ASPECTS REGARDING THE INSPECTING AND MONITORING OF INSULATION AT MEDIUM VOLTAGE ELECTRICAL CABLES USED IN POWER DISTRIBUTION SYSTEMS

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Abstract: *In the presented paper we tried to highlight the importance of the medium voltage electric cables in power transistors through electrical networks distribution to medium voltage consumers. Starting from consideration, the paper summarizes the prophylactic checks through which it is possible to monitor the evolution over time of the insulation condition of the power lines in the cable.*

Key-words: verification, monitoring, insulation, electrical cable, medium voltage, absorption coefficient.

1. INTRODUCTION

Starting from the assumption that the distribution of electricity to domestic and industrial consumers is mainly done by means of cable electric lines, we considered it of interest to present a way of checking the insulation status of these cables.

The distribution of electricity to household consumers is mainly carried out in a radial system by the power supply being made from the distribution transformers incorporated in the buildings built and usually increased in the center of gravity of the residential neighborhoods. The power supply of these transformers is provided by the zonal network operators, also by means of electrical lines in the cable, whose voltage level is 20 kV or 6 kV. Electric transformers that are part of the electrical energy distribution system for domestic and industrial consumers also have a very important role in the power distribution process by converting electricity to two levels / voltage levels:

- for industrial consumers from 20 kV to 6 kV,
- for home consumers from 6 kV to 0,4 kV.

Starting from the above-mentioned aspects, it can be said that cable electric lines can be included in that category of electrical installations of major importance in the process of distribution of electric energy to domestic and industrial consumers and their operation is conditional on the observance of the performance standards through which regulates the value of the quality parameters (voltage variations, power continuity, non-symmetry, etc.) [1-2].

Starting from these considerations in the paper, a synthesized presentation of the types of insulation and its application to the conductors in the configuration of the electric cables is attempted.

The difference between the notion of isolated conductor and largely insulated cable is conventional and their meanings most often get confused. As a rule, electrical cables are distinguished as perception of electric conductors in that they incorporate several power paths. In addition to this, for greater flexibility, each current path may be multifilamental, that is, made up of a larger number of thin conductors. Insulated electric conductors and cables can be classified into four categories [3]:

- ➢ conductor insulated with flexible strip;
- ➢ conductors with waterproof insulation;
- ➢ fiber-insulated conductors;
- ➢ enamelled conductors.

2. STUDY ON HOW TO ACHIEVE THE INSULATION OF ELECTRICAL CABLES

When insulating insulated conductors with flexible bands, the manufacturing plants use insulation technologies based on the following insulating materials[3]:

- paper,
- insulating cloth,
- insulating foil.

The way to insulate conductor insulated with flexible stripes can be manually or automatically (under the coordination of a process calculator) and can be done by three processes [3]:

- ➢ by touching the spirals apart (figure 1.*a*);
- ➢ with overlapping in positive sense (figure 1.*b*);
- ➢ with overlapping in negative sense (figure 1.*c*).

The most common method used by manufacturing plants is overlapping, and the applied method consists of a half-overlapping wrapping operation, i.e. overlapping half the bandwidth. Conductor insulation can be applied only once or more times, depending on the functional role and the supply voltage level (low voltage, medium voltage). Strip insulated conductors are used in the windings that come into the configuration of electric machines [3].

In the second category of conductors (with waterproof thick insulation), the application technology consists of applying a layer of insulation with a thickness much larger than the lacquer film applied to the enamelled conductors. The thickness of this insulation layer may vary depending on the usefulness of the conductors, from tens of millimeters to a few millimeters. This type of insulation can be classified as thermoplastic articles with invariable cross-section or in rubber articles. It should be noted that the construction with impermeable thick insulation is used by the manufacturing companies, especially for the electric conductors and cables that come into the configuration of the electrical installations related to the electric power distribution schemes [3].

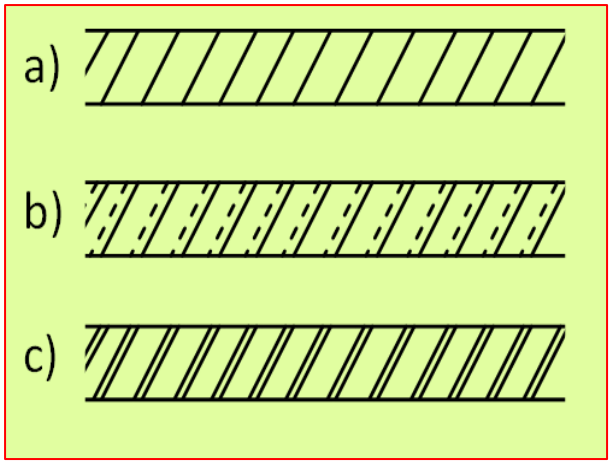

Figure 1.Ways to achieve insulation

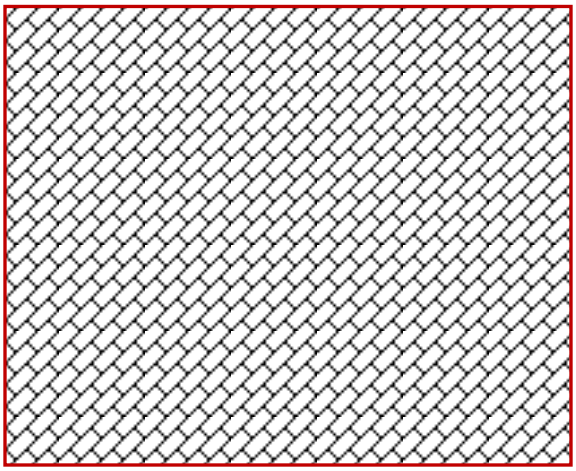

Figure 2. Detailed view of the most required tape of the conductors with flexible materials

With regard to the third category of conductors (fiber-insulated), it can be said that the application technology consists of the interaction between two basic systems: windings and ribbons.

The winding is the insulation obtained through the bobbin-like sheath wrap. Applies to conductors used to make windings for electrical machines.

Ribbon is a more complex mantle, obtained by intermingling a few bundles of threads (Figure 2). The ribbons are typically not used independently and underneath a solid rubber casing. The ribbons are also made separate from the conductors, when after lacquer impregnation and drying they get the name of a lacquer tube. Varnish tubes with diameters of 1.5-10 mm are made. They serve as additional insulation of the conductors, and more often in the place where they connect [3].

In electrically insulated conductors, the insulation layer consists of a thin film formed by repeated deposition and drying of the lake. The thickness of this layer is within the range (0,015 ÷ 0,15 mm), where the lower limit is characteristic of electric conductors with relatively small sections, and the upper limit is characteristic of electric conductors with relatively large sections [3].

The basic application of enamelled conductors is for windings (winding conductors). Besides, in some cases, at the same time with other insulation on the surface of the conductor is also emailed.

The use of enamelled conductors as windings of electrical machines and apparatuses has as main advantage a relatively low insulation thickness, which directly leads to the reduction of the dimensions of the winding mass and indirectly to the reduction of the dimensions of the machine gauge and electrical equipment (electric motors, transformers, meters, etc.) as a whole [3].

3. PROPHYLACTIC TESTS THAT CAN BE PERFORMED ON MEDIUM VOLTAGE POWER CABLES

In order to fit the estimated lifetime from the design phase and the operation under flammability conditions to medium voltage elctric cables, a set of prophylactic checks

with due dates for monitoring is required, among which [4]:

- checking the protective wrapper (which may be PVC or PE);
- continuity check and phase identification;
- proof resistance of conductors and screens;
- insulation resistance verification;
- absorption coefficient check and polarization index;
- high-voltage insulation check;

This set of prophylactic checks is performed prophylactically when putting into service, technical revisions, but may also be conditioned by unforeseen incidents (defects, damage). The manner in which these verifications are carried out is usually governed by audit verifications issued by the licensing company and endorsed by the competent authority.

Of the 6 checks listed, it can be said that checking the insulation level and the coefficient of absorption on the electric cables has a permanent character, as it is also a desideratum for the operating personnel.

Referring to the various flowcharts of electricity generation, transport and distribution, it can be said that exploitation implies continuous (direct or indirect) monitoring of the insulation level of the power lines. For this reason, a case study will be carried out on how to determine the insulation level.

Determination of the insulating level on the medium voltage electrical cables is done with metering devices and the applied voltage depends on the nominal supply voltage of the cable. Table 1 shows the correlation between the metering range of the metering and the nominal voltage to which the electric conductors belonging to a cable electric line (LEC) [4] operate.

Table n^{o}1

Nr. crt.	***Type of network / line (LEC)***	***Rated line voltage Un[kV]***	***Verification rated voltage Un[V]***	***Checking moment***	***Reference value***
1.	***Cable Line (LEC)***	<5,8/10	>2500	PIF, after IA, RT at 5 years	100 MΩ/km
2.	***Cable Line (LEC)***	>12/20 kV	>5000	PIF, after IA, RT at 5 years	100 MΩ/km

The reference parameter that directly characterizes the insulation state of the medium voltage electrical cables is the absorption coefficient. The verification and testing norms have established that the value of the absorption coefficient should be greater than 1.3 . The value of the absorption coefficient is given by the ratio between the value of the insulation resistance measured by the megammeter at a time interval of 60 seconds and a time interval of 15 seconds respectively.

In Table 2 are presented the values and the control values of the coefficient of

absorption and of the polarization index on the cable electric lines (LEC) [4].

Table n°2

Nr. crt.	*Type of network / line (LEC)*	*Rated line voltage Un[kV]*	*Rated checking voltage Un[V]*	*Checking moment*	*Indications and control values*	*Ip*
1.	***Cable Line (LEC)***	<5,8/10	>2500	PIF after IA only when insulation resistance values are inadequate	>1,3	Ip > 2
2.	***Cable Line (LEC)***	>12/20 kV	>5000	PIF after IA only when insulation resistance values are inadequate	>1,3	Ip > 2

4.CONCLUSIONS

1. Determination of insulating resistance on medium voltage cables is a vital preventive measure in preventing the occurrence of fault and failure modes that may occur as a result of the dielectric depreciation between both the active conductors of the electric cable and between these conductors and the conductor null.

2. For medium voltage electrical cables, the reference parameter that reflects the insulation state is the absorption coefficient. The value of this coefficient must be greater than 1.3, and the determination method consists in reporting the value of the insulation resistance measured with a megamer at a time interval of 60 seconds, respectively at a time interval of 15 seconds.

3. To prevent the occurrence of fault and fault condition in cable electrical lines, it is necessary to monitor in time the evolution of the insulation level by means of verification bulletins, recording the values of the insulation resistance and the absorption coefficient obtained on the occasion measurements (commissioning and subsequent to technical revisions or incidents).

5.REFERENCES

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