THE LEVEL OF ENERGY LOSSES IN THE NETWORK OF A DISTRIBUTION COMPANY AS MULTIPARAMETER CORRELATION FUNCTION

Jerzy SZKUTNIK
Faculty of Electrical Engineering, Technical University of Częstochowa

SUMMARY

In the report, the software package designed by the team of the Technical University of Częstochowa has been presented. The software is commonly used in distribution companies for calculation of efficiency of energy distribution in the networks. Calculations are conducted for current and forecasted periods of the network functioning. The report depicts the impact of energy saving transformers on the level of losses in distribution networks.

Keywords: *eficiency in distribution networks*

1. INTRODUCTION

The calculation of energy losses in the distribution network is a complicated issue, as knowledge of many parameters is required. There are many methods, which enable to conduct such calculations.[1] Some of them constitute regression models, other require detailed description of the network.

The methodology of the Technical University of Częstochowa commonly used in the distribution companies to calculate energy losses has its long tradition. In 90's, the software STRATY`95 [LOSSES'95] and STRATY`96 were designed. Presently, 28 distribution companies in Poland use the software, including the brand new version STRATY`2002 PLUS – the system for complex analysis of energy losses. The package consists of the following components:

Software STRATY`2002

The software, which enables calculation of energy losses in the distribution networks of 110 k, medium and low voltage. Losses in the low and medium voltage can be calculated in scale of energy boards (or for a single energy board) with details for each month. The real technical losses are spit into network elements and trade losses. Additionally, technical "justified" losses are calculated i.e. the losses, which would occur without significant investments in the infrastructure, which could be an indication by how much the existing technical losses could be reduced. The software is supplemented by software TRANZYTY [TRANSITS], which calculates losses in the 110 kV network, including subtotals resulting from flows to neighbouring energy boards. Comparing to STRATY`96, the software STRATY'2002 has the following new features:

a) Additional data package adjusted to the reporting requirements:
   - Energy flow from 110 kV to low voltage network
   - Energy flow from medium voltage to 110 kV network
   - Own needs
   - Illegal consumption

b) Calculations
   - The possibility to split trade losses into low and medium voltage network according to the assumptions of energy board
   - Results include additional information: balance sheet losses in the low and medium voltage network
   - Verified calculations in the 110 kV network

Software ANALIZA [ANALYSIS]

The software constitutes an extension to the software STRATY`96. The extension has been initiated by the existing users, who required the possibility to present the results of calculations for a longer period of time. The software STRATY'96 didn't offer such a possibility.

The software possesses all advantages of its predecessor and additionally enables presentation of results for any period corresponding to the data base. So, calculation possibilities are used for analysis of energy losses in the period longer than one year. It is assumed that the analysis depicting the levels of losses during longer periods may constitute an additional argument for evaluation of strategies related to reduction of losses in a distribution company.

Software TREND

The software enables forecasts of energy losses in the networks of a distribution company. It constitutes inevitable help for creation of new tariffs for energy.

On the basis of research conducted in some distribution companies, the set of correlations (curves) have been determined, which enable to estimate the trend of changes of energy losses. This gives the possibility to conduct calculations after checking and adjustments of curves. In order to do the checking, data for at least 4 years are required: 3 years for analysis and 1 year for verification. Calculations, similar to the main software, can been

conducted in scale of regions for low and medium voltage networks and in scale of energy boards - for 110 kV and combined for low and medium voltage.

2. ANALYSIS OF LOSSES IN A DISTRIBUTION COMPANY

With usage of the package STRATY`2002 PLUS one can conduct various calculations related to the current situation, make long-term comparative analyses, forecast energy losses as well as make simulations how particular factors lead to the reduction of losses in a distribution company.

One of the ways of increasing efficiency of energy distribution is implementation of new type of transformers characterised by lower values of losses both in iron and windings. This fact is included the software. Figure 1 depicts the impact of the share of new transformers on the level of losses in the transformer iron, Figure 2 - in transformer windings.

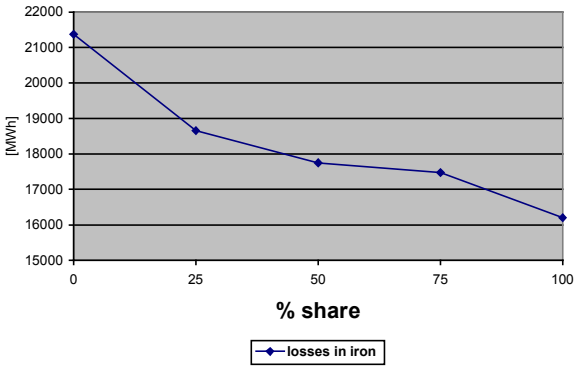

Figure 1. Impact of the share of new transformers on the level of losses in the transformer iron

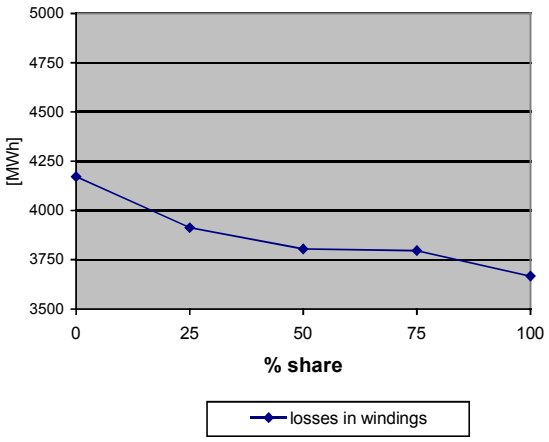

Figure 2. Impact of the share of new transformers on the level of losses in the transformer windings

The presented graphs prove that usage of new transformers lead to the reduction of losses in the low voltage network of a distribution company. These are, however, not the final effects of the changes. By using the software, one can see that the level of losses in the medium voltage network also decreases – this is a result of lower flows of energy through this type of network due to lower losses in transformers. Figure 3 depicts how load losses in this network change according to the share of new transformers.

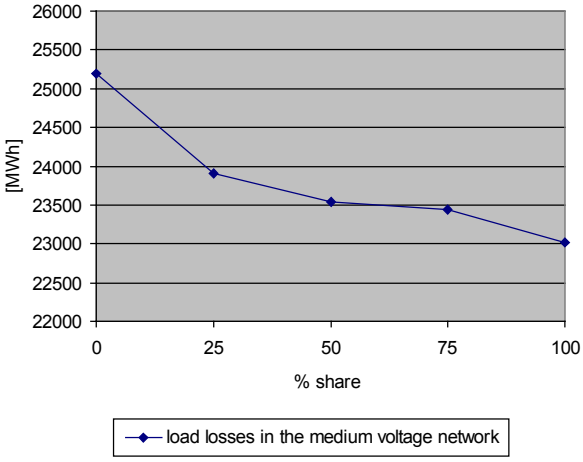

Figure 3. Impact of the share of new transformers on the level of load losses in the medium voltage network

The final effect depicts Figure 4. Losses in the distribution company declined from 100055 MWh to 93761 MWh when the new transformers had 100 % share.

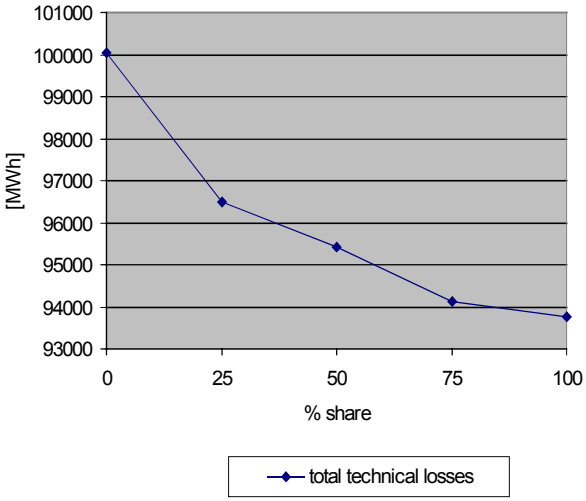

Figure 4. Impact of the share of new transformers on the level of technical losses in the networks of a distribution company

The difference between shares 0% and 100 % amounts to 6294 MWh, of which the reduction due to the usage of new transformers gives 5732 MWh. Additional effect of approx. 10% resulted from lower losses in the medium and 110 k voltage networks.

3. CORRELATIONS

For the analysed company, correlations between the share of transformers $u_{\%}$ and the relative coefficient of changes of losses in particular elements in the distribution networks $w_{\%}$ have been calculated. The following strong relations have been identified (correlation coefficient k >0,93):

1. Energy losses in transformer iron

$$w1 = 0,908 - 0,0014 \bullet u_{\%} \quad (1)$$

2. Energy losses in transformer windings

$$w2 = 0,955 \bullet 0,999^{u_{\%}} \quad (2)$$

3. Technical losses in the low voltage network

$$w3 = 0,950 \bullet 0,999^{u_{\%}} \quad (3)$$

4. Load losses in the medium voltage network

$$w4 = 1,032 \bullet u_{\%}^{-0,02539} \quad (4)$$

5. Total technical losses

$$w5 = 1,028 \bullet u_{\%}^{-0,01972} \quad (5)$$

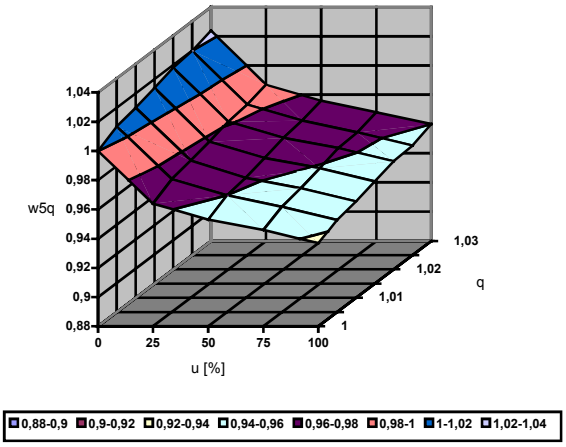

Figure 5. Impact of energy saving transformers and load increase on the level of energy losses in the distribution networks

The correlations mentioned above include only changes of the share of transformers. Figure 5 depicts the impact of two elements on the level of total technical losses: the share of transformers $u_{\%}$ and the dynamics of load changes q.

The correlation depicted in the graph above, can be described also as the following function:

$$w5q = 1,028 \bullet u_{\%}^{-0,01972} \bullet q \quad (6)$$

The conducted analyses show the impact of loss characteristics of transformers on the level of losses in the network. In addition, justification of such undertakings may be done by usage of effectiveness ratios [2].

REFERENCES

[1] Ograniczanie strat Energii Elektrycznej w elektroenergetycznych sieciach rozdzielczych pod redakcja Jerzego Kulczyckiego PTPiREE Poznań 2002 [Reduction of energy losses in the distribution networks, group work led by Jerzy Kulczycki]

[2] Szkutnik, J.: Selection of distribution network development in energy board on the basis of instrument effectiveness ratios from the energy losses point of view I TH International Scientific Symposium ELECTRO-ENERGETIKA STARA LESNA, SLOVAKIA, January 2001, pages 65-68

[3] Kolcun, M. and team: Operation Control of Electric Power System, Košice 2002, ISBN-80-89061-57-5

BIOGRAPHY

Jerzy Szkutnik Works in theFaculty of Electrical Engineering, Institut of Electrical Engineering in following areas: transsmision and the distribution of the electrical energy in technical and economical aspects, expert of distributive networks for distribution companies co-author of several softwares of distribution efficiency in high, medium and law voltage. The participation in passed 150 scientific works - investigative of executed on the order of the Institute of the Energetics , the department of the energetics and on immediate orders companies of distibution electricity, currently cooperation from 28 with distribution companies of Poland. The co-author of 2 books , the author and the co-author 70 of articles in periodicals and of reports presented on conferences national , international and foreign, for example: in Berlin, Bangkok, Kosice, Budapest, Florence. Performed functions: Deputy Director of the Institute of Electrical Engineering. The initiator of many international contacts with Technical University of Częstochowa. Since 1999 the Vice- President of the Association of Graduates of Technical University of Częstochowa.