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A Review on the Environmental Impacts of Corona Losses and Their Suggestive Measures

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ABSTRACT

Transmission losses are one of the biggest concerns around the globe. These losses have become an important issue for the poor economy of the third world. Extra High Voltage (EHV) and Ultra High Voltage (UHV) are one of the prevailed options for the reduction of these losses. But EHV and UHV transmission lines are responsible for corona loss. Corona effect at transmission line produces an audible noise under certain weather condition which affects the environment and the local people who are living in the vicinity. Audible noise produced by EHV and UHV transmission lines is becoming a major concern today. The generation of unreasonable audible noise within the environment is regarded as a form of pollution because it lowers the quality of life. There have been several specific ways in which excessive noise can affect people adversely. Noise has been found to interfere with our activities at three levels that are audio logical level, biological level and behavioral level. Due to this the noise affects categorically, performance, physiology and psychology of the humans. Noxious has been known to cause of nervous disorder, headache, high blood pressure and short memory. In this paper different techniques used for the reduction of noise produced by corona discharge is reviewed and its remedies has also been discussed in detail.

KEYWORDS: Corona losses, Noise pollution, EHV transmission lines, UHV transmission lines.

1.INTRODUCTION

Noise pollution is excessive, displeasing human, animal, or machine created environmental noise that disrupts the activity or balance of human or animal life. The word noise may be from the Latin word nauseas, which means disgust or discomfort. The source of most outdoor noise worldwide is mainly construction and transportation systems, including motor vehicle noise, aircraft noise, rail noise, noise created by power grid and many others.

Environmental noise produced by the power grid is mainly due to effect of corona discharge which generate very high audible noise in the form of humming and hissing. Corona, also known as partial discharge, is a type of localized emission resulting from transient gaseous ionization in an insulation system when the voltage stress, i.e., voltage gradient, exceeds a critical value. The ionization is usually localized over only a portion of the distance between the electrodes of the system. Corona can occur within voids in insulators as well as at the conductor/insulator interface.

Coronas can generate audible and radio-frequency noise, particularly near electric power transmission lines. They also represent a power loss, and their action on atmospheric particulates, along with associated ozone and NOx production, can also be disadvantageous to human health where power lines run through built-up areas. Therefore, power transmission equipment is designed to minimize the formation of corona discharge. Corona discharge is generally undesirable in Electric power transmission, where it causes Power loss, Audible noise, Electromagnetic interference, purple glow, ozone production, Insulation damage etc.

2.HIGH VOLTAGE AC TRANSMISSION LINES: REDUCTION OF CORONA UNDER FOUL WEATHER

The Corona effect is mainly associated with the transmission of electrical energy at extra high voltage (EHV) and ultra-high voltage (UHV). Especially in the case of AC lines the corona discharges at the surface of conductor produce more audible noise, electromagnetic interference and power loss under rainy season. In this paper the improvements of corona performance under rainy conditions have been discussed by optimizing the flow characteristics of water on the conductor or by using the shielding effect of ionic space charge to eliminate streamer discharges at the conductor's surface that leave the conductor's diameter untouched.

In this paper three different types of the conductors have also been reviewed, that are: hydrophilic, hydrophobic and ion-shielded [1]. The corona activity of a conductor under rain depends greatly on how well water adheres to its surface. If the contact angle is larger than it causes curbing corona activity and if it is smaller to the surface then water will spread in a thin coat along the surfaces, reducing drastically the linear density of water protrusions and leading to an accumulation of water on and in the stranded conductor. When the conductor finally sheds water, it does so by ejecting from an intermittent water jet shaped by the electric field. This means of shedding water is known as "Mode III"[2] and is very desirable, since it produces comparatively low corona interference levels. Also, the design of an antenna of 30- 50 Mc bands which affords a high degree of immunity from the noise of precipitation and corona has been reviewed. The main feature of this design is a dielectric sheath enclosing the radiating conductor. To reduce the contact angle to more favorable value, the aging of the surface, essentially a chemical aggression by the environment is used. In this paper both hydrophobic and hydrophilic methods is used to reduce corona interference were investigated.

3.SURFACE PREPERATION

A "Hydrophobic" condition is obtained by condensing a thin film of paraffin on a cold conductor. A cavity is filled with warm paraffin vapors from a hot plate. When the cooler conductor is rotated inside the cavity, a uniform coat is obtained within one hour [1]."Hydrophilic" condition is obtained by heating the conductor in a tubular oven to 600°C. A similar effect is obtained by passing the flame of a gas burner over the surface, although the effect does not then extend to the inside surfaces of the stranded conductor. The hydrophilicity is caused by the parceling out of the oxide layer due to differential thermal expansion of metal and oxide and to the dehydration of aluminum oxides. Unless the sample is kept in a dry atmosphere, the hydrophilic quality obtained by this method will not last beyond a few days [1]. The contact angle of a water drop with a surface can be measured at the triple point where surface, air and water meet.J.E. Cross[1] has investigated methods to recover the maximum amount of available information from an image. Some radio frequency and optical sensors collect large-scale sets of spatial imagery data whose content is often obscured by fog, clouds, foliage and other intervening structures. Often, the obstruction is such as to render unreliable the definition of underlying images. Various mathematical operations used in image processing to remove obstructions from images and to recover reliable information were investigated, to include Spatial Domain Processing, Frequency Domain Processing, and non-Abelian group operations.

4. AN ANTENNA FOR 30-50 MC SERVICE HAVING SUBSTANTIAL FREEDOM FROM NOISE CAUSED BY PRECIPITATION STATIC AND CORONA

This section describes the design of an antenna of 30-50 Mc bands which affords a high degree of immunity from the noise of precipitation and corona. The main feature of this design is a dielectric sheath enclosing the radiating conductor. Noise from the charged particles is estimated to be reduced about 30 db by the dielectric sheath. A standard approach is used to minimize corona effects. Vertically polarized, half-wave antenna is designed to reduce the received noise caused by electrically charged particles striking the antenna, and by corona discharge from the antenna into surrounding air. By placing the discharge point beyond the field of antenna is the most effective means of reducing corona noise. A considerable reduction in corona noise is possible if the discharge is permitted to occurring a gradual manner. "This technique, too, is applied in aircraft practices where corona noise is severe.

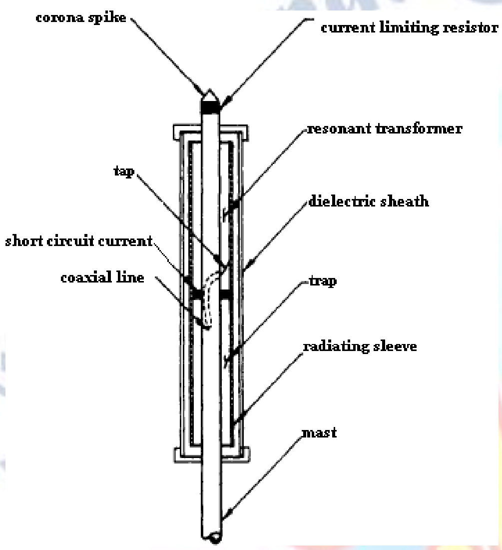

Figure 1: Sketch of antenna with dielectric sheath.

The method used to obtain a gradual discharge is to make it occur at a point, where a low gradient will start a small discharge. A high series resistance keeps the discharge at this low level, reducing the noise and also reducing the erosion of the point. By the design of antenna with dielectric sheath and laboratory tests have proved that 20 to 30 db noise is reduced from precipitation static and corona. A 30 Mc base-station antenna has been built embodying these techniques and more than one year of actual experience in the field, in a region of severe precipitation static, has confirmed the effectiveness of these measures [3].

A primary corona effect which is important to select the conductor is the Audible Noise (AN) due to higher voltage. The mainly audible noise is present in case of higher voltage power system (380 kV and higher) transmission lines.

In this paper Simulation is done for the different transmission configuration under various weather conditions, that exists in the Eastern part of Saudi Arabia. ACDCLINE program of TL Workstation designed by EPRI is used for the simulation. Mathematical formulas to calculate (audible noise) of transmission lines of 34.5 and above is calculated by a software package written in FORTRAN 77 compiler, The results are compared for both simulated and formulas and verified for some existing data. The effect of rainfall intensity, lateral profiles of audible noise and the effect of bundle sub conductor spacing is also explained in this paper. To control audible noise in high voltage transmission line, several factors based on these effects have to be manipulated.

Audible noise in high voltage transmission line has two characteristics components, which is broad band noise (frying, crackling or hissing) and pure-tone components at frequencies of 120 Hz and multiples. The pure tone components are superimposed with the broadband noise. The tone or sound which is most noticeable is the 120 Hz “hum”. It is very difficult task to define how much audible noise can be acceptable from a high voltage transmission line. However, it is important to know the fact that, as voltage levels are increasing day by day, audible noise becomes one of the restrictive factors in the design of high voltage transmission lines.

Audible Noise Frequency Spectrum

The Higher part of the audible noise frequencies spectrum is formed in between 800 and 10.000 Hz which is due to random noise generated by the conductor during rain. The most stable audible noise was the 8 KHZ.

Table 1 The comparison of Audible Noise of Different weather conditions.

WEATHER	TEST LINE dB(A)	PREDICTEDBPA dB (A)
FAIR WEATHER	42.1	23.5
STABLE RAIN	48.8	48.5
HEAVY RAIN	52.8	52.0

- **The Influence of Rainfall Intensity**

It has been found that at the higher rainfall intensities. the nuisance effect of corona noise for residents living near the line will be lower because of the higher noise created by the falling rain. On the other hand, the measurement on the test line and the corona cage indicates that the audible noise reaches a saturation point at a rain intensity of about 30 mm / hr.

- **Effect Of Test Voltage**

Electric field at the surface of conductor is directly related to the test voltage which greatly affects the audible noise generation are shown in table 2.

Table 2 shows the relation Voltage & Noise

Test Voltage (KV)	Audible Noise (dB)
630	46.6
765	48.8
783	50.5
800	51.6

- **Effect of Bundle Conductor Spacing**

The result of the bundle sub conductor spacing on audible noise is shown in tables 3 and 4. A spacing of 40 cm for the heavy rain condition and 35 cm for the case of wet conductor condition produced the minimum Audible noise.

Table 3 shows the bundle sub conductor spacing on audible noise

Distance from Outer Phase	Audible Noise in Heavy Rain	Audible Noise in Wet Conductor
0	62	56
50	58	49
100	51	45
150	47	41

Table 4 shows the bundle sub conductor spacing on audible noise

Semiconductor Diameter	Audible Noise n=2	Audible Noise n=3
3	67	63
4	65	50
5	55	52

5.TECHNIQUES OF AUDIBLE NOISE REDUCTION

There are different methods to reduce the audible noise in transmission line. Some of the methods are- Use of small wires or protrusions which generate "ultra-corona", Conductor covered with a thick layer of insulation, Conductor covered with insulating tubes, Application of a dc voltage bias to reduce the positive peak, Bundle geometry optimization, Change in surface conditions.

6.MODIFICATION OF TRANSMISSON LINE AUDIBLE NOISE SPECTRA TO REDUCE ENVIRONMENTAL IMPACT

An unavoidable problem in the design of extra- and ultra-high voltage (EHV and UHV) transmission lines is the audible noise which comes into the picture under some weather conditions.

In this paper investigator take 5 corona noise samples for examine so as to over-come from the responsible factors for corona noise or audible noise. Since acoustic spectra and their modifications were the major factors under investigation, compensation was made for differences in the recorded (natural) levels of the 5 corona noises in the sample. This was achieved by equating all 5 spectra at a relatively high A-weighted sound level, representing possible "worst case" corona noises. Preliminary findings from the present experiment were briefly reported at an earlier Conference.[6]

Five samples of transmission line audible noise were recorded on magnetic tape. These are the following samples

Apple Grove Corona - The audible noise from a test 775 kV ac transmission line located at Apple Grove, West Virginia, was recorded in the early morning after a heavy dew.

Roanoke Corona - The audible noise was recorded from an operating 765 kV ac transmission line located near Roanoke, Virginia. The recording was made during steady rain in a field at the base of a hill.

Peru Corona - The audible noise from an operating 765 kV ac transmission line located near Peru, Indiana, was recorded at night in a heavy fog.

Redmond Corona - The audible noise was recorded from an operating twin 500 kV ac transmission line located near Redmond, Oregon. The recording was made on a clear morning in a quiet desert.

The Dalles Corona - The audible noise from a test 600 kV dc transmission line located at The Dalles, Oregon was recorded in the desert on a clear evening. Three different levels of differential attenuation were applied to each of the 5 corona samples: 1) the low-frequency components (below 500 Hz) were attenuated by 12 dB; 2) the high-frequency components (above 500 Hz) were attenuated by 6 dB; and 3) the same high frequency components were attenuated by 12dB. Figure 2 shows 1/3-octave band spectra of the stimuli as reproduced in the realistic listening room and shows the unmodified spectra for the remaining 4 corona noise samples.

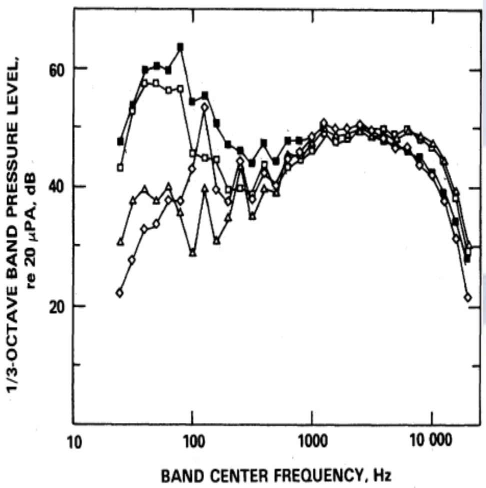

Figure 2:1/3-octave band spectra for 4 corona stimuli (◊Roanoke, Δ Peru, □ Redmond, and ■ The Dalles).

From this experiment we concluded that the high-frequency hissing and crackling components of corona noise are more effective than the low frequency humming and buzzing components. Therefore, the major concern for the audible noise is to reduce high frequency component of the noise spectrum.

7.CORONA SIMPLE TECHNIQUES USED TO ELIMINATE IN CONNECTOR & CABLE ASSEMBLIES

For high voltage and high reliability applications connectors and cables should have good characteristics. If we choose bad quality of connectors and cable then it causes corona. For it is very difficult to choose good connectors or cable between large numbers that specially when faced with selective solutions for high reliability applications. this paper illustrates some design techniques which improves the overall performance and quality of connectors and cable techniques which indirectly reduces corona.

CABLES- Coaxial type cable is mainly used for the high voltage of application where corona is the main consideration. In this paper a stranded type coaxial cable is designed which creates many interstices which act as air traps making it virtually impossible to eliminate all air during the insulation extrusion process. The capability of the cable is improved by introducing semiconductor layer around the air. Semiconductor provides a uniform surface for bonding to the primary insulation during the extrusion process. It produces a good cohesive bond with no air voids. The minimal conductive properties of semiconductor make it in equal voltage potential to the center conductor and hence eliminates the effect of the air in the center conductor.

CONNECTORS- We cannot get high reliability only by corona free cable. It is essential that the be combined with compatible termination process so that a reliable corona free cable assemble will result. This paper provides different termination techniques which have been used to eliminate corona. They are as: Shield Termination, Semiconductor Removal, Molded Configuration, Molded Body to Shell Fit and Sharp Corners. All have their different characteristics but molded configurations are far superior to field assembly type units because it is impractical to consistently eliminate all of the air between the cable and the insulator when assembled mechanically.

8.CONCLUSION

The investigators have done a thorough review of the audible noise produced by the corona discharge which cause the noise pollution and its reduction techniques. Noise increases, decreases or stays constant, depending on the bundle conductor geometry, surface condition etc. one method to reduce audible noise which is produced under foul weather by improving conductor design such as hydrophilic, hydrophobic, ionic shielding. Investigator showed that in comparison to low frequency high frequency hissing and crackling sound is more aversive. In order to reduce high frequency component long- term sampling of corona noise from different transmission lines may be considered. Some methods are proposed to reduced corona noise still it is not up to the mark. Experiments to elucidate these effects are not finished up to now. Hence there is a wide scope for research in this field. transmission lines may be considered. Some methods are proposed to reduced corona noise still it is not up to the mark. Experiments to elucidate these effects are not finished up to now. Hence there is a wide scope for research in this field. Russ [2] has investigated techniques of image processing. These are operations that start with a grey scale (or color) image and return another grey scale image. The next chapter will deal with some additional techniques that operate on grey-scale images for purposes of locating feature edges in the context of isolating features for measurement.

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