radial distribution network is considered. More than 60% power loss due to technical and non technical loss etc. In this paper a new attempt of calculation of various distribution losses in power system and their economic effect on the utility are introduced..With the help of case study of radial distribution of local city, some new concepts are introduced to reduce the power losses and improve the voltage profile in practical distribution.

Keywords -Distribution Transformers, HVDS, LVDS, Losses, Load Flow Technique, Radial Distribution System, Real Power Flow, Reactive Power Flow.

I. INTRODUCTION

A power system is composed of a generation, transmission and distribution system, where the distribution system is that part of the power system that links electric utilities and power to consumers. The purpose of a power system is to provide electricity to its consumers in a reliable and economical way [1]. However, the power industry has made remarkable modifications towards deregulation to improve economic efficiency [2].

In a deregulated power system, generation, transmission and distribution are disaggregated into separate companies: generation companies (GENCOs), transmission companies and distribution companies (DISCOs). Each company is dedicated to its particular function in the power system. This power system privatisation and deregulation, along with the technological revolution and evolving customer expectations, are the driving forces that have placed electric power utilities into a competitive market. The deregulation of electric utilities may also assist in breaking the monopoly of power system brokers and creating competition between different GENCOs and DISCOs [3].

Consequently, a customer may be able to select the power supplier depending on the supply cost and its acceptable level of reliability [4]. Hence, it is essential for electric utilities to satisfy the customer's need of power demands at a reasonable cost. Moreover, due to the drastically changing nature of power network users, distribution systems may operate under heavily loaded conditions. According to [5], global energy demand is expected to increase 37% by 2040. The annual growth rate for electricity consumption in residential and commercial sectors will be 0.5% and 0.8% from 2013 through 2040, respectively [6]. Therefore, this increasing load demand may overload the distribution feeders and may complicate the system operation [7]. Thus, to meet load demands, distribution networks have to be upgraded, maintained and operated with better planning and incorporate smart technologies.

THE Low Voltage Distribution System (LVDS), accounts for about 1/3rd of the total transmission and distribution losses in India. The main contributing factor of this loss is the present practice of using 3+ Distribution Transformer of considerable capacities, which leads to the use of very long LV lines. This is based on European practice. The LV line is extended to cater a group loads and useful particularly when catering loads of high load density. Presently, the LT lines are extended irrespective of voltage drops up to full capacity of distribution transformers and sometimes even above the transformer capacity ignoring the load of lines. This leads to severe voltage drops, high line losses accompanied with low power factor, chances of unauthorized connections etc.The practical and feasible solution is to eliminate or minimize the LV lines by changing over to HT distribution system, where the HT line is drawn as near the load as possible and small capacity 3/I distribution transformers are installed.

This is best suited to meet the scattered loads. Several studies [1][2] on this subject revealed that, distribution losses can be brought down considerably by suitable HT distribution System. In India, many State Electricity Boards have conducted studies and proved that distribution losses can be brought down to levels prevailing in advanced countries by adopting this system. In the existing LT distribution system 100KVA and 63KVA distribution transformers are provided and lengthy LT lines are laid till the consumer end as the consumer equipment is of 400V. In the proposed HVDS the existing LT lines are converted as 11KV lines and a small capacity transformer suitable for consumer load is provided at the nearest support of the line and LT supply is extended through AB cable. Smart Grid (SG) is the integration of communication and control technologies in a traditional grid in order to transmit and distribute electricity in an efficient way[1][2].

The purpose of this transformation is to reduce global warming by reducing carbon emission and reduce electricity cost by efficiently manage the load. Demand Side Management (DSM) is an important feature of SG to manage energy. The goal of DSM is to efficiently utilize the available grid energy to improve the economics of the power system. Managing the load pattern can reduce the peak load demand which improves efficiency of grid; reduce the carbon emission and electricity bill of the user. Dynamic pricing schemes are the unique features of the SG. By usage of smart meters and automatic metering infrastructure, it is easy to manage the load according to dynamic pricing schemes. Some of the dynamic pricing schemes which commonly used in DSM programmed are Real Time Pricing (RTP), Time of Use (TOU), Critical Peak Pricing (CPP), Day Ahead Pricing (DAP) and Extreme Day Pricing (EDP). When these dynamic pricing schemes are used along with the DSM strategies, control of customer energy usage is influenced by penalties and incentives.

However, the rationale behind DSM is to increase power system stability, sustainability, security and economics by maximizing system capacity without changing whole physical infrastructure of the power system. DSM also plays a key role in the electricity market. Electricity price is depends on the energy consumption of the users. With exceeds in demand the price is also vary and increase. This increase in electricity pricing affects whole users in the power system. By reducing the Peak to Average Ratio (PAR), DSM regulates the electricity price in an electricity price market. DSM modifies the customers' demand pattern to get the desire change in load shape of power network. The DSM strategies modify the shape of load pattern by shifting the controllable appliances during peak hours, and shift these loads to an appropriate time to reduce the cost.

There have been six methods for load shaping of different types of users [3-4] peak clipping, valley filling, load shifting, flexible load shape, strategic conversation and strategic load growth. Peak clipping and valley filling reducing the difference between peak load and valley load by filling the valley from a curtail load from the peaks to reduce the load burden. While, strategic conversation, reduce the peak load demand at customer premises. Strategic load growth introduce large demand in the valley in off-peak to produce optimized load curve. Flexible load shape, only modify the demand curve of the customers which are willing to take part in the DSM program in exchange for incentives. Whereas, load shifting is generally used to shift load from on-peak to off-peak in order to minimize the cost. In this work, we proposed a DSM strategy based on load shifting technique. Several types of large number of appliances are considered in this work to show the effectiveness of the proposed algorithm. In the load shifting problem is solved using GA to reduce the cost and PAR. We solve the same problem as in with a different load shifting strategy to get better results than the previous one. For this we formulate the load shifting problem as a cost minimization problem with some constraints to achieve electricity bill and PAR reduction [5].

Electrical Power System Energy is the basic need for the economic development of the country. It is practically not possible to calculate the actual value of energy that will be consumed by consumers. The availability of huge amount of electrical energy in the modern time has resulted in higher agricultural and industrial production and better transportation facilities. Hence, there is a close relationship between the energy used per person and his standard of living. The power system is very important part of electrical engineering, which deals with generation, transmission and distribution of electrical energy.

The conveyance of electric power from a power station to consumer premises is known as electric supply system. Principal components of supply system are:

a) Generating station
b) Transmission lines
c) Distribution systems

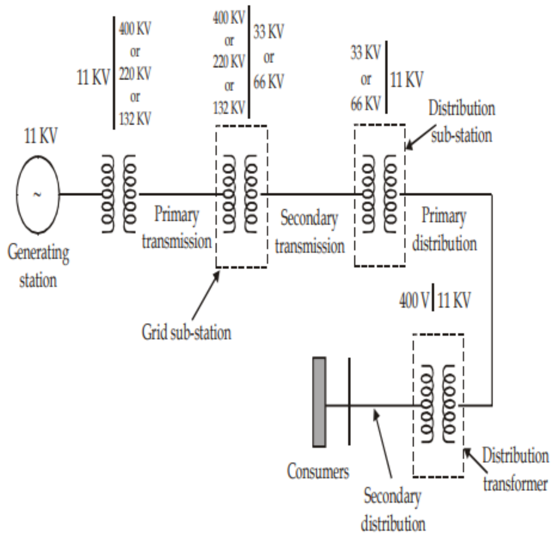

Figure 1: Single Line Diagram of Power System.

Characterization of Power Losses & Power In Distribution Systems

The energy and power losses are due to the conditions of the facilities. In general, two types of losses stand out:

- Ohmic Losses or Copper Losses: They are caused by the circulation of electric current through the circuits. Its magnitude then depends on the characteristics of the networks and the burden to which they are required. They are also called load losses.
- Vacuum losses: These are caused by the circulation of magnetization currents in the iron cores of transformers and other equipment in the network. Also included in this category are losses from stray currents in line insulators and by corona effect. The latter are manifested primarily in transmission networks. In distribution they are insignificant. Unlike load losses, vacuum losses appear whenever the circuits are energized, regardless of the level of load or power flow circulation through them. The characterization and identification of the different types of losses in distribution networks is not easy. It is very difficult to be able to do it through measurements, and in general it is not a task that companies usually do. The Electric Power Research Institute (EPRI) of the United States carried out a very thorough research program during the years 2008 to 2011, where a large number of feeders of different companies and of varied physical and operational characteristics were analyzed, for the purposes to discriminate the different types of losses and their relative weight in the total losses.

II. LITERATURE REVIEW

In recent decades, a number of methods have been developed to resolve the issue of power flow in distribution networks. Since it is not possible to give all the work carried out in this direction, it will be sufficient to describe some of them only.

Sirojiddin R. Chorshanbiev et.al (2019) This paper presents the results of a structural study of power losses in the Dushanbe (6-10 / 0.4 kV) distribution network in the Republic of Tajikistan. Data were given on the number of converters and the capacity installed in Dushanbe (6-10 / 0.4 kV) and the length of the distribution network (0.4-6-10 kV). A power loss structure dividing the power level and the type of loss is presented. The cost of electricity on the distribution network that Dushanbe studied is compared to the average loss value on the Russian electricity grid. In the 6-10 / 0.4 kV distribution network of Dushanbe and Russia, there was a significant discrepancy between the load rate and the conditional constant loss rate.[1]

Dai Wan et al. (2019) As the load increases each year, the number of distribution converters also increases. Meanwhile, the impact of coordination interventions on the power system has become even greater in recent years. In order to study the effect of the alignment in hot weather the spread of the fuel pipe, based on the calculation of the load loss, the effect of the uneven distribution of the current loss density on the heat. 'the warm place of the entire seat examined. Adjust the model to be under the logical period set in the previous study. The results show that the horizontal wave will cause an additional temperature rise in the converter. When the harmonic distortion rate is 40%, the temperature rise in the hot zone reaches 102.7 K which exceeds the limit of 78 K in the hot spot distortion. When the harmonic conversion rate is 60%, the maximum temperature of the heat transfer at the top of the converter is more than 60K. At present, the high oil temperature reaches 112.2 ° C, which is close to the flash of mineral insulate oil, which has a significant impact on the safe operation of the material.[2]

Ying DING et.al (2018) Disruption of power supply and energy causes problems with power supply and demand problems. Direct power exchange between the provinces can make full use of the power lines in the region to alleviate this problem. However, the members of the market involved in direct power exchange between the provinces are very different from the region, therefore, the transmission losses caused by the differences cannot be ignored. not found. When we negotiated direct power exchanges in the provinces, we did not consider the impact of losses on transmission, which resulted in unfair exchanges in the market. Based on consideration of the safety issues and losses of transmission, this paper sets out a model of direct power negotiation in the province. This model considers the various methods of power lines, offers a way to measure and quantify transmission losses, and examines the queue rules for direct power exchange between regions. The law considers the impact of transfer losses under priority on cost and energy protection and environmental protection. This model promotes the improvement of trading methods and maintains fairness in electronic market transactions. The results are relatively stable and can be used as empirical data for practical applications. This model provides support for decision-making on the relationship between supply and demand in the power market and the optimum distribution of large-scale resources.[3]

Dai Wan et al. (2019) Distribution transformers are widely used as large energy transmission tools. In the last few years, with the use of large non-slip loads in power cables, the impact of continuous pollution on electrical systems has become more serious. Harmonic interference will affect the no-load loss, load loss and temperature range of the distribution converter, thus shortening the life of the converter. This paper offers an improved method for calculating heat losses and temperatures. First, the effect of harmonics on load loss is examined. A computational model for the low-yield losses was set up under different contact groups. Second, the variability of the base loss with the coordinated temperature and the density of the climate change. The computational model for transformer-load-loss losses was set up under different contact groups. Finally, the temperature calculation model proposed by IEEE C57.110 has been modified. Considering the influence of the loss loss and the non-load loss, a more accurate method of calculating the temperature in a hot place is proposed.[4]

Constantin Moldoveanu et.al (2019) In the process of supplying power to end users, a lot of energy is lost to the transmission and distribution systems due to technical and non-technical losses. Although line losses alone represent a type of power loss that occurs during the transmission and dissipation of power, these power losses are often referred to as “line losses”. All components of the power transmission and distribution system will incur losses, so at the level of power generation, the losses to the end user are greatly reduced. Technical losses represent economic losses affecting the environment at the national level, and their improvement should be done from the perspective of the entire country, regardless of organization. The scope and assets of the operating power company [1].

The EU Energy Efficiency Directive 27 / CE / 2012 have placed a major obligation on energy companies to improve energy efficiency while providing services to their customers. The guidelines put in place a common framework to improve energy efficiency within the EU to ensure that the 20% energy target is reached by 2020 and pave the way for over -the -date energy growth [2]. The amount of energy reduction in the transmission and distribution system is important because it is usually as high as 3-13%. The amount of power losses in transmission and distribution systems in Romania is very significant, around twice the European average. This article presents the results of the author’s research on power consumption control and analysis systems in power transmission and distribution systems.[5]

Why Loss Minimization Is Essential?- All energy supplied to a distribution utility does not reach to the end consumer. A substantial amount of energy is lost in the Transmission and Distribution system by way of Technical and Non Technical Losses. The distribution system accounts for highest technical and non technical losses in the power system. The Transmission and Distribution Losses in our country, which were around 15% up to 1966-67, increased gradually to 28.36 % by 2011-12[3]. Total Transmission and Distribution Losses are about 30-50%. The major part of the loss is taking place only in distribution sector which accounts for 80-90% of total T&D losses. Cost of power theft is Rs 20,000 Crores / year and the total loss incurred by all State Electricity Boards is Rs 26,000 Crores per year in India. The Transmission and Distribution losses in advanced countries of the world have been ranging between 6 to 11%. Even in many developing countries, T & D losses are less than the level obtaining in India. As per the T & D losses issued by CEA, taking into consideration the Indian conditions, it would be reasonable to aim for containing T & D losses within 10 to 15% in different States [3],[4]. The aggregate losses accumulated by all utilities from 2006-07 to 2010-11. The losses (on accrual basis) of all the utilities increased from Rs 24,796 crores in the year 2008-09 to Rs 30,466 crores in 2009-10. In the year 2010-11, the aggregate losses of all utilities decreased to Rs 29,701 crores [5]. With the setting up of State Regulatory Commissions in the country, accurate estimation of T&D Losses has gained importance as the level of losses directly affects the sales and power purchase requirements and hence has a bearing on the determination of electricity tariff of a utility by the commission. Higher AT & C losses have severe impact on tariff as well as economy. So, minimization of this losses is utmost essential.

III. LOSS MINIMIZATION TECHNIQUES

Technical Loss Reduction The causes of high technical losses[6] are varied and require different remedial measures to be implemented to bring them down to acceptable levels. Short-term Measures: The immediate improvement and reduction of losses [6],[8] in the technical system are based upon sample studies, statistical scrutiny/ analysis of the information/ data collected from the existing system detail. These are:

Network Reconfiguration – It gives an option to handle the increased demand and increases system reliability ii. Conductor Replacement in Network –A lower conductor size can cause high ohmic losses and high voltage drop which causes a loss of revenue as consumer’s consumption and hence revenue is reduced. The recommended practice is to find out whether the conductor is able to deliver the peak demand of the consumers at the correct voltages, that is, the voltage drop must remain within the allowed limits specified in Electricity Act, 2003.

Preventing Leakages at Insulators - Cracking of insulator and flashover across insulators often cause outages and result in loss of revenue. Use of appropriate material for insulators, depending on the nature of pollution, and designed protected creep age path helps in reducing insulator failure. Preventive actions are regular inspection and hot line washing.

Automatic Voltage booster – it is similar to that of the series capacitor as an on-load tap changer it boosts the voltage at its point of location in discrete steps. This, in turn, improves the voltage profile and reduces the losses in the section beyond its point of location towards the receiving end. It has a total voltage boosts of 10% in four equal steps and the loss reduction is directly proportional to voltage boosts.

Better Management of Distribution Transformers – the following measures can be taken in this regard:

- Augmentation/ addition of distribution transformers and relocation of distribution transformers at load centres. ¬
- Low voltage (less than declared voltage) appearing at transformers consumers terminals
- Guarding against loss in transformers through oversized transformers operating at low loading, undersized transformers, unbalanced loads in secondary side, connector at bushings, low oil level/ oil leakages, hot spots in core, use of energy efficient distribution transformers(DT).

Load Balancing and Load Management – if the loads on each of the three phases of a distribution lines or among feeders are redistributed, the losses will be reduced. The best method to identify load balance is to construct current duration curves for all three phases. Distribution automation along with SCADA (Supervisory Control and Data Acquisition System) is an important tool for load management which should be introduced.

IV. CONCLUSION

From the above discussions it is found that there are various factors responsible for AT & C losses which need to be eliminated. As it is extremely difficult to eliminate all the causes simultaneously in our country, strategically measures should be taken to reduce or marginalize the major causes of losses. The distribution losses can be reduced by proper selection of distribution transformers, feeders, proper re-organization of distribution network, placing the shunt capacitor in appropriate places, theft control, adoption of upgraded technology etc.

HVDS should be implemented at a faster rate. Training of the operating personal would result in improved system operation. The distribution companies should be ready for initial investment keeping in view of future savings in energy

REFERENCES

[1] D. L. Nickel, "Higher Voltage Distribution Systems", Transmission and Distribution magazine, Aug 1974, pp.52-56.
[2] M. Chen, et. al, " Distribution System Power Flow Analysis - a rigid Approach", IEEE PWRD Vol.6, N03, pp. 1146-1152, July 1991.
[3] M.Srinivas, "Distribution load flows; a brief review", in Proceedings IEEE PES Winter Meeting, Vol.2, Jan.2000, pp.942-945.
[4] S. Sivanagaraju, N. Sreenivasulu, M. Vijay kumar, New method of load flow solution of radial distribution networks, Proceedings All India Seminar, Power Systems; Recent Advances and Prospects in 21st Century, 2001, pp.226-234.
[5] W. H. Kersting, Distribution System Modeling and Analysis, Boca Raten, FL: CRC, 2002.
[6] Sirojiddin R. Chorshanbiev;Galaktion V. Shvedov;Hamdy M. Sultan;Khurshed B. Nazirov;Firdavs O. Ismoilov Structural Analysis of Power Losses in (6-10 / 0.4 kV) Urban Distribution Electric Networks of the City of Dushanbe, the Republic of Tajikistan 2019 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus) Year: 2019
[7] Dai Wan;Liu Zhang;Miao Zhao;Hengyi Zhou;Simin Peng;Tao Peng Calculation Method of Hot Spot Temperature of Distribution Power Transmission Equipment Insulation Winding Based on Eddy Current Loss Density Distribution 2019 IEEE 3rd Conference on Energy Internet and Energy System Integration (EI2) Year: 2019
[8] Ying DING;Lin LI;Bo SUI The direct power transaction model between provinces considering the safety constraints and transmission loss 2018 International Conference on Power System Technology (POWERCON) Year: 201
[9] Dai Wan;Fei Qi;Miao Zhao;Liuming Mao;Xujin Duan;Yun Liu An Improved Method for Calculating Power Transmission Equipment Loss and Hot Spot Temperature in Distribution Network under Harmonic Disturbance 2019 IEEE 3rd Conference on Energy Internet and Energy System Integration (EI2) Year: 2019
[10] Constantin Moldoveanu;Irene Ionita;Virgil Brezoianu;Alexandru Tava;Sorin Zaharescu;Sorin Dan Grigorescu Requirements of a real time monitoring and analysis system of power losses in electrical transmission and distribution systems 2019 8th International Conference on Modern Power Systems (MPS) Year: 2019
[11] S. S. Venkata, A.Pahwa, R.E. Brown, and R.D.Christie, "What Future Distribution Engineers need to learn", IEEE Trans. on Power Systems, Vol 19, 2004, pp.17-23.