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UTILIZATION OF THE FINITE ELEMENT METHOD FOR OPTIMIZING OF OVERHEAD COVERED CONDUCTORS

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Abstract: *The paper desribes optimalization covered pendent conductors by the help of method final elements. Was solving electric intensity about conductors for their various geometric sequenced on brackets poles. Experimental solving breakdown strength XLPE isolation ant it appearance to distance between conductor and size conductor insulation airline is described in the next part of contribution.*

Key words: *XLPE cable, ANSYS, Permittivity, Electric field*

1. INTRODUCTION

System type PAS was build already in 1976 in Finland. These types of electric line with began to develop mainly in northern Europe, and gradually get into other countries including the Czech Republic. Construction electric line isn´t different from the classical lines with bare conductors, but substantial change is using XLPE cable insulation. This isolation is mainly used to reduce the distance between the conductors up until third of the distance with bare conductors.

The paper solving by the help of the finite element method electrostatic field around the conductors placed on the console masts. This method uses software ANSYS, which displays the results graphically. This makes it possible to compare the most suitable geometric arrangement of overhead line conductors.

The ANSYS program is addressed to the calculation of intensity electric field for real layout conductors on consoles masts and also their experimentally proposed geometric layout. In the last part of the paper deals with ANSYS dependence of electric intensity on the thickness of insulation. All calculations in ANSYS are solved for the time interval of 20 ms at a voltage U_f = 13 kV. Information thus obtained can be further used to optimize the geometry of conductors on masts, as well as for manufacturing overhead line conductors. [Hamacek at al; 2009]

2. CALCULATION OF REAL DISTRIBUTION OF ELECTRIC FIELD AROUND CONDUCTORS

In this part is solving electric field around the wires for different types of masts.

To calculate at program ANSYS were chosen values distance between the phases of according these types of construction:

1) Anchorage console 3x IZV with overhang to JB and DB pole (distance among phases 600 mm)
2) Corner running console 3x IZV to JB and DB pole (distance among phases 950 mm)
3) Vertical anchorage console 3x IZV to JB pole (distance among phases 500 mm)
4) Vertical anchorage console 6x IZV to DB pole (distance among phases 600 mm)
5) Horizontal console 6x IZV to DB pole (distance among phases 600 mm)

Explanation of abbreviations:
IZV - insulated wires,
JB - concrete pole,
DB - double concrete pole.

In Fig. 1 is example distribution electric intensity around wires fixed to the console number 2) for U_f= 13 kV.

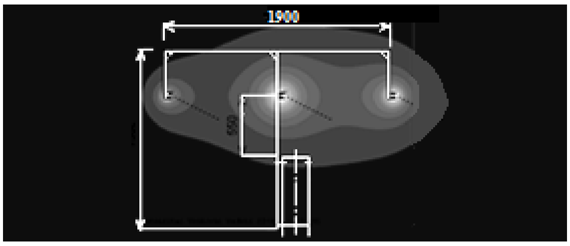

Fig. 1 Intensity distribution around the conductors of No. 2) [Mišák, S. at al; 2010]

The calculated values of electric intensity for each console are shown in the chart, see. Fig. 2. The lowest value E_{max}= 0,56 kV·mm^{-1} was calculated to console 2). The highest value of electric intensity E_{max}= 0,64 kV·mm^{-1} was calculated for the console 3).

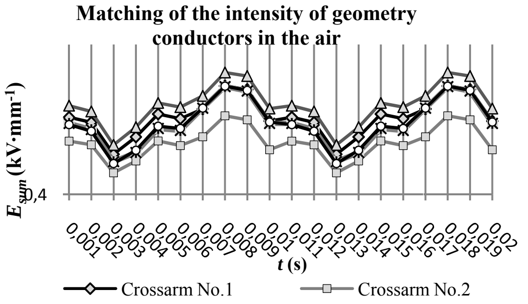

Fig. 2 Comparison of the intensity of conductor layout in the air [Mišák, S. at al; 2010]

3. CALCULATION ELECTRICAL INTEZITY DEPENDING ON THE DISTANCE BETWEEN CONDUCTORS

In this part of those referred to the value of the calculated values of electric intensity, depending on the distance phase conductors among each other. Calculations were performed for a distance of 0.01; 50, 100, 150; 200.

Distance (mm)	0,01	50	100	150	200
E_{max} (kV·mm^{-1})	19,2	1,52	1,07	0,9	0,82

Tab. 1. Calculated values for various distances

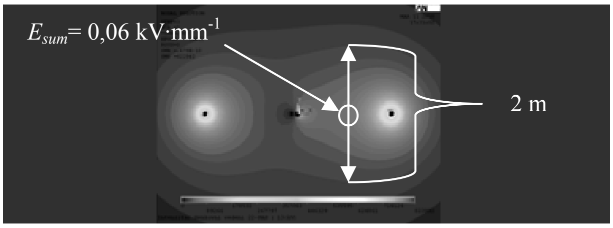

Fig. 3 Distribution E_{max} at time t=0,003 s, l= 200 mm

On the picture Fig. 3 is distribution example of the electric field at case t= 0,003 s for distance 200 mm. For insulation material XLPE is indicated value of electric strength of about 30-40 kV·mm^{-1}. As seen from theFig. 4, isn´t value electric strength material XLPE exceeded neither at zero-distance conductors.

Overview maximum values intensity are representation in Fig. 4

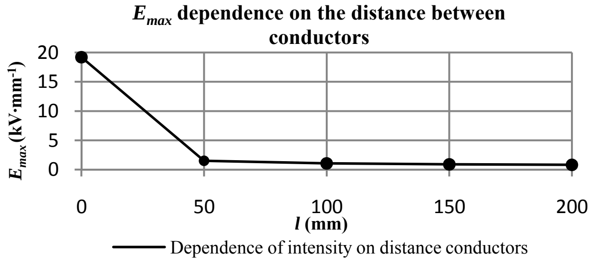

Fig. 4 Values E_{max} in dependence on conductor distances [Mišák, S. at al; 2010]

4. CALCULATION ELECTRICAL INTENSITY DEPENDING ON THE THICKNESS INSULATION

Another task was to compare, how altering electric field, depending on the thickness insulation. For calculation was used insulated pendent conductor 22-PAS 70 mm^2 with thickness insulation 2 mm.

Insulation thickness (mm)	0,73	1,03	1,23	1,98	2,23	2,48
E_{max} (kV·mm^{-1})	46	36,2	28,8	24,6	24,6	15,5

Tab. 2. Values for different thicknesses of insulation

In the Fig. 5 is representation area field electric strength. As you can see from this chart, was in this part field decrease electric intensity in view to distance less, as is apparent with chart.

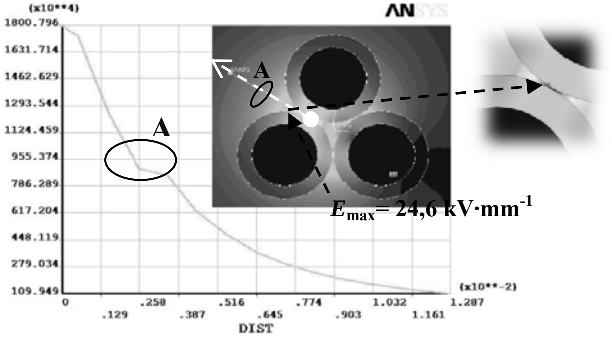

Fig. 5 Evaluation of electric field intensity

Dependence electric strength on thickness insulation are shown in the chart, see. Fig. 6. The graph shows that for insulation thickness of 1,23 mm insulation still complies with maximum breakdown voltage for XLPE insulation. During calculating for thickness insulation 1,03 mm can be seen that in this minimum difference already insulation XLPE doesn´t meet required parameters. These results show that even a small change isolation has a big effect on the reliability of the conductors.

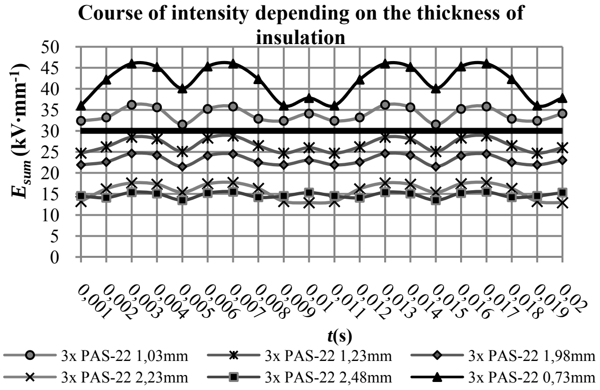

Fig. 6 Course of electric intensity depending on the thickness of conductor insulation [Mišák, S. at al; 2010]

5. ACKNOWLEDGMENT

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6. CONCLUSION

The aim this paper was to emphasize problems optimization overhead line insulated overhead cable type 22-PAS.

The result at first section shows distribution electric intensity during real layout phase conductors and distribution electric intensity for different geometric arrangement of conductors. In the results shows that, for the variant where the wires are touching each other is the electric field intensity E_{max}= 19,2 kV·mm^{-1}. This value still meets the requirements for electrical insulation strength of XLPE, which is E_p= 30 kV·mm^{-1}.

In the second part resulting dependence breakdown strength at insulation thickness XLPE insulated overhead cable type PAS. The minimum thickness 1,23 mm XLPE insulation is still satisfy indicated value disruptive strength 30 kV·mm^{-1}. From these results it is seen as are conductor and masts for medium voltage overdesigned. It is therefore appropriate to deal with in the future further analysis of the optimization overhead insulated overhead cable on which is working.

7. REFERENCES

Hamacek, Š.; Marek, M. (2009). *Experimentální zjišťování průrazné pevnosti typových kabelů CYKY v závislosti na teplotě se simulací elektrostatického pole*, Sborník konference ANSYS, Plzeň, ISBN-978-80-254-5437-4

Mišák, S.; Sokanský, K. (2007). *Analysis of Electic Arc at High-voltage System*, Sborník IV. International Scientific Symposium Elektroenergetika 2007, Košice:Technical University of Košice, 220-222, Technical University of Košice, ISBN 978-80-8073-844-0

Mišák, S. (2007). *MATHEMATICAL MODEL OF ELECTRIC ARC AT HIGH VOLTAGE SYSTEMS*, 18th DAAAM International Symposium 25th October 2007 at the University of Zadar, Zadar, Croatia. Ed. Branko Katalinic, Publisher DAAAM International Vienna, Vienna 2007, Zadar:University of Zadar, 2007, Editor: Branko Katalinic, Publisher DAAAM International Vienna, Vienna 2007, s. 150-154, University of Zadar, ISBN 3-901509-60-7

Mišák, S., Hamacek, Š. (2010). *Využití programového prostředí ANSYS, pro optimalizaci vodičů venkovního vedení*, Brno:MSD, s.r.o., 2010, 859, ISBN 978-80-214-4094-4

Hamacek, Š., Mišák, S. (2010). *Analýza namáhaní izolace typových kabelů AYKCY a NAKBY v poruchovém a provozním stavu s využitím modelování v programu ANSYS*, Ostrava, 15, ISSN 1210 – 311X