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RESEARCH ARTICLE

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LOSS REDUCTION BY IMPROVING RATIO OF HT/LT LINE IN ELECTRICAL DISTRIBUTION SYSTEM

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ABSTRACT

Power generated in power in power station does not match with the power distributed to the consumers. The electrical power loss occurs at different stages of transmission and distribution. In this technique of loss minimization distribution network is minimized as possible as such that the HT/LT ratio is high. The advantage of this review paper is to see the improvement in supply quality and reliability. In this paper one no of distribution transformer at 11 KV Vitner AGR feeder emerging from 33/11 KV Jalake substation is taken for study. In these technique first losses in existing distribution transformer named Piparin DTC in which distribution of electricity is done by L.T. line network. In this present situation LT line is higher than H.T. line. The distribution loss with existing LT network is calculated . Then L.T. line network is replaced by H.T. line network. The 100 KVA rating distribution transformer of name Piparin DTC in existing Low tension lines is replaced by nos. of low capacity transformers. The LT line conductor is also dismenteled and fine quality high voltage conductor is erected in place of that. Again losses are calculated with H.T. network is in working stage. The net savings of electricity is calculated in terms of units. The actual cost of electrical energy saved is realised. Capital investment necessary to carry out this project of HVDS is analysed. Rate of Revenue Return is lastly calculated with the help of these figures i.e. units saved and realized in terms in terms of money and initial investment required to put into practice this scheme. We compare the power flow diagrams in both the systems and see the improvement in the line voltage at tail end consumer. In LT network consumers have a complaint of voltage regulation. The voltage at consumer first to DTC is high and as we goes towards the far end consumer we find the voltage is very low. The voltage at last end user is below the values that must be supplied as per electricity regulation authority. In HVDS system we can observe the improvement in voltage also.

Keywords—Transformer, HVDS, LVDS, DTC, HT network, LT network.

INTRODUCTION

In this paper we are going to study the improvement of losses in distribution system by replacing the network by HVDS. For the study we have taken one DTC of name Piparin connected at 11 KV Vitner AGR feeder emerging from 33 / 11 KV Jalake substation.The legally connected consumers and illegal connections are shown in single line diagram of L.T. line network.

Existing low voltage distribution system(lvds)

The existing distribution system in India employs large three-phase 11KV main distribution feeders with three-phase spur lines and three-phase distribution transformers transforming 11KV into 400V. Distribution system with low voltage employs four core cables and long low tension lines and multiple loads fed from a bulk power transformer resulting in the increase in system losses affecting voltage profile and performance of distribution system. Low voltage distribution is done either by three-phase four-wire, three-phase five-wire, single phase three-wire and single phase two-wire low tension lines. This distribution system involves nearly 2:1 ratio of low and high voltage line lengths. Generally, in the process of supplying electricity to the consumers, energy losses occur due to technical and commercial losses. The technical losses are mainly caused by the energy dissipated in the conductors and equipment used for transformation, transmission and distribution of power.The commercial losses are caused by pilferage, errors in the meter reading or defective meters and in the estimation of unmetered energy supply.These losses depend on the load density, energy pattern used and configuration of transmission and distribution system.

Reason for high technical & commercial losses

1. Improper location of distribution transformer:

Distribution transformer should be located at load center. In practical situation once the erection of distribution transformer has been completed it is very costly to shift it as per future load that comes in system. Due to this unequal and unpredictable demand of load it is usually not possible to keep the distribution transformer at load center. Due to this unequal expansion losses increases due to the facorI2*R*L.

2. Non – optimal conductor size:

Losses in the feeder are inversely proportional to the conductor size. The bigger the size, the lower the resistance and the lower is the losses. While doing expansion of the electricity to new areas , the conductor size is usually selected on the based on the thermal loading limit to curtail the capital investment ,ignoring the cost of losses .With rapid load growth, the conductor size have become inadequate ,causing in high power losses. Investigations on numerous distribution feeder discovered that about 5% of the feeder segments from sources end are responsible approximately for 70 to 80% of the losses in the feeder and loss reduction in the order of 30 to 40% can be achieved by reconductoring of the first few segments of feeders.

3. *Inadequate reactive power compensation:*

The power factors at which the system is operated is an vital pointer of power loss level as the losses are inversely proportional to square of power factor.In urban areas, the lighting load (comprising fluorescent tube lights) is liable for the poor PF .The fluorescent lights have low power factor of 0.5, while in rural areas, the inductive load comprises of the agricultural pump sets with PF of the order 0.7 to 0.75.The investigations made on several distribution feeders indicated that the loss reduction to the extent of 20 to 30% can be achieved by optimal shunt compensation. For a given load if power factor is low the current drawn is high and the losses proportional to the square of the current will be more. Thus the line losses owing to the poor power factor can be reduced by improving the power factor.

4. *Inadequate augmentation of transmission and distribution system:*

Normal load increase of the Indian Utilities is around 8%.This rapid load growth, in turn, calls for the setting up of a large number of substations to meet growing demand. The erection of a new substation requires substantial investment; say Rs. 2.0 to 25 crore s on an average. The incapability of utilities to execute for long range planning and setting up of new distribution substations at most favorable locations has resulted in high power losses.

5. Lengthy distribution lines:

The distribution lines in rural areas are largely radial laid. These lines extend over long distances. It results in high resistance losses in the lines.

6. Bad workmanship:

Joints are source of power loss. Therefore the number of joints should be kept minimum. Firm connections must have been done by using proper techniques. In LT distribution system joints are used at line terminations, cut-point locations, DTC locations, at drop out fuses, in distribution boxes where cutouts and bus bars are present, in substations and at transformer bushings. These joints should be periodically inspected. Sparking and heating at joints should be eliminated if it has been observed. Replacement of deterioted wires and lines should be done timely to avoid losses of power.

7. Unbalanced load at distribution transformer:

The losses in distribution system increases when the load at distribution system is unbalanced. Unequal load distribution among three phases in L.T. system causing high neutral currents, leaking and loss of power.

8. *Poor quality of equipments :*

The losses are due resistance of conductor used for lines and losses in transformers. In transformers two types of losses occurs

a. *Fixed losses:* These are the magnetic losses which consist of hysteresis losses and eddy current losses. These can be kept at minimum by using high quality silicon steel stampings.

b. *Variable Losses:* These are dependent on load and mainly due to winding resistance of transformer. Thus it can be kept at minimum level using high quality copper for winding.

9. *Commercial reasons for high distribution losses:*

Commercial losses are near about 18% to 20% .Theses are related to theft of energy, meter reading, faulty meters and error in billing of customer and unmetered supply to customers. 99.95% of these losses occur on LT network.

*Theft***:** Theft of power has been done by connecting hooks of wires on L.T. distribution system. This power delivered to customers is not measured by energy meter. This direct and illegal hooking is possible only in L.T. distribution system. If we convert L.T. system in H.T. system people cannot connect illegal hooks on HT lines. Theft of energy is also done by tempering of energy meters by various ways.

Adoption of high voltage distribution system(hvds)

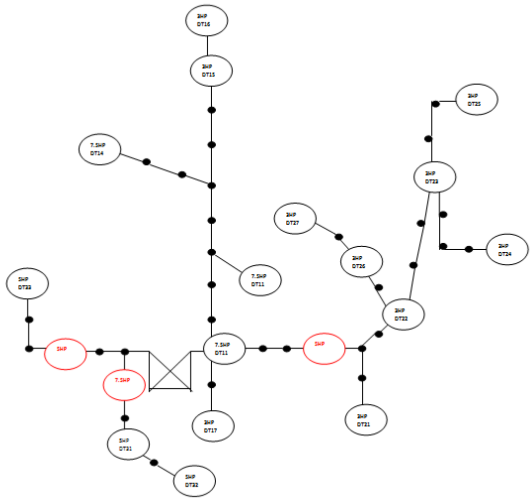
To improve quality of supply and reduce losses HVDS is suggested.11 KV lines are extended to as nearer to the loads as possible and erect small size single phase transformers 5, 10 or 15 KVA and release supply with zero or minimum LT line and the unavoidable short LT lengths to be enclosed by insulated wires like ABC (Aerial Bunched Cables). The major advantages of using ABC in HVDS are that the faults on LT lines are totally eliminated, thus improving reliability and also theft by direct tapping is avoided. HVDS project is to reconfigure the existing Low voltage (LT) network as High Voltage Distribution System, wherein the 11kV line is taken as near to the loads as achievable and the LT power supply is fed from small capacity transformer and minimum length of LT line. Existing network consists of large capacity transformers at one point and the connections to each consumer are provided through heavy distance LT lines. This long length of LT lines is causing low voltage condition to the majority of the consumers and high technical losses. In the HVDS plan, LT distribution network is converted into 11 kV mains feeders and thereby installing the small capacity distribution transformer as near as to the load. By converting these LT lines to HVDS, the current flowing through the lines shall reduce by 28 times and will carry down the technical losses in the LT line hugely. The prevailing low voltage in the LT line is also affecting the efficiency of the electric equipments and breakdown is also very high. Also there is a tendency of unauthorized connections to hook to the LT lines which results in over loading of the transformers and failure of the transformers. The scheme consists of converting the existing 3 phase 4 wires lines to 11 kV systems using the existing supports and providing intermediate poles wherever necessary and individual transformers are provided to both agricultural loads and loads other than agriculture. HVDS is most successful method in dropping the technical losses and improving the quality of supply in power distribution system. As the authorized consumers do not allow unauthorized tapping by another as their transformer gets overloaded or may get damaged, resulting in outage of power supply for longer durations. Based on the feedback received from Andhra Pradesh and Gujarat where HVDS schemes have been operational in urban and rural application it is noticed that the investment on conversion from LVDS system to HVDS is recovered by way of loss reduction within a period of 5 to 7 years. There are three types of High Voltage Distribution System namely, Single phase and single neutral , two phase two wire and three phase small rating transformer with three phase HV system.

CASE STUDY

The proposed work includes the conversion of existing LVDS into HVDS in order to minimize the distribution losses and pilferage thereby, improving the voltage profile and quality of supply to the consumers in agricultural sector. For this purpose, two stage methodology is used. In first stage, the power losses in the line and transformer losses for both LT and HVDS system are determined.

SR NO	CONSUMER IDENTITY NO	LOAD
1	DT11	7.5HP
2	DT12	3HP
3	DT13	5HP
4	DT14	7.5HP
5	DT15	3HP
6	DT16	3HP
7	DT17	3HP
8	HOOK 1	5HP
9	DT21	3HP
10	DT22	3HP
11	DT23	3HP
12	DT24	3HP
13	DT25	3HP
14	HOOK 1	7.5HP
15	DT31	5HP
16	DT32	3HP
17	HOOK 2	5HP
18	DT33	3HP

Single line diagram of existing L.T. network is shown below.



Matlab simulink

The LVDS system model was drown using matlab simulink shown in below fig.

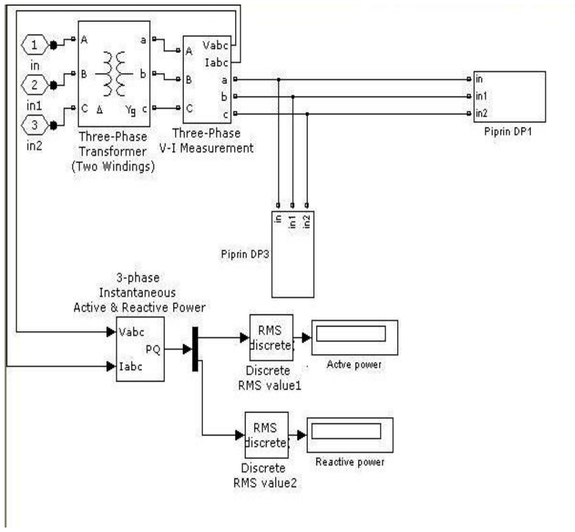


Fig. *Piparin DTC main*

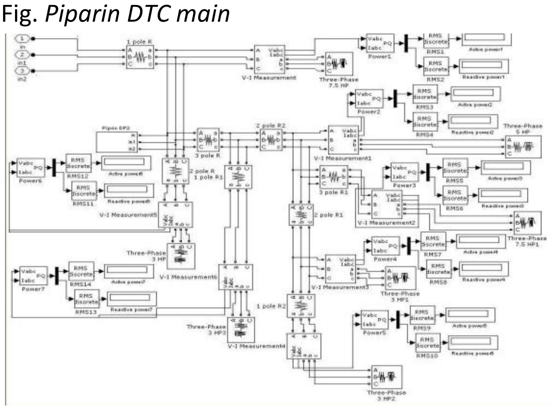


Fig. LVDS module-piparin DTC-1

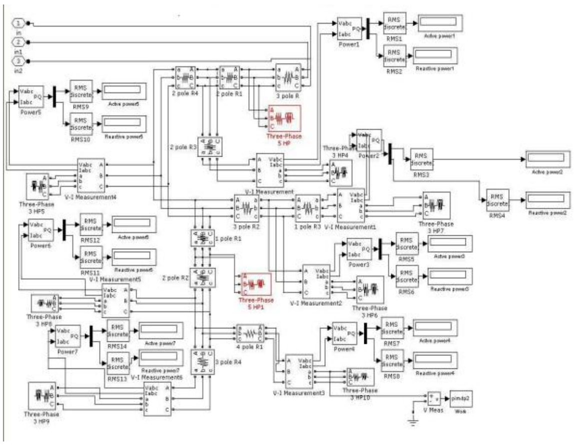


Fig. LVDS module-piparin DTC-2

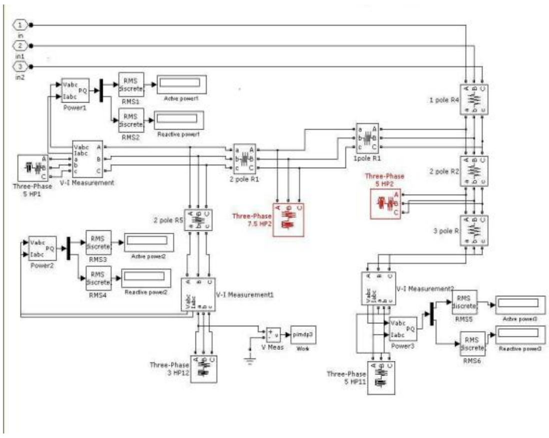


Fig. LVDS module-piparin DTC-3

DTC loss calculation in existing LVDS system

Pimprin DTC total units= 53050

DTC -1

SR. NO.	CONSUMER IDENTITY	LOAD	UNITS MEASURED
1	DT11	7.5HP	4727
2	DT12	3HP	1824
3	DT13	5HP	2986
4	DT14	7.5HP	4426
5	DT15	3HP	1780
6	DT16	3HP	1777
7	DT17	3HP	1885
Total-DTC-1			**19405**

DTC -2

SR. NO.	CONSUMER IDENTITY	LOAD	UNITS MEASURED
1	HOOK 1	5HP	0
2	DT21	3HP	1779
3	DT22	3HP	1741
4	DT23	3HP	1717
5	DT24	3HP	1706
6	DT25	3HP	1708
7	DT26	3HP	1725
8	DT27	3HP	1722
Total-DTC-2			**12098**

DTC -3

SR. NO.	CONSUMER IDENTITY	LOAD	UNITS MEASURED
1	HOOK 1	7.5HP	0
2	DT31	5HP	3151
3	DT32	3HP	1885
4	HOOK 2	5HP	0
5	DT33	3HP	3145
Total-DTC-3			**8181**

Consumption at Piparin DTC	53050
Total consumption of consumers	39684
Loss in (KW)	13366
% Loss	**25.20**

In order to remove drawback of system we propose the HVDS system instead of LVDS system and the model is drown on Matlab simulik to compare the losses. The following fig shows that.

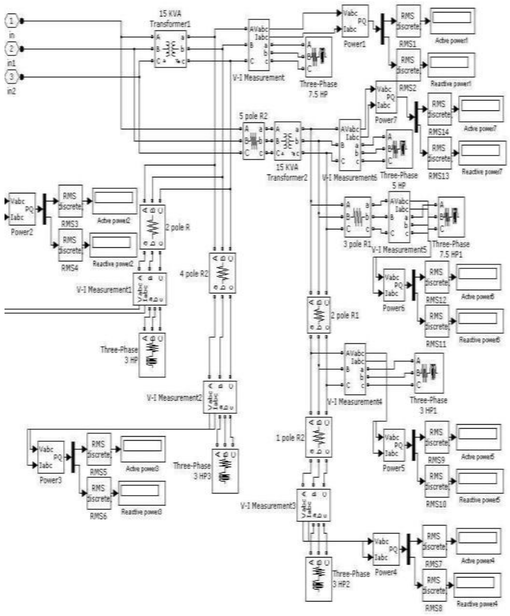


Fig. HVDS module-piparin DTC-1

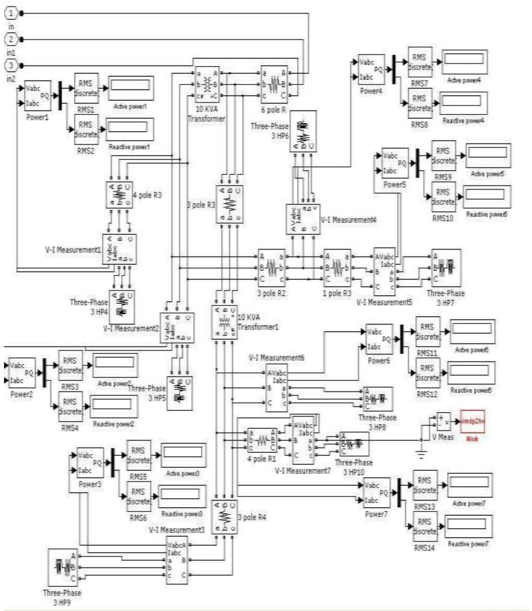


Fig. HVDS module-piparin DTC-2

CALCULATION ON HVDS SYSTEM

PIMPRIN DTC total unit = 41380

SR. NO.	CONSUMER IDENTITY	LOAD	UNITS MEASURED
1	DT11	7.5HP	4787
2	DT12	3HP	1905
3	DT13	5HP	3022
4	DT14	7.5HP	4488
5	DT15	3HP	1811
6	DT16	3HP	1808
7	DT17	3HP	1910
Total-DTC-1			**19731**

DTC -2

SR. NO.	CONSUMER IDENTITY	LOAD	UNITS MEASURED
1	HOOK 1	5HP	0
2	DT21	3HP	1814
3	DT22	3HP	1824
4	DT23	3HP	1915
5	DT24	3HP	1905
6	DT25	3HP	1907
7	DT26	3HP	1809
8	DT27	3HP	1807
Total-DTC-2			**12981**

DTC -3

SR. NO.	CONSUMER IDENTITY	LOAD	UNITS MEASURED
1	HOOK 1	7.5HP	0
2	DT31	5HP	3105
3	DT32	3HP	1857
4	HOOK 2	5HP	0
5	DT33	3HP	3315
Total-DTC-3			**8277**

Consumption at Piparin DTC	41380
Total consumption of consumers	40989
Loss in (KW)	391
% Loss	**0.94**

Above result shows that HVDS system is better than LVDS so we write a comparative programmers in Matlab to analysis losses in LVDS system following fig shows the comparative result.

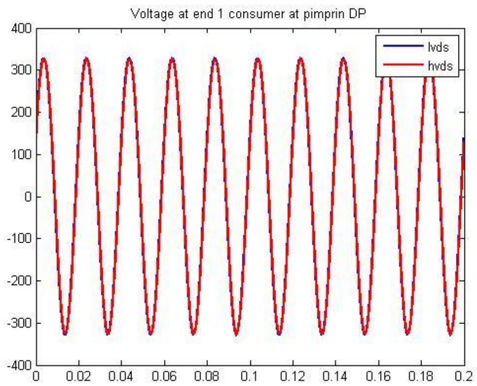


Fig. Voltage waveform at Pimprin DTC 1

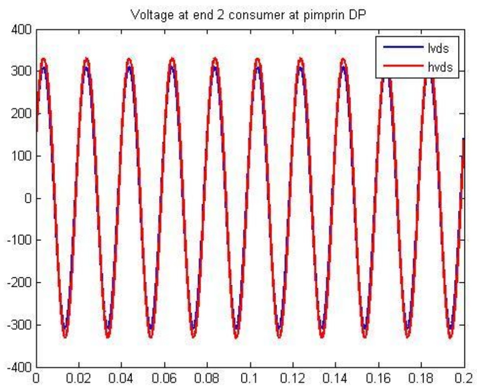


Fig. Voltage waveform at Pimprin DTC 2

CONCLUSION

The loss in existing LVDS system at Piparin DTC was 25 % which is reduced to 0.9% in HVDS scheme. Also there is a great improvement in voltage at tail end consumer from approximately 320V to 360 V.

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