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The disturbances in the power system due to environmental conditions

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Abstract
In most of our electronics and electrical devices are very sensitive to the real voltage and current values and other parameters. A slight fluctuation in the voltage and in the current may damage the devices. Therefore proper care needs to be taken for the proper functioning of these devices. But at the same time we cannot neglect the effect of environmental conditions on the devices used in the power system. The environmental conditions such as rainfall, heat, wind, humidity, thundering and lightning etc. has a significant influence on various electrical parameters and also even in the transmission lines. Taking the various environmental conditions into the account the efficiency and the reliability to the devices and the power system can improved.

Keywords: Power system, Environment, Lightning

INTRODUCTION

All the electronics and electrical devices such as diodes, transistors, various kinds of sensors etc that we are using nowadays are very sensitive devices and a little disturbance in the voltage, current or power rating can damage the device if it is beyond the rated value of the device. This increase in the voltage and current may be due to the increase or decrease of the load or may bedue to the environmental conditions. An increase in the voltage or the current due to the change in load can be easily monitored and controlled by the human beings but the change in environmental conditions are not in the hands of human beings and the effects that arise due to the environmental conditions cannot be avoided. So a study of the environmental conditions in which the device has to be embedded or networked is to be done at the beginning of designing any power system and protective measures need to be taken to protect the devices from sudden change in the voltage or current caused by the various environmental conditions such as thundering and lightning, rainfall, humidity, temperature, wind etc.

Effect of environmental conditions
Thundering and Lightning

Lightning can be likened to a disruptive electrical discharge due to the dielectric breakdown of the air between the clouds or between the clouds and the ground. Certain clouds create meteorological conditions that are favorable to the accumulation ofelectrostatic charges. Breakdown which is visible in the form of the lightning flash, itself has a very complex phenomenology (leader stroke, return discharge etc.). It is accompanied by a sound wave, thunder, caused by a sudden expansion of the air which is overheated by the electric arc. When lightning reaches the earth, it generally does so directly on natural elements (trees, hills, water etc.) but also occasionally on structures, buildings and other man-made structures.

The effects of lightning are commonly divided into direct and indirect effects.

Direct effect: At the point of strike the lightning generates- direct thermal effects caused by the electric discharge and thermal and electrodynamic effects induced by circulation of the lightning current Protection must be provided against these indirect effects in electrical installations and also the blast effects (shock waves and blast air) produced by heat and the expansion of the air.Protection against the direct effects of lightning is based on catching the current and discharging it to the earth.

Indirect effect: Over voltages due to the lightning can reach the installation by three means of access:By conduction following direct lightning strikes on lines (power, telephone, TV etc) entering or exiting buildings.By feedback from earth via the earthing system, the protective conductors and the exposed conductive parts of the equipments.

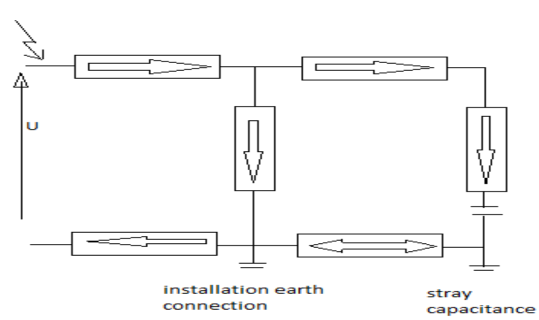

fig1. over voltage due to strike on line

The lightning current that falls on the lightning conductor causes an increase in the earth potential of the installation, which will cause an over voltage between the earthing system (foundations)

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and the internal lines (power, telephone, TV etc.) within the installation. This over voltage spreads to neighboring installations via the distribution network. When a lightning strike hits the ground or an item nearthe building (prominence, tree, post etc.) directly, there is a similar increase in the earth potentialcausing over voltages in installations near the strike.

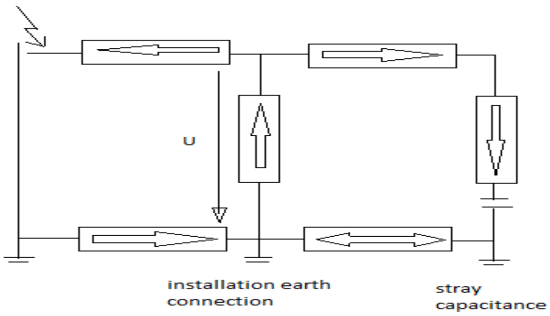

fig2. over voltage caused by feedback from the earth

Close to the lightning strike the over voltage is said to be fed back from the earth spreads from the earth to the network via the installations. In case of lightning strikes on a lightning conductor or in the immediate vicinity of the installation, the effects are extremely destructive if there are no voltage surge protectors. The over voltage spreads via the network to the neighboring installations and can cause destructive secondary spark over between the live conductor and the exposed conductive parts of the equipment in those neighboring installations whose earth is referenced to different potential.

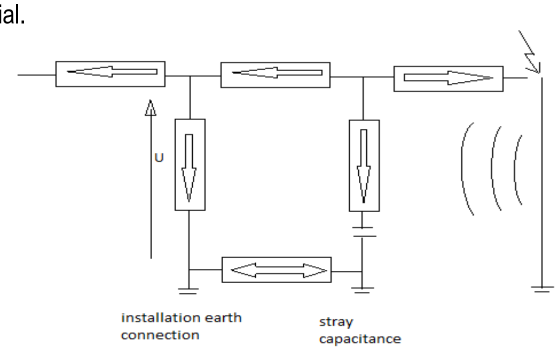

fig3. over voltage caused by electromagnetic induction

The lightning discharge current, whether by direct strike or carried by a lightning conductor, generates a field whose electrical and magnetic components reach considerable values (several kV/m and several tens of microtesla). This radiation is received by all the conductors forming a more or less appropriate aerial which becomes the focus of the induced currents. It is particularly on the conductors which make up loops with large surface areas that the effect of magnetic induction is predominant.

The system can be protected from lightning in various ways such as using single rod lightning conductors, lightning conductors with spark over devices, lightning conductor with meshed cage, lightning conductors with earthing wires, etc.

Effect of rain in satellite communication

Rain affects the transmission of electromagnetic signals in three ways: (1) It attenuates the signal; (2) It increases the system noise temperature; and (3) It changes the polarization. All three of these mechanism cause a degradation in the received signal quality and become increasingly significant as the carrier frequency increases.

At C-band the effects are minor and at Ku-band while they are noticeable can be accommodated. But at higher frequencies such as Ka-band or V-band the degradation can be so great that it simply cannot be compensated.

The first and well known effect of rain is that it attenuates the signal. The attenuation is caused by scattering and absorption of electromagnetic waves by the drops of liquid water. The scattering diffuses the signal while the absorption involves the resonance of the waves. Absorption increases the molecular energy, corresponding to a slight increase in the temperature and results in an equivalent loss of signal energy. Attenuation is negligible for snow and ice crystal, in which the molecules are tightly bound and do not interact with the waves. The attenuation increases as the wavelength approaches the size of a typical rain drop which is about 1.5mm.For example at the C-band downlink frequency of 4 Ghz, the wavelength is 75mm, which is 50 times larger than a rain drop and the signal passes through the rain with relatively small attenuation. At the Ku-band downlink frequency of 12 GHz, the wavelength is 25mm, again the wavelength is much greater than the size of the rain drop. At Ka-band with downlink frequency of 20 GHz, the wavelength is 15mm, and at V-band downlink of 40 GHz, it is only 7.5mm. At these frequencies the rain drop size and wavelengths are comparable and the attenuation is quite large. The standard method of representing rain attenuation is through an equation of the form

$$L_r = \alpha R^{\beta} L = YL$$

Where L_r is rain attenuation in decibels (dB), R is rain rate in millimeters per hour, L is an equivalent path length (km), α and β are the empirical co-efficient that depend on the frequency and to some extent on the polarization. The factor Y is called the specific rain attenuation which is expressed in dB/km. The equivalent path length depends on the angle of elevation to the satellite, the height of the rain layer, and the latitude of the earth station.

Soil resistivity

Soil resistivity is a measure of how much the soil resists the flow of electricity. It is critical factors in design of system rely on passing the current through the earth's surface. An understanding of the soil resistivity and how it varies with depth in the soil is necessary to design the grounding system in an electrical substation, or for lightning conductors. It is needed for designing of grounding electrodes for high voltage direct current transmission system. In single wire earth return power transmission system, the earth itself is used as the path of conduction from the end customer (the power customers) back to the transmission facility.

Humidity

The most common effect of humidity is the corrosion of the electronic components. The most critical condition with regard to corrosion and contamination threat of electronic devices include getting wet either from water condensing from the air or from dripping water. If the immediate environment of the device is relatively dust free and dry, relative humidity of the air is less than 40% and there is no dripping water, the main share of corrosion problems in temperature below 40°C is erased or corrosion becomes so slow that it will not have much effect during the life span of the product.

Mechanical vibrations and changes in the temperature cause fretting of the male and female connectors against one another. This abrasive motion results in wear and fretting corrosion which can increase the contact resistance.

Electrical stress also speeds up corrosion. For instance strong current can heat the soldier joint and gradually weaken it. In dense wiring patterns the high field intensity between the wires increases the leakage current and accelerates corrosion on contaminated surface.

The various other factors that are responsible for corrosion are as follows: high operating temperature, air pollutants, salts, dust, solar radiation, emission of industries etc.

Corrosion control can be summarized into two principles: (1) produce a fault tolerant device and (2) use inert materials as possible.

Fault tolerance here means the capability of the device to operate despite the changes in the properties of its part. Fault tolerance can considerably alleviate the effect of gradual corrosion on the operability of the product.

No material is completely inert (chemically passive) but the components, component boards and metal parts and plastic structures can be made relatively inert to climate, chemical and also corrosive effect with reasonable work.

Temperature

The effect of temperature can studied as the change in the resistance of any conductor with the temperature and also the change in the current of the device with the temperature.

The conductors have the negative temperature coefficient in case of resistors i.e. with the increase in the temperature, the resistance of the conductor decreases and vice versa. The variation in the value of the resistance is governed by the relation as shown

$$R_t = R_o(1+\alpha t)$$

Where R_t is the resistance of the conductor at the specified temperature, R_o is the resistance of at 0^oC, α is linear coefficient expansion and t is temperature in kelvin at which the value of the resistance is to be calculate.

Also with the increase in the temperature of the conductor, the more number electrons leaves the valence band and comes into free state and these free electrons in turn constitute the current flow. As the current in the device increases it will produce heat which in turn again releases the free electrons from valence band and the current will increases further. Thus this phenomenon of increase in the current occurs continuously and at one time the value of current will become so large that it will burn the device.

Thus protective measures are need to be taken to compensate for this increase in the value of the current so that the device reliability can be increased.

RESULT

The human beings cannot control the environmental effects such as heat, thunderstorm, pressure, rainfall etc. therefore conditions are very critical factors in the designing of power system and cannot be avoided because these will alter the functioning of various devices used in power system as discussed above. Also environmental conditions such as wind, solar energy etc. can be used for the production of electricity which will lessen our dependency on natural resources for energy requirements

CONCLUSION

As the natural resources of energy that are available with us are becoming scarce day by day therefore, we being the engineers have to look for other renewable sources of energy for electricity generation, and also we cannot live without electricity thus knowing the use of environmental conditions can serve as a boon for human beings as these can be utilized for the generation of electricity.

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