Evaluation & Minimization of Distribution losses In Distribution System

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ABSTRACT

Power system losses can be divided into two categories: technical losses and non-technical losses. Technical losses are naturally occurring losses and consist mainly of power dissipation in electrical system components such as transmission lines, power transformers, measurement systems, etc. Technical losses result from the impedance of the network components such as electric lines/ cables, transformers, metering and protecting equipment etc. Non-technical losses, on the other hand, are caused by theft, metering inaccuracies. In this paper a method for losses calculation & minimization is presented.

Keywords— *Line Loss; Transformer Loss; Load Factor; cable losses; Load Duration Curve*

1. INTRODUCTION:

System loss is basically arithmetic difference between the units purchased from suppliers and the units billed to consumers in the respective period.The total system loss for any given period is expressed as percentage of total energy input in the system and is computed as follows

Total distribution loss = (Energy input- Energy sold).The total losses comprises of technical loss and commercial loss. The commercial loss mainly consists of losses due to theft of energy and unrecovered billed amount. While, technical losses are the losses occurred in the electrical elements during transportation of energy from the source to consumer end and mainly comprises of ohmic and iron losses. Technical loss is an internal loss are transfer of energy across transmission and distribution networks.

Losses in an electrical system can be classified into two categories: [4]

1)Current dependent losses • Copper Losses

= $(\text{Current})^2$ * Resistance

2) Voltage depending losses

• Iron Losses of transformers

Causes of Line Loss- Line Losses are a result of passing current through an imperfect conductor such as copper.

The line losses can be calculated based on $P_{loss} = I^2R$ Where,

I is current

R/L is resistance / Kilometer

L is length of cable in Kilometers

For a 3phase system, the losses for each phase are

calculated separately according to the measured current as:

$P_{loss}total = (P_{loss}–R) + (P_{loss}-Y) + (P_{loss}–B)$

$= I^2R$ Watt (R-Y-B Phases)

2.CAUSES OF TRANSFORMER LOSSES:

Power and distribution transformer losses are a combination of the power dissipated by the cores magnetizing inductance (Iron loss) and the windings impedance (Copper loss). Iron losses are a function of the applied voltage and are often referred to as no load losses, they are induced even when there is no load current. Copper losses are a function of the winding current and are often referred to as load losses.

These losses are calculated for any operating condition if a few parameters of the power transformer are known. The transformer manufacturer commonly provides this information on the transformer test sheet: [4]

1. Rated total kVA of the power transformer.
2. Rated voltage of the power transformer.
3. No-load test watts - the active power consumed by the transformers core at the rated voltage with no load current (open circuit test).
4. Full-load test watts- the active power consumed by the transformers windings at full load current for rated kVA (short circuit test).
5. %Excitation current - ratio of No-load test current (at rated voltage) to full load current.
6. %Impedance - ratio of Fullload test voltage (at rated current) to rated voltage.

3. LOAD FACTOR:

The ratio of the average load during a designated period to the peak or maximum load occurring in that period.[1]

$$\text{Load Factor} = \frac{\text{Average Load}}{\text{Maximum Demand}}$$

$$= \frac{\text{Energy consumption upto billing period}}{\text{KW demand} \times \text{Number of hours upto that period}}$$

4. LOAD CURVE:

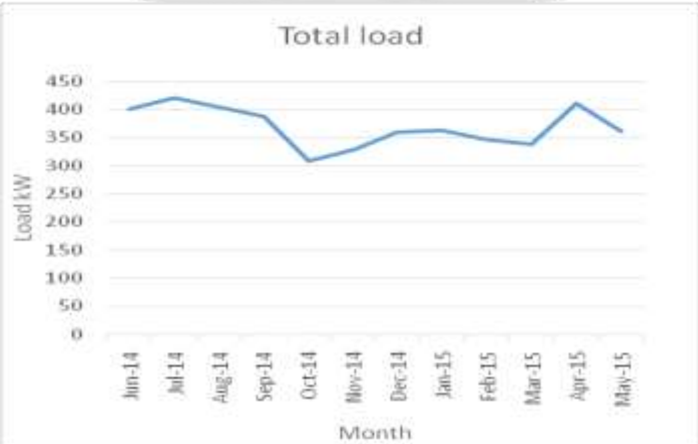


Fig 1 Annual load pattern

Analysis from above load Curve as follows:

Average Load = 368.84 kW
Maximum Demand=420.64 kW
Load factor = 0.87

5: CASE STUDY

Semiconductor Device Manufacturing Company

This company has a diverse portfolio of semiconductor and passive components including diodes, MOSFET, resistors and capacitors. They have their own distribution system consist of eight different load centers. Incoming supply of 22kV from Theur substation, then it is stepped down to 6.6kV, further it is stepped down to 0.4 kV. Power loss takes place in all these zones which can't be totally overcome but can be effectively mimimize. In this paper an effective methodology is employed in calculating and minimizing these distribution system losses.

6. CABLE LOSSES:

In cable losses considering heat losses (I^2R),This losses are calculated by using average current of the month and resistance of cable is used at the temperature 35^0 Celsius. Following are the results of losses in each zone.[2]

22Kv
- 1079.4 kwh
- 7232Rs.

6.6Kv
- 3987.6 kwh
- 26717 Rs.

0.4Kv
- 143403.6kwh
- 960804Rs.

[3]

Total losses:- 148470.6 Kw
₹994753.

Pie Chart – Cable losses

7: TRANSFORMER LOAD SHIFTING

While loadshifting the following points should be considered.

- Temperature rise of transformer.
- Ageingof the transformer.
- Efficiency of transformer.
- Continuous overload capacity of the transformer.
- Overloading of transformer (upto 110% of rated capacity).
- Transformer losses at different loading conditions.

7.1 Method for calculationof transformer losses according to loading condition of transformer. [2] [3]

Pcu = Full load copper Loss

Pi = Full load iron loss

1. Copper losses is proportional to the load current² or kVA²

2. Copper losses at the (50%) half load =¼ of full load

3. Copper losses at given load or kVA = Pcu× (loading kVA ⁄Full load Kv Or (% loading) ²× Full load copper losses

4. Total copper loss in 24hrs= Hrs × Pcu in kW

Copper loss in Rs =Rs⁄kWh× (Hrs × Pcu in kW)

5. Iron loss takes place 24hrs irrespective of load

On transformer because primary energize 24 hrs

Total iron losses in 24hrs = Hrs × Pi in kW

Core or Iron loss in Rs =Rs⁄kWh× (24× Pi in kW)

6. Transformer output in 24Hrs= Hrs × kW at given instant.

7. Output of transformer at given %loading and corresponding

Power factor is given by

= %x of kVA at full load × Power Factor

= (%x ⁄ 100 ×Rated or full load kVA) × Power Factor

Example-:

Transformer Rating = 500kVA, 6.6/0.4kV

Full load current =721.68 Amp

Full load losses = 4700 watt

Core losses is 30% of full load losses

Core losses = 1425 watt (Rated)

Core losses = 1.4225kW × 24 Hrs.

Copper losses = 3760 watt (Full Load)

Transformer load losses (Pcu) at different loading conditions per day.[4]

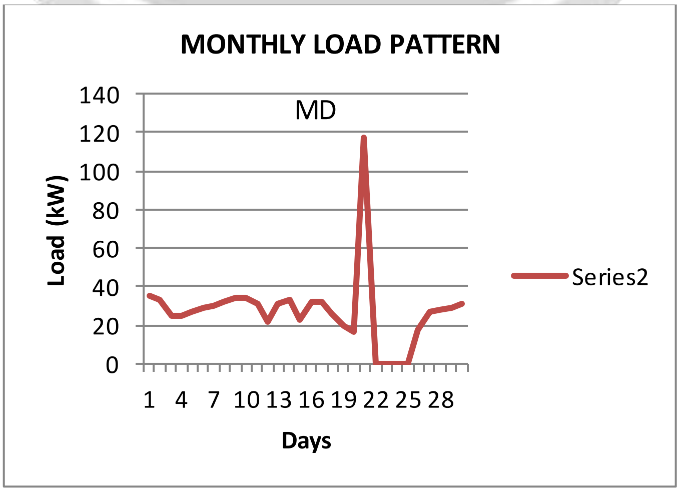
% of Rated load (Avg)	P.F	Hrs	%load× kVA×PF (kW)	Pcu kWh	Pi kWh	Pi+ Pcu kWh×6.71Rs
30%	0.99	24	148.5	27	34.2	410.65
9%	0.99	24	44.55	8.12	34.2	283.97

Transformer load losses (Pcu) at different loading conditions per month.-

% of Rated load (Avg)	P.F	Hrs	%load× kVA×PF (kW)	Pcu kWh	Pi kWh	Pi+ Pcu kWh×6.71Rs
30%	0.99	24×31	148.5	27×31	34.2×31	12711
9%	0.99	24×31	44.55	8.12×31	34.2×31	8803.07

8. REMEDIAL ACTIONS TO MINIMIZE THE LOSSES:

1. Demand Reduction:- Reduce demand by distributing your loads over different time periods
2. Flattening of load curve (Load Shifting):-Keeping the demand stable and increasing your consumption is often a cost-effective way to increase production while maximizing the use of your power [4]



3. Remove 6.6 kV Stage of transformations

4. Proper load management

9. CONCLUSION

This paper demonstrates method for power loss calculation is presented, the methodology is simple to implement. The data used is readily available from the energy management system(EMS) of power Distribution of Company. The results obtained can be used for financial loss calculations & Effective energy management & conservation in company.

10. ACKNOWLEDGEMENT:

1. 1. Shrinivas Patil (Manager – Plant Engineering &IEHS)
2. 2. S M Kulkarni (HOD – Zeal collage of Engineering)

We would like to thanks for giving your Technical Support valuable Time for completion of project.

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[4ElectricalTechnologyVol.2byB.L.Thereja