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Minimization of the Bypassing of High Voltage Insulators by the Attenuation of the Transient over Voltages

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Abstract: In this research it is shown that the correct evaluation of the attenuation and the distortion of the over voltages of atmospheric origin while leaning at a time on the convenient experiences make on the line 220 kV and of the experiences of charges q = f(u). One deducts that the corona effects has impact only on the transverse constant and notably the capacity that undergoes a remarkable modification of the apparition of corona effects. The corona effects reduced the amplitude transient of the electrical constraints and the protective material inside the station because of the distortion of the amplitude of the wave also that the front of wave is sufficiently long for the enlightening functioning with the best efficiency without forgetting that this research contribute to the improvement of the electrical constraints and a best economic optimization and a perfection of bets in service of the protective device.

Key words: Over voltage, insulation, bypassing, propagation, effect crowns

INTRODUCTION

The continuity of service and energy feeding by the transmission lines networks are primordial for the costumers. The bypassing of the insulators polluted is one of the major problems and presented 80% of the failures in the electric high tension lines (Gary and Dragon, 1989; Guiller, 1992). The essential reasons are on (Tome, 1980) the coordination of the insulators and on the temporary transient phenomena in general due to the lightning. The present research is dedicated to the survey and the analysis advanced of the over voltages of which the results, gotten after long research, remained controversial: To know in the first, the over voltages of lightning that propagate along an electric line undergo a distortion under the influence of the corona effects (Janvier, 1991).

This attenuation that superimposes itself to a distortion by effect of skin is due to the supplementary dissipation of energy by injection of space loads around the drivers as soon as the critical voltage of the corona effects is passed. The problem is posed a long time ago However the divergence of the results gotten has been marked because of the natural complexity of the lightning phenomenon (Chang, 1985) as well as these researchers had used sections of wires relatively weak and non representative to present wires.

Nowadays and thanks to a new experimental support adopted to the lines as well as certain refinement of the theory; as the research of the likeness (IEEE, 1994) laws remains therefore necessary, without forgetting the recent research on the physics of discharge to big distance these permit us to deduct a new interpretation of the phenomena put in game in the over voltages of lightning.

To this consideration, a general protection defining the main parameters that influence the attenuation and the distortion of the lightning over voltages under the influence of corona flux is necessary for the first left of this research.

While using the experimental works elaborated by C. Gary (1989) and his group of research in the laboratory of Clamart (France); we treated the based general principle mainly on the cycle of the loads as using an analogical model of a line in presence of the transient corona effect.

MATERIALS AND METHODS

The calculation of the distortion of propagation of the lightning over voltages and the analysis of the detained results are the main subject of our research and to validate our calculations that form a theoretical interpretation of the measures of the load cycles q = f(u) done at the laboratory and providing the physical basis of this calculation and to compare it with the group of researchers of Romania (Tome, 1980) and in France (IEEE, 1994). On the real line of 65 km of length and under a voltage of 220 kV. This line has the following features,

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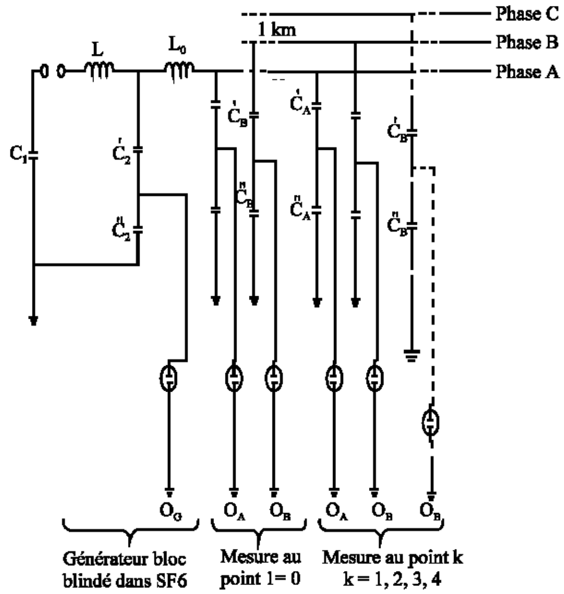

Fig. 1: Injection and measure of the mobile waves along the line 220 kV

it is of 411 mm^2 of section and Ø = 26 diameter, 2 mm and of a distance between phases d =7 m the generator of shock uses the following features, it is a generator armoured SF6 of voltage U_n = 1MV, of a W = 21 KJ and of a shock capacity C_{choc} = 21.4nF. The generator of shock is connected to a phase of the considered line.

The registration of the measurements has been done with the help of the mobile oscilloscopes under shapes of station connected, respectively in each phase of the line in OA, OB and OC as indicated in Fig. 1.

The voltages of shock used positive and negative polarity with amplitudes of 300 kV inferior to critical voltage U0, then 600, 850 and 950 kV.

While taking advantage of these enormous works, we present the diagrams of the oscillographe connected to the phase A seat of the injected shock and therefore some corona effects these graphs present mobile waves of voltage in several points of the line (0, 1, 3, 7 and 10 km) Fig. 2.

According to these experimental diagrams the authors notes without ambiguousness a distortion due to the corona effects (Gary, 1983) a lot more important than the one due to the skin effect.

The respective effects of the distance of propagation and the amplitude of the initial wave and the polarity are distinctly visible.

The most remarkable of these registrations is the dependence between the amplitude of the wave (Umax), the time of the forehead or the stiffness tmax and the distance of propagation. According to these graphs

Table 1: Variation of the maximal amplitude along the propagation

1 (km)	0	1	3	7	10
U_1 max kV	995	820	580	350	300
U_2 max kV	850	670	520	360	330

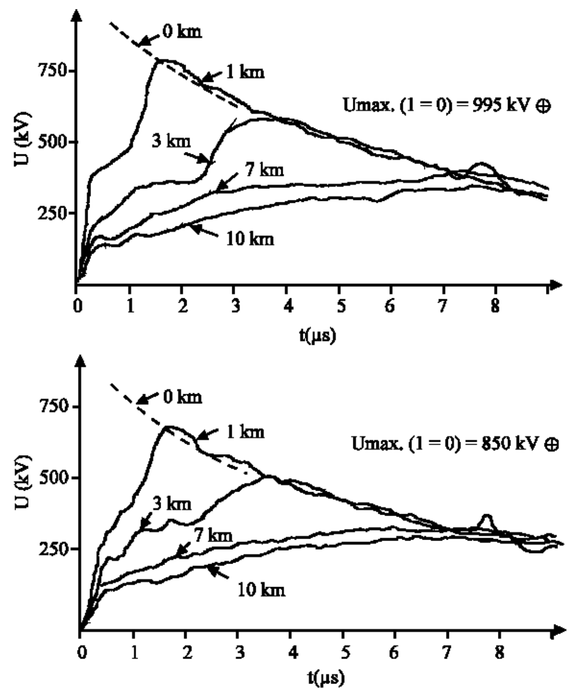

Fig. 2: Distortin and propagation curves of a voltage wave superior to the critical voltage (positive polarity)

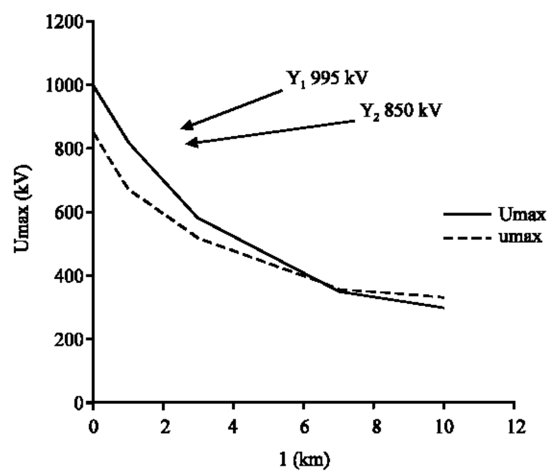

Fig. 3: Variation of Umax according to the propagation distance

Fig. 2 we can deduct several points that illustrate this dependence that we present the Fig. 3 and 4 represented in the Table 1 and 2.

Table 2: Variation of the stiffness time of the wave along the propagation

1 (km)	0	1	3	7	10	
T_1 max µs		0.2	1.2	3.5	7.1	7.7
T_2 max µs		0.2	1.8	3.3	5.2	6.1

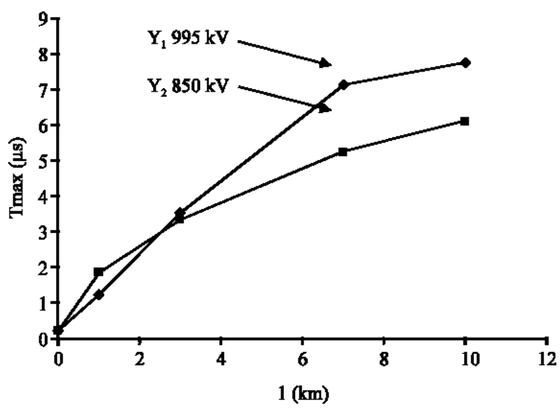

Fig. 4: Variation of Tmax according to the propagation distance

Method of the laboratory samples: the cycles q-v: The principle of the survey consists in applying an over voltage with a shock generator to a sample of wire of about ten meters and to measure the space charge q (t) injected by the corona effect at the neighbourhood.

The explanation of this phenomenon is given by the cycles q = f (u) in the Fig. 5 from where one gets a closed buckle figure from where the name of cycle q-v.

When the applied voltage is lower to the critical voltage (law of Peek) (Revue electro-energetique, 1987) the load is solely capacitive and the relation between q and u is linear, as

$$q = C_{gem}.u \quad (1)$$

Where C_{gem} is the wirer's geometric capacity and depends to the over of this critical voltage appears to a charge space around the wire whom there leads a charge said of supplementary corona. The wirer's charge becomes:

$$q = C_{gem}.u + q_{cor} \quad (2)$$

The charge q_{cor} varies with u voltage . One could consider the relation then:

$$q = C_{dyn}.u \quad (3)$$

Where C_{dyn} would be the dynamic variable capacity with voltage. This capacity gives account of the increase of

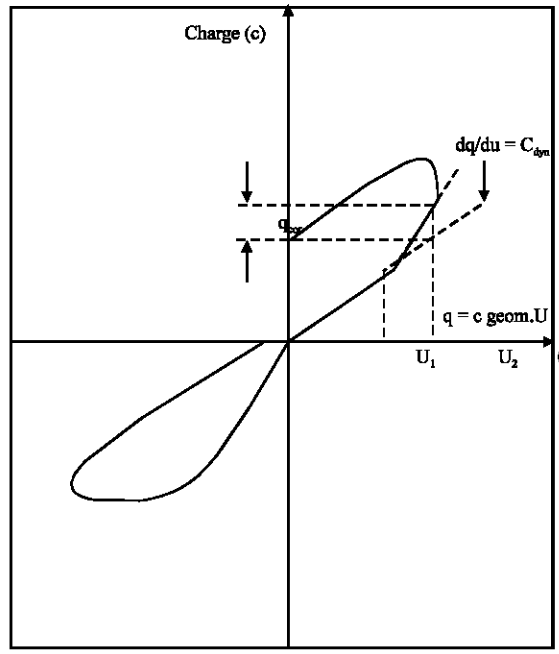

Fig. 5: Cycle of charge/voltage

the load by the corona effects, and must be therefore superior to C_{gem}. The speed of propagation of the waves on the lines is nearly equal to the one of light, is given by:

$$v = \frac{1}{\sqrt{L.C_{dyn}}} \quad (4)$$

Where L and C are, respectively the inductance and the capacity of the line.

One sees that v is a function of C_{dyn} then of u. One can interpret the distortion undergone by the wave of voltage that moves with a different speed lower to the speed of light determined by the instantaneous capacity C_{dyn} then; the delay, Δt characteristic of the distortion will express itself by:

$$\Delta t = \Delta l.\left(\frac{1}{v} - \frac{1}{c}\right) \quad (5)$$

In the Fig. 5.

In the other hand the dissipation of energy by the corona effects during the propagation of any voltage along the day will be Δl worth:

$$W_1 - W_2 = \frac{1}{Z}\int\left[u_1^2(t) - u_2^2(t)\right].dt \quad (6)$$

Where Z is the impedance of the line and u_1 and u_2 voltages between two points of propagation, respectively

1 and 2. If there is corona effect, the existence of the energy dissipation requires a lower voltage from where the explanation of the attenuation of the over voltages by the corona effects.

On the other hand, one knows that the cycles (q, u) depend solely on the amplitude of voltage and the geometry of the line (Gary, 1983). Knowing that the energy dissipated by the corona effect is represented by the area of these cycles (Guiller, 1992) it follows that more these cycles are inflated the losses corona, more are important. What is equivalent to a bigger resistance corona and to an important attenuation of over voltages (Revue électro-énergétique, 1987). One can pull like important remark that without the losses corona, there would not be big differences, between the different representations of the over voltage during the propagation. One be able to also pull of it, for the same reason that the attenuation of the transient over voltages due to the effect crowns is a lot more important than the one that would be due to the only skin effect.

CONCLUSION

The survey and the analysis of the atmospheric over voltage wave propagating itself on a line in direction of the electric station and permitting to define the dielectric isolation of the works to high and very high voltages opposite the lightning.

The correct evaluation of the attenuation and the distortion of the over voltages of atmospheric origin while leaning at a time on the convenient experiences (Gary and Dragon, 1989; Revue électro-énergétique, 1987) make on the line 220 kV and of the experiences of charges $q = f(u)$. One deducts that the corona effects has impact only on the transverse constant and notably the capacity that undergoes a remarkable modification of the apparition of corona effects.

As regards to coordination of the isolation and the installation of the protections, this research is very beneficial in the financier point of view and continuity of service of the electric facilities; for example an atmospheric over voltage wave distorts itself very quickly during its propagation on the electric line: A stiff forehead wave to the point of injection $t_f = 0.2$ ms has a front of t_f only = 0.3 ms after 10 km of propagation. On average one deducts that the forehead flattens of about 0.9 to 1.1 ms by km.

The corona effects reduced the amplitude transient of the electrical constraints (Gary, 1983) and the protective material inside the station because of the distortion of the amplitude of the wave also that the front of wave is sufficiently long for the enlightening functioning with the best efficiency without forgetting that this research contribute to the improvement of the electrical constraints and a best economic optimization and a perfection of bets in service of the protective device.

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