Protection Against over voltages and Insulation co-ordinati

Introduction:

At several instances the elements of power system i.e, generators, transformers, transmission lines ... etc. are subjecte to over voltages i.e, voltage above the normal value. These voltage may occur due to the opening of a CB, lightning etc. Most of the over voltages are not a significant magnitude but may still be important because of thier effect on the performance of circuit interrupting equipment and protective devices. Quite often these over voltages may be of such magnitude as to cause insulation breakdown of the equipmen in the power system. Hence, ++ Insulation co-ordination implies the selection of the insulation of equipment with regard to its application in order to minimize undesired incidents due to voltage stresses with in the system. when an insulation system is co-ordinated, the solid insulation materials involved should have a voltage breakdown level higher than that of either the associated over voltages protective devices or the clearance on which the co-ordination is based.

Causes of over voltages:

The over voltages on a power System may be caused by internal or external voltages.

Internal Over voltages :-

These voltages are caused by changes in the operating condition's of the network. Internal over voltages can further be divided into two groups as follows

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→ Dynamic Overvoltages :- These voltages occur at normal syste frequency and persist only for few seconds. These may be happen by disconnection of a generator which overspeeds when a large portion of the load is suddenly thrown off

→ Stationary overvoltages :-

These voltages also occur at system frequenc but they may persist for sometime, perhaps hours. Such c condition can arise when an earth fault on one line is sustained, as indeed it may intentionally be when the neutral is grounded through an arc-suppression coil, there by leading to the overvoltages on the healthy phases.

External overvoltages :-

External overvoltages originate from atmospheric disturbances, mainly due to lighting. These overvoltages take the form of a unidirectional impulse or surge whose maximu possible amplitude has no direct relationship with the operating voltage of the system.

External overvoltage causes hardly increase th system voltage twice the normal voltage. Normally such surges can be taken care of with the precision of prop insulation of the equipment in the power system. on the other hand the surges produced by external over-voltages are very severe and may increase the system voltage t several times of the normal voltage. Thus, if the equipm is not protected against the lightning surges, these surges

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may damage it considerably. Hence the protection devices incorporate in a power system check mainly the surges caused due to lightning

External overvoltages may be due to any of the following causes.

→ Direct lightning stroke
→ Electromagnetically induced overvoltages due to lightning discharge taking place near the line
→ Electrostatically induced overvoltages due to the presence of charging clouds nearby.
→ voltages induced due to changing atmospheric conditions along the line length.

Switching Surges :-

Switching surges are the overvoltages produced on a power systems due to switching operation's. Study of switching surges are important from the point of view for designing the insulation of winding and for insulation Co-ordination of EHV lines

The causes for production of switching surges are

→ switching of an unloaded line or open line
→ switching of a loaded line
→ Reactor Switching
→ short circuits and line fault interruptions.
→ ~~Auto-reclosing~~ of CB in long EHV lines.
→ Opening of only one phase due to occurance of fault
→ Switching off unloaded transformers
→ Switching off capacitor banks
→ Breaking of inductive currents
→ Breaking of charging current switched off.

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Overvoltages Due to lightning:

Consider a line having a surge impedance Z_s and discharge current I_d, then the overvoltage due to lightning is given by

$$V_d = I_d Z_s \quad -(1)$$

The equation is true when the travelling waves flow on in one direction. However when they travel in both the directions, the current is halved and the overvoltages is given by $V_d = \frac{I_d Z_s}{2}$

Overvoltage due to a direct stroke on the tower or earth conductor, is given as

$$V_d = I_d Z_s + \frac{L di}{dt}$$

where Z_s = impedance of the earth conductor

L = inductance of the line conductor

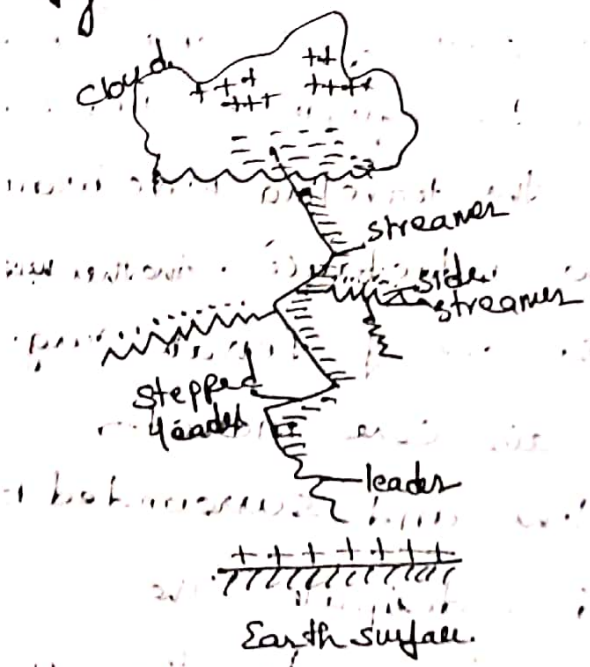
$\frac{di}{dt}$ = slope of current wave.

Mechanism of Lightning Discharge:-

lightning is a huge spark that takes place due to all electric discharge between cloud and the earth or between clouds or between charge centres of the same cloud. Large number of discharges occur between or within clouds than to earth and some of them terminate on the earth to cause some serious damage. The lightning discharge occurs, when a charged cloud passes over the earth, it induces equal and opposite charge on the earth below it. The earth and the cloud acts as two huge capacitor plate

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and the dielectric medium between them is air. As the charge in the cloud increases the potential between cloud and earth increases when the potential is large enough to break down the surrounding air, the lightning discharge starts flow by a huge sound (thunder). The mechanism of lightning can be explained by to following figure.



when the air breakdowns, a streamer starts from the cloud to the earth. The gradient required to start the streaming is 5 to 10kv per cm. The leader streamer will continue downwards to earth as long as the cloud from which it originates supplies enough charge to it to maintain gradient at the tip of leader streamer above the strength of air. If the charge is insufficient, the streamer will not reach the earth. But very often the streamer propagates until it makes contact with the earth or tallest object on the earth. The current in the leader is low of nearly 100 amps. The leader proceeds in zig-zag manner the average velocity of propagation is about 0.05 of velocity of light and its luminosity is also very low. As the leader approaches the earth the electrostatic gradient and voltages increases and the gradient becomes strong enough to cause a streamer earth's surface

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to rise from the surface of earth and finally contacts with the leader of the cloud resulting in a sudden spark. It is like closing a switch between two opposite charges.

Surge Absorber

A surge absorber is a device which absorbs energy contained in a traveling wave. corona is a means of absorbing energy in the form of corona loss. A short length of cable between the equipment and the rover headline absorbs energy in the traveling wave because of its high capacitance and low inductance. Another method of absorbing energy is the use of Tegnér surge absorber which consists of an air core inductor connected in series with the line and surrounded by a metallic sheet called a dissipater. The dissipater is insulated from the inductor by the air as shown in below.

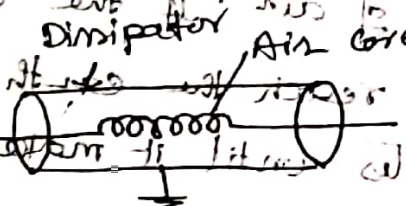


Fig: Tegnér surge absorber

It is a air-cored transformer where primary is the low inductance inductor and the dissipater acts as single turn short-circuit secondary. When the travelling wave is incident on the surge absorber a part of the energy contained in the wave is dissipated as heat due to transformer action and by eddy currents. Because of the series inductance,

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steepness of the wave also is reduced. It is claimed that the stress in the end turns reduced by 15% with the help of surge absorber. ⑥4

Ground Rods :—

Ground rods are used to reduce the tower footing resistance. These are put in the ground surrounding the tower structure. The below figure shows the variation of ground resistance with length and thickness of ground rods used. It is seen that the size of the rod does not play a major role in reducing the ground resistance as does the length of the rod. Therefore, it is better to use thin but long rods or very small rods.

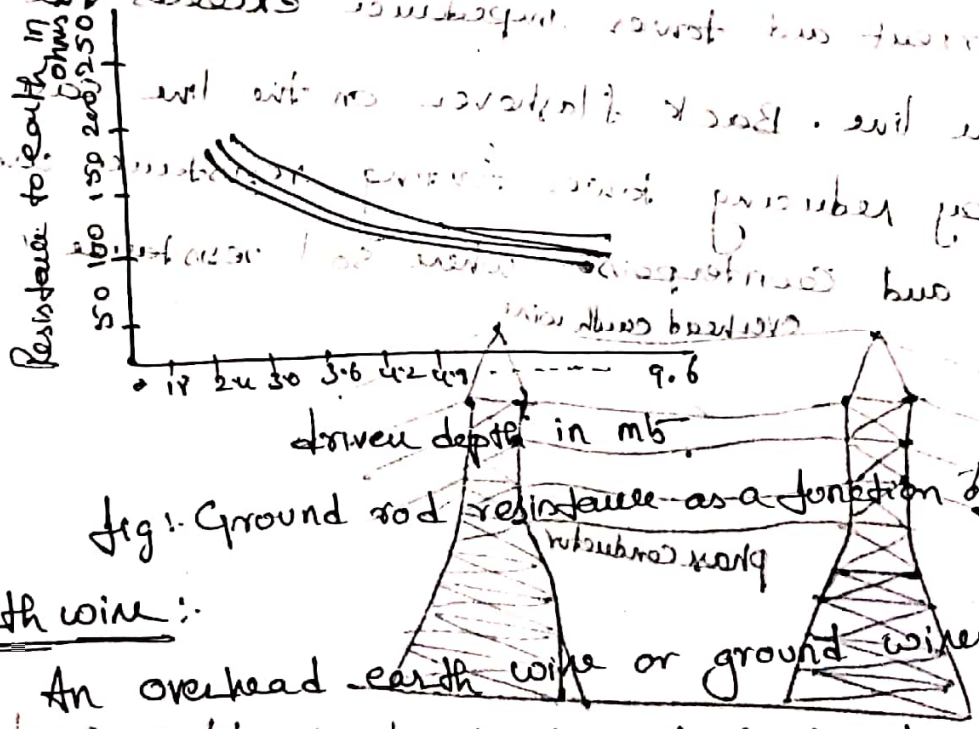


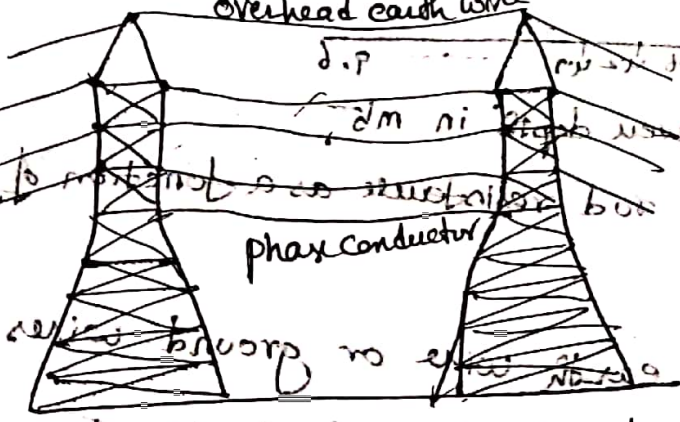
fig:- Ground rod resistance as a function of rod length.

Earth wire :-

An overhead earth wire or ground wires is one of the most common devices used to protect the line against lightning. It is a wire carried by the line supports and run over the phase conductors. The purpose of the earth wire is to intercept direct lightning strokes which would

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other wise strike the phase conductors. It has no effect on switching surges. when lightning strikes an earth wire at span, waves are produced which travel in opposite direction along the line. The waves reach the adjoining towers, which pass them to earth safely. It should be noted that the earth wire is effective only when the resistance between the tower footing and earth is sufficiently low. In case the resistance is not low, the earth wire or tower struck by lightning will be raised to a very high potential, which will cause a flashover from the tower to one or more phase conductors, such a flashover is known as back flashover. It occurs only when the product of tower current and tower impedance exceeds the insulation level of the line. Back flashover on the line can be minimized by reducing tower footing resistance using driven rods and counterpoises where soil resistance is high.



The efficacy of an earth wire to shield a conductor depends on its shielding angle. The smaller the shielding angle, the better the protection. Usually the shielding angle is taken as 30°.

angle included between the vertical through the earth wire and the line joining the earth wire to the outer most phase conductor is taken as shielding angle. For effective shielding the protective angle should be taken as small as possible. Adequate shielding is achieved by providing this angle less than 40°. The angle between 20°–30° are quite safe.

Two earth wires are used in modern high voltage systems with wider spacing between the conductors. The protection afforded by two earth wires is definitely better than a single earth wire. Moreover, the surge impedance is low for two earth wires and the coupling effect with the conductor is increased.

The earth wire arrangement is useful infront of high voltage stations for one or two kilometers on the line for extra protection. Both electrical and mechanical considerations are made to select earth wire. It should have a current capacity to carry half of short circuit currents or the current when the phase conductors are earthed. It should also be sufficiently strong mechanically, steel cored aluminium conductor or aluminium weld conductors may be used as earth wire.

Advantages

→ It provides considerable protection against direct lightning strokes on T.L

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→ A grounding wire provides damping effect on any disturbance travelling along the lines as it acts a short circuited secondary.

Disadvantages:

→ It requires additional cost

→ There is a possibility of its breaking and falling across the line conductors there by causing a short circuit fault.

Types of lightning Arresters:

There are many types of lightning arresters which are employed to protect the power system. The selection of a lightning arrester depends upon the following factors.

→ line voltage
→ lightning frequency.
→ cost of the arrester
→ weather conditions
→ Reliability etc.

Various types of lightning arresters are

→ Rod gap arrester
→ Horn gap arrester
→ Expulsion type arrester
→ valve type arrester
→ Zinc oxide gapless arrester.

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Valve Type Arrester:-

It is also known as non-linear surge diverter. It is improved but more expensive lightning arrester. It consists of a multiple spark gap assembly in series with non-linear resistor as shown in below figure. The spark gap assembly keeps the circuit open between line and earth under normal working conditions.

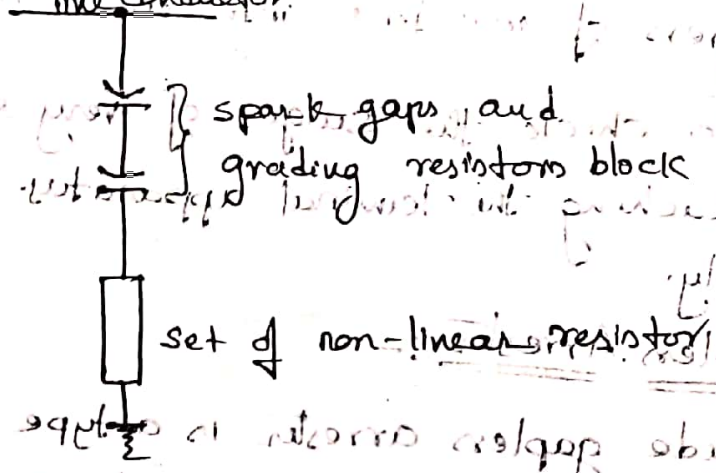


Fig: Schematic diagram of valve type arrester.

Under normal operating conditions, the normal system voltage is insufficient to cause the breakdown of the gap assembly. On the occurrence of an over voltage surge, the breakdown of the series spark gap takes place and the surge current is conducted to earth via the non-linear resistors.

As the magnitude of surge current is very high, the non-linear elements will offer a low resistance to the passage of surge. As a result the surge will rapidly move to earth instead of being sent back over the line. When the surge is over, the non-linear resistor assume high resistance

and flow of the current ceases

Advantages:

→ It provides very effective protection against surges
→ It operates very rapidly, taking less than a second.
→ Its impulse ratio is practically unity.

Eventhough it has very superior characteristics, but suffer the following disadvantages

→ Its performance characteristic is adversely affected by the ingress of moisture into the enclosure.
→ It may fail to check the surges of very steep wave front from reaching the terminal apparatus.
→ It is more costly.

Zinc oxide Gapless Arrester:

Zinc oxide gapless arrester is a type of metal oxide surge arrester. It works on the principle that certain elements have the property to change from a good conductor to almost ideal insulator when slightly heated. As the name itself indicates that it is gapless arrester. Due to the non-linear characteristics of zinc oxide elements it is possible to construct surge arresters without series connected spark gaps. They operate in such a way that at normal power system voltage they offer high resistance for power frequency current and so on. But when surges of higher magnitudes they offer a very low resistance path to ground.

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The construction and working of zinc-oxide (6) gapless arrester resembles to that of valve type arrester except instead of spark gaps, zinc oxide elements having a highly non-linear resistance are connected. As the main constituent of this ceramic material is zinc oxide. The non-linear resistors made of this material are commonly known as zinc oxide elements and surge arresters are called as metal oxide surge arresters.

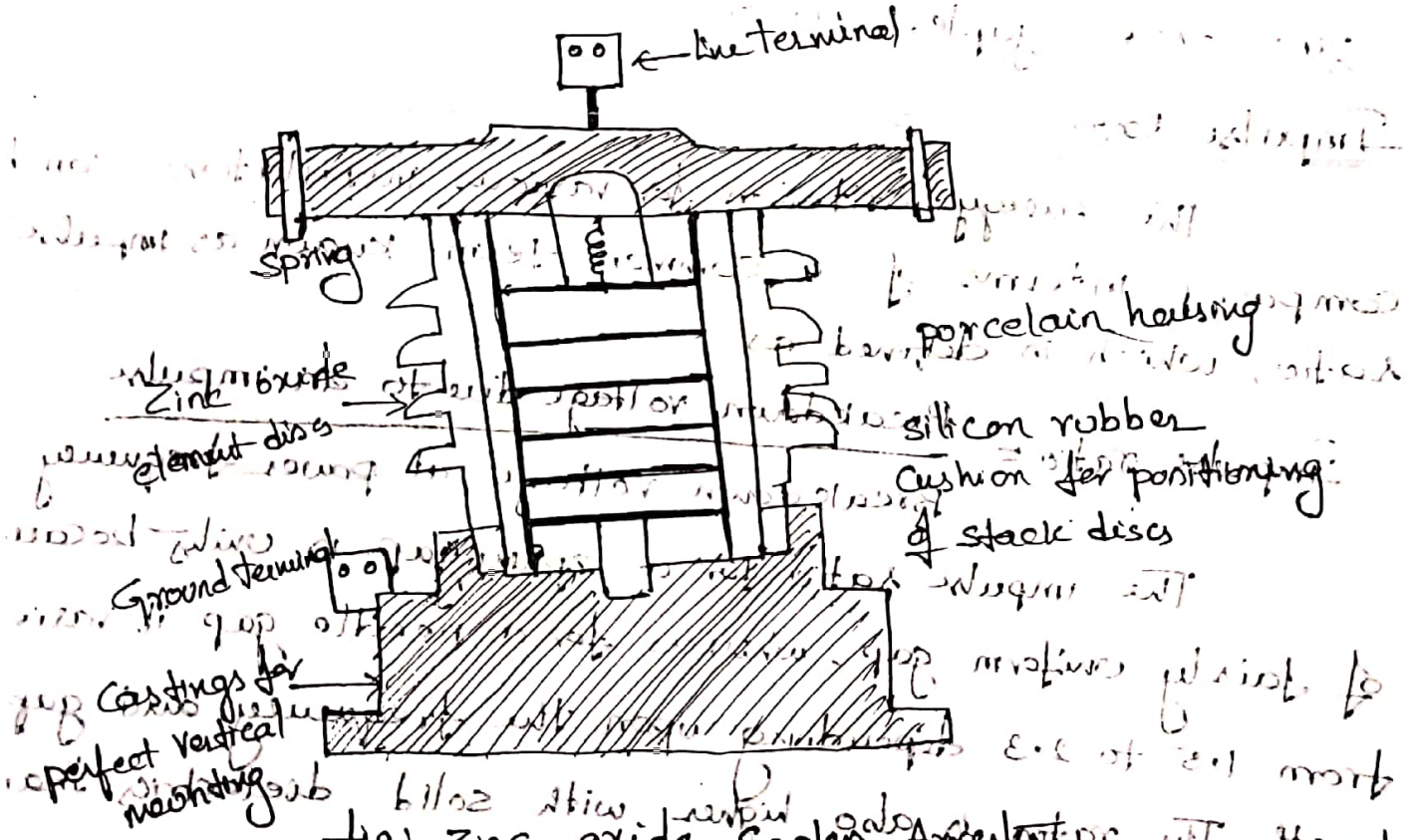


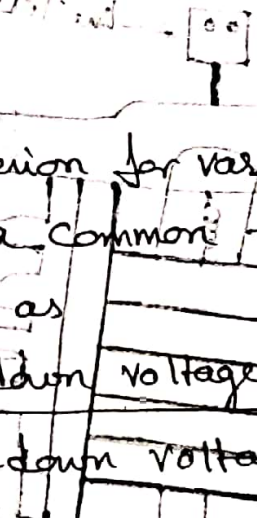
Fig: Zinc oxide Gapless Arrester

The zinc oxide surge arresters consist of series connected stacks of zinc oxide elements. It is constructed in such a way that under normal operating conditions the peak value is always less than the sum of the rated voltages in series connected discs and the resistance losses in the arrester are less under high voltage surges, the current will flow without any delay.

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A continuous transition is observed during the conducting state and the current is decreased. after the transition is completed. Moreover, there will be no follow up current. zinc oxide arresters have excellent V-I characteristics and higher energy absorption level. They are preferred for the protection of EHV and HVDC syste

The above figure represents the constructional features of zinc oxide gapless arrester.



Impulse Ratio

The energy criterion for various installations can b compared interms of a common term known as impulse ratio, which is defined as

$$\text{Impulse ratio} = \frac{\text{Breakdown voltage due to an impulse}}{\text{Breakdown voltage at power frequency}}$$

The impulse ratio for a sphere gap is unity because of fairly uniform gap, whereas for a needle gap it varies from 1.5 to 2.3 depending upon the frequency and gap length. The ratio is also higher with solid dielectric than with air dielectric for the same dimensions.

Basic Impulse Insulation level :-

The insulation strength of equipment like transformer circuit breakers should be higher than that of the lightning arresters and other surge protection devices. in order to protect the equipment of the power systems from over voltage surges, it is necessary for an insulation level for the system to see that lining insulation in the above

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system does not breakdown for flash over below this level and to apply protective devices that will give the apparatus effective protection.

Several methods of providing coordination between insulation level in the station and on the overhead line leading to the station have been offered. The best method is to establish a definite common level for all the insulation in the station and bring all insulation to or above this level.

This limits the problem to three fundamental requirements

→ The selection of a suitable insulation level

→ The assurance that the breakdown or flash over strength of all insulation in the station will equal and exceed the selection level

→ The application of protective devices that will give the apparatus as good protection as can be justified economically.

The common insulation level for all the insulation in the station is known as "Basic impulse insulation level" (BIL) which has been established in terms of withstanding voltages of apparatus and lines.

The BIL can be defined as reference level expressed in kV crest voltage value with standard 1.2/50 μsec lightning impulse wave apparatus should be capable of withstanding test waves above BIL

The BIL for a system is selected such that the system could be protected with a suitable lightning protective devices. The margin between the BIL and the lightning arrester should be fixed, such that it is economical and also ensures protection to the system. The BIL chosen should be higher than the maximum expected surge voltage across the selected arrester.

Significance: The significance of BIL in power system studies is to get the desired insulation level for the system to be protected. Such that below BIL is any insulation should not breakdown or flashover to provide effective protective devices for the power system. The protective devices for particular power system are selected based on these levels. The gap between the BIL and the protective device should be kept such that it is not only economical but also gives necessary protection of the system.

"level" selected should be greater than the expected surge voltage across the equipment protective device.

The protective margin is given as

with stand level of the system —

protective level of surge arrester.

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Volt-time characteristics :-

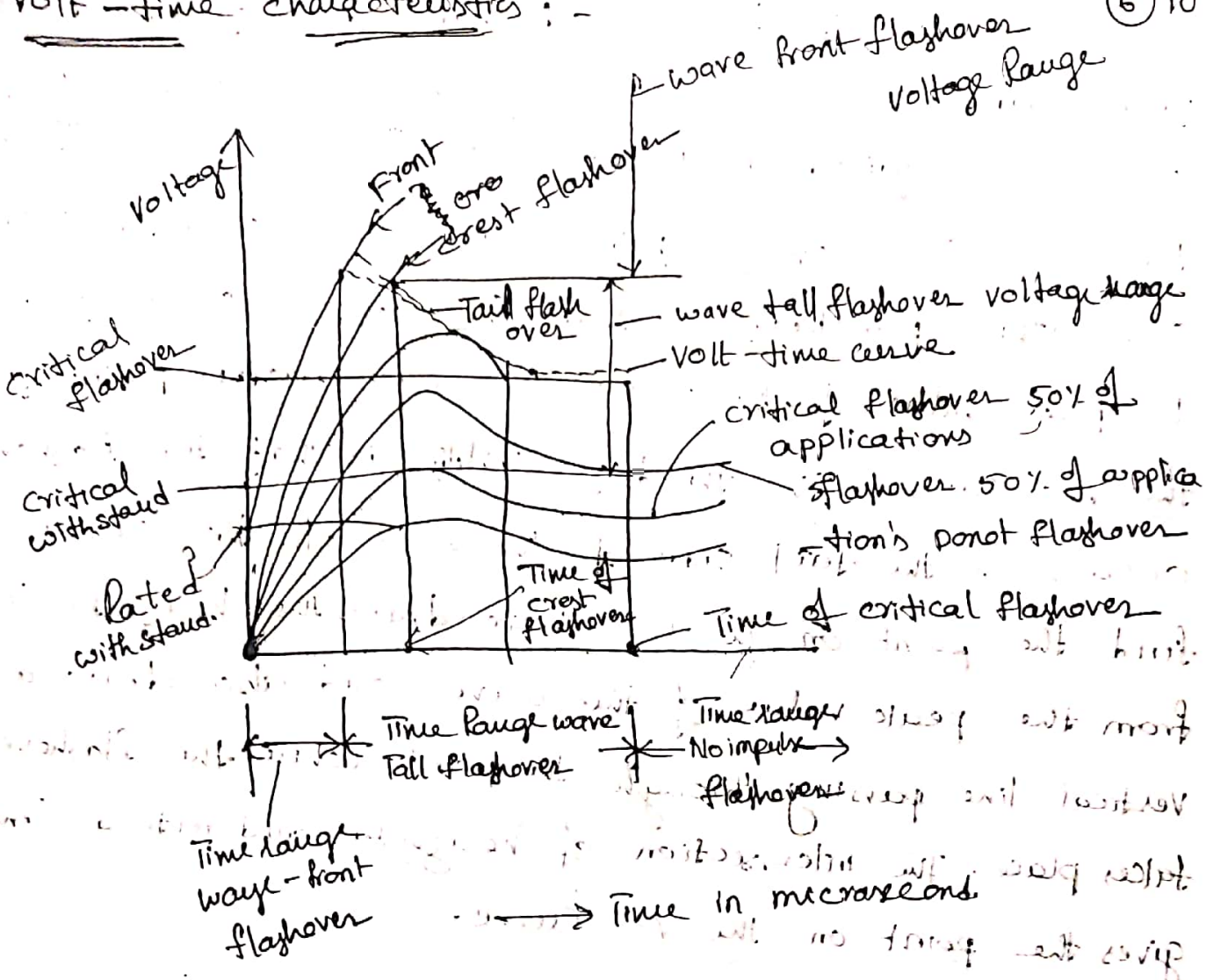


fig: Construction of volt time curve.

The breakdown voltage of any insulation or the flash over voltage of a gap depends upon both the magnitude of the voltage and the time of application of the voltage. The volt time is a graph of the crest flashover voltages plotted against time to flashover for a series of impulse applications of a given wave shape. The construction of the volt time curve on the terminology associated with impulse testing are shown in above figure. The construction of volt-time curve the following procedure is adopted.

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waves of the same shape but of different peak values are applied to the insulation where volt-time curve is required. If flashover occurs on the front of the wave, the flashover point gives on point on the V-T curve. The other possibility is that the flashover occurs just a the peak value of the wave, this gives another point on the V-T curve. The third possibility is that the flashover occurs on the tail side of the wave. In this case to find the point on the V-T curve, draw the horizontal line from the peak value of this wave and also draw a vertical line passing through the point where the flashover takes place. The intersection of horizontal and vertical lines gives the point on the V-T curve.

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Neutral Grounding

Introduction

The process of connecting the non-current carrying parts of electrical equipment or the neutral point of the supply system to the general mass of earth in such a manner that all times an immediate discharge of electrical energy takes place without danger is called as earthing.

Earthing means connecting earth terminals to electrical installed solidly in the mass of earth. For all practical consideration the earth potential is always takes as zero and good earthing means which gives very low resistance to the flow of fault current of a circuit.

Ungrounded System :-

The main feature of an ungrounded system is its ability, in some cases, to clear earth faults without interruption. The self-clearing feature disappears when the length of the line becomes excessive.

In an ungrounded neutral system, the neutral is not connected to earth as shown in below figure.

It is known that there exists capacitive coupling between the conductors and the conductor to earth as shown in below figure. The delta-connected capacitance has little effect on grounding characteristics.

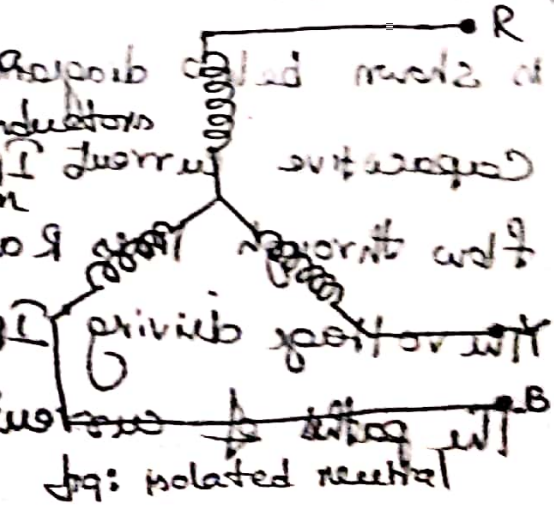
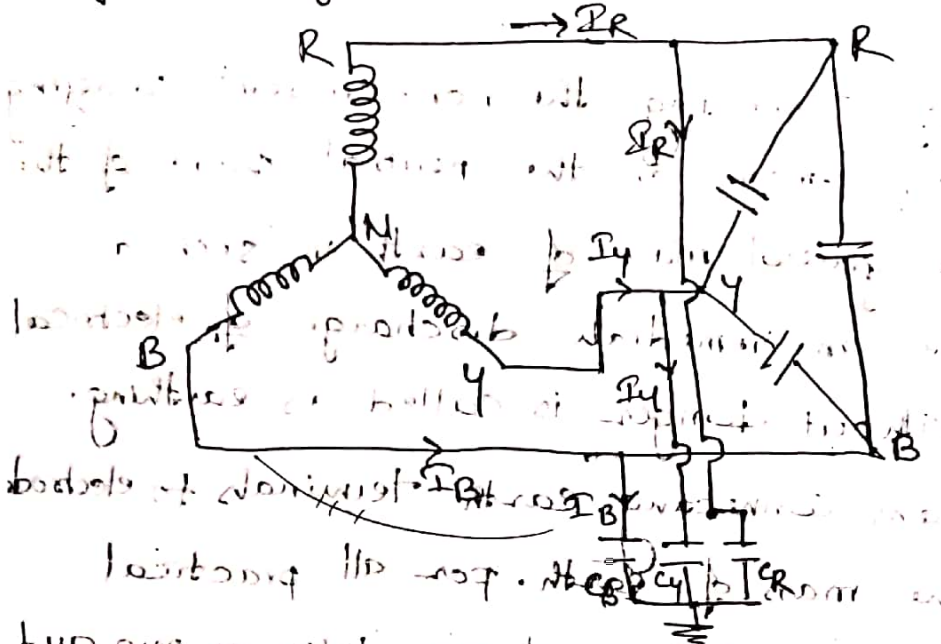


fig: Isolated neutral

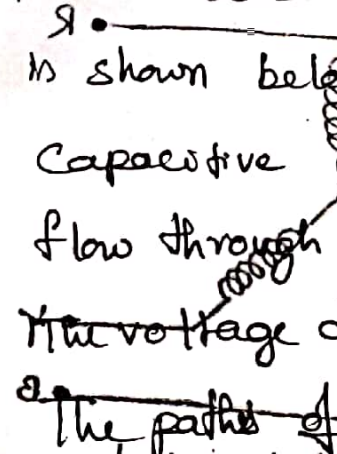
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of the system and therefore can be neglected.



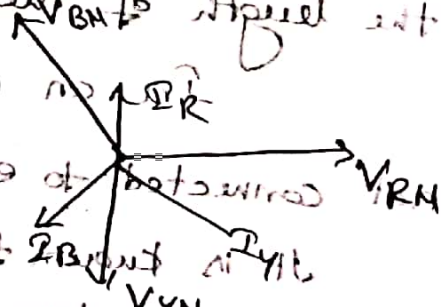
The perfectly transposed line will have the same capacitance to ground, thus $C_R = C_Y = C_B$ i.e under normal operating balanced condition the charging current of each phase is same. They form a balanced set of current spaced 120 apart as shown in the below figure. Therefore, the resultant current is zero and no current flows to ground. The potential of the neutral is same as the potential of the ground.

Suppose phase to ground fault occurs in line at some point F, the circuit under this condition is shown below diagram. The capacitive currents I_R and I_B flow through the lines R and B.



The voltage driving I_R and I_B are V_{YR} and V_{YB} respectively

The paths of current I_R and I_B are capacitive



Phasor diagram of isolated neutral system

and hence these currents leads their respective voltages by 90° and their respective voltages by 90° and their vector sum is equals to fault current I_F as shown in below figure.

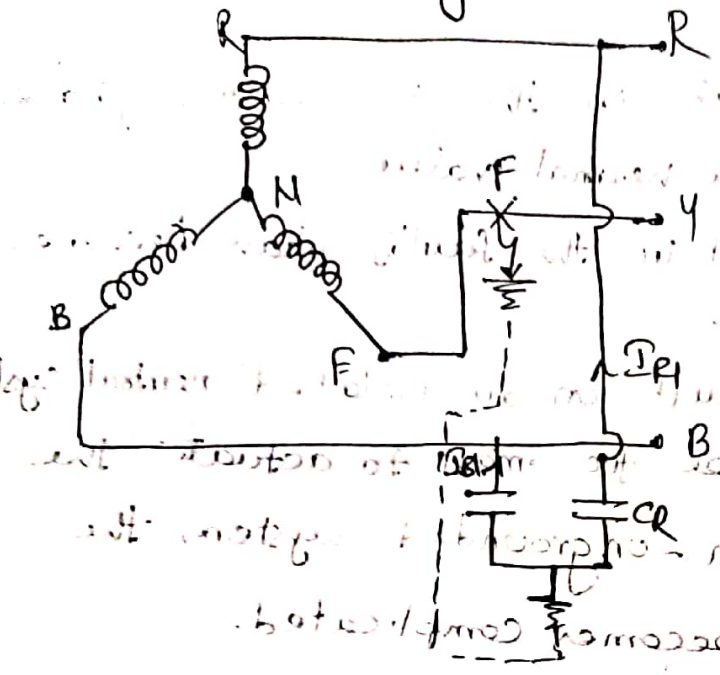


Fig: Circuit diagram

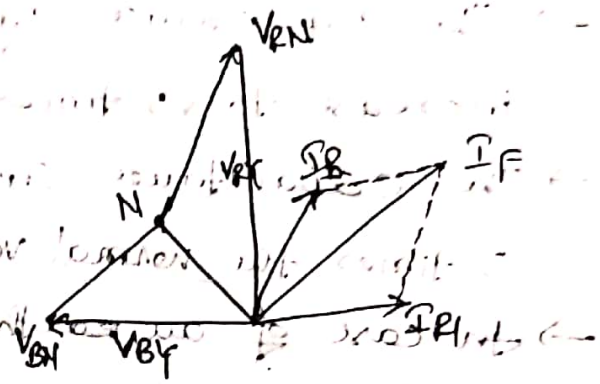


Fig: phasor diagram

Since phase voltages (V_{ph}) are equal and capacitive reactances (X_C) from line to ground are also equal.

$$I_{YR} = \frac{V_{YR}}{X_C} = \frac{\sqrt{3}\,V_{ph}}{X_C}$$

Similarly, $I_{YB} = \frac{V_{YB}}{X_C} = \frac{\sqrt{3}V_{ph}}{X_C}$

$$I_B = \sqrt{3}\,I_{YB} = \sqrt{3} \times \frac{\sqrt{3}V_{ph}}{X_C} = \frac{3V_{ph}}{X_C}$$

The following are the advantages of operating system with isolated neutral or no fixed earthing

→ It is possible to maintain the supply with a fault of one line

→ There is no zero sequence current

→ Interference with communication line is reduced because of the absence of zero sequence current.

The following are the disadvantages of operating system with isolated neutral.

→ The capacitance currents in the two healthy phases increase to $\sqrt{3}$ times the normal value.

→ The capacitance current in the faulty phase becomes 3 times the normal value.

→ In case of an earth fault on an isolated neutral system the fault current may be too small to actuate the protective devices. Thus in ungrounded systems the earth fault relaying becomes complicated.

→ The over voltages due to induced static charges are not discharged to ground in isolated neutral system. The voltage due to lightning surges do not find path to earth.

→ The danger to equipment on the occurrence of line to line ground fault is appreciable and danger to life in the proximity of the fault is often prolonged.

For the reasons mentioned above it is not desirable to operate 3-phase system with an isolated neutral

Methods of Neutral Grounding :—

The various methods commonly used for grounding the three-phase systems are

→ solid grounding
→ Resistance grounding
→ Reactance grounding
→ peterson-coil grounding (or resonant grounding)
→ voltage transformer grounding
→ Earthed transformer.

Solid Grounding or Effective Grounding

The term effectively grounding is now used instead of the old term solidly grounding. The neutral is directly connected to ground without any impedance between neutral and ground as shown in below figure.

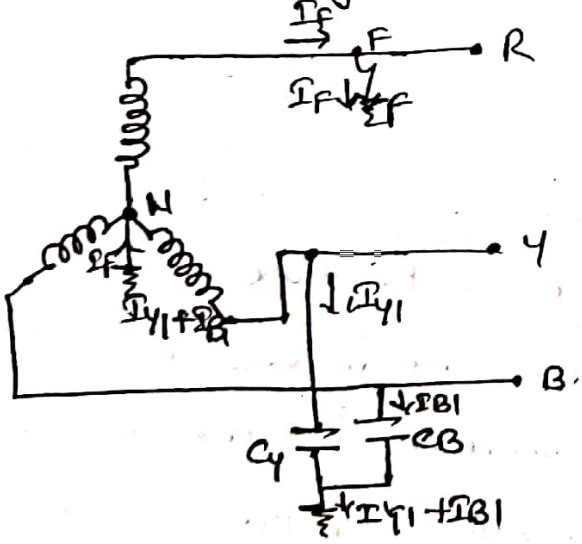


fig: Solid grounding system with ground fault on phase R.

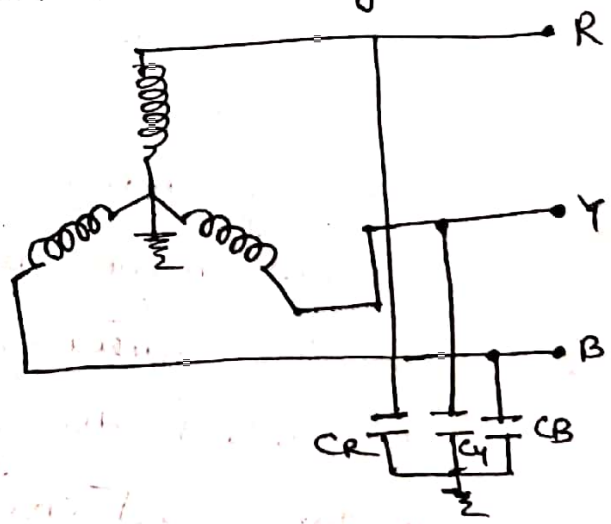


fig: solid or effective grounding system.

Consider a line to ground fault in line 'R' at a point F as shown in above figure. As a result of this fault the line to ground voltage of phase R becomes zero but the voltage

to the earth of the remaining two healthy phases have the same voltage as before, as shown in below figure.

The capacitive currents flowing in the healthy phases be I_{Y1} and I_{B1}. The resultant capacitive current I_c will be the vector sum of healthy phase currents I_{Y1} and I_{B1}.

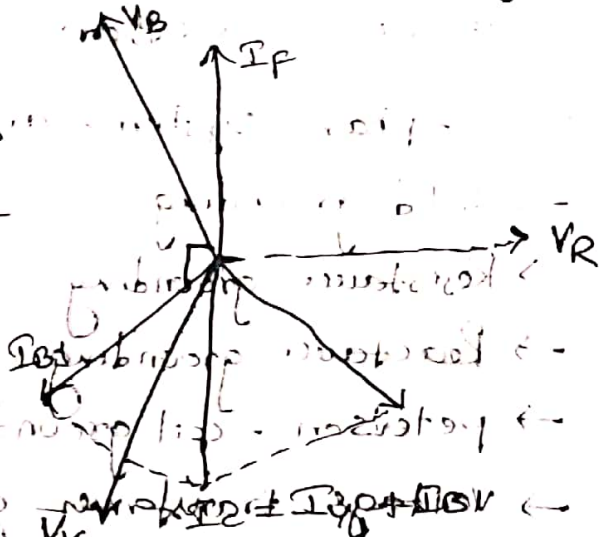


fig: phasor diagram of solidly grounded system

It should be noted that in this system, in addition to charging currents, the power source also feeds the fault current. This fault current would get to the fault point through the healthy phase and then return back to power source through the earth and the neutral conductor. As the generator and transformer have their own reactance's in series with the generator is low, solid grounding of the generator without any external impedance may cause the single line to ground fault current from the generator to exceed the max. phase fault currents which the generator can deliver, and this may exceed the short circuit current for which it windings are braced. If the reactance of the generator or transformer is very large, then also the value of ground fault current is considerably reduced. The resistance of the earth path is negligible, the magnitude of the fault current is practically determined by the zero sequence impedance of the power system.

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source and that of the phase conductor upto the point of fault. The resistive component of the zero sequence impedance is usually negligible, so high magnitude fault current can be considered as lagging the faulty phase voltage by approximately 90°. As shown in above figure. I_f will be having an opposite phase relationship to that of I_c. Due to this the effect of the capacitive current will be neutralized by high faulty current, thereby the chances of arcing grounds and over-voltages are eliminated up to a greater extent.

Application's

→ For high voltage systems, below 33KV with total capacity not exceeding 5,000KVA, it is economical to operate with a solid earthed neutral point.

Advantages:-

→ In this grounding the neutral is effectively held at earth potential.

→ In case of occurance of an earth fault on any phase, the phase to earth voltage of the phase over which the fault occured becomes zero, where as the phase to earth voltages of the remaining two healthy phases remains normal because the potential at the neutral point is fixed at earth potential. Hence, the equipment is to be insulated for phase voltage, which results in saving in the cost of equipment.

→ In this grounding the arcing ground phenomenon and over voltage conditions cannot occur.

→ when compared to other types of grounded systems, solid grounded system are less expensive for all operating voltages, as the voltages on healthy phases in case of LG fault doesnot exceed 80% of the line to line voltage, where as in case of other groundings the voltage of healthy phases rises to about 100% of line to line voltage

→ A large fault current will flow between fault point and the grounded neutral, when an earth fault occurs on any of the phase of the system. This permits the use of discriminative protective year.

→ In this grounding, the ground fault relaying is simple and ~~sta~~ satisfactory.

Disadvantages:-

The increased earth fault current results in greate interference to neighboring communication circuits.

since the fault has to be cleared by circuit breaker, heavy earth fault currents may result in burning of contacts

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Resistance Grounding

When it is necessary to limit the high earth fault current, resistance is introduced in the neutral and the earth is called as resistance earthing as shown in below figure. The value of the resistance commonly used is quite high as compared with the system reactance. The resistor may comprise of metallic resistance or water column. It is more usual to use liquid resistors if the voltage is 6.6kV or more. with the increase in operating voltage the value of resistance required for grounding also increases to limit the short circuit current during LG faults.

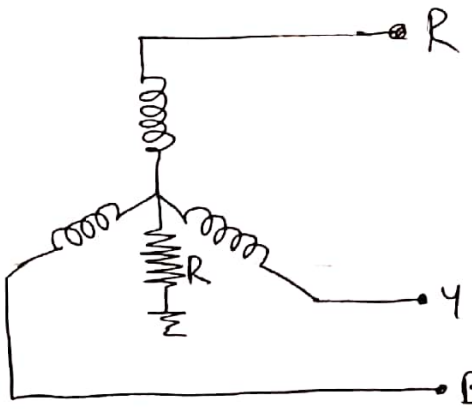


fig: Resistance grounding System

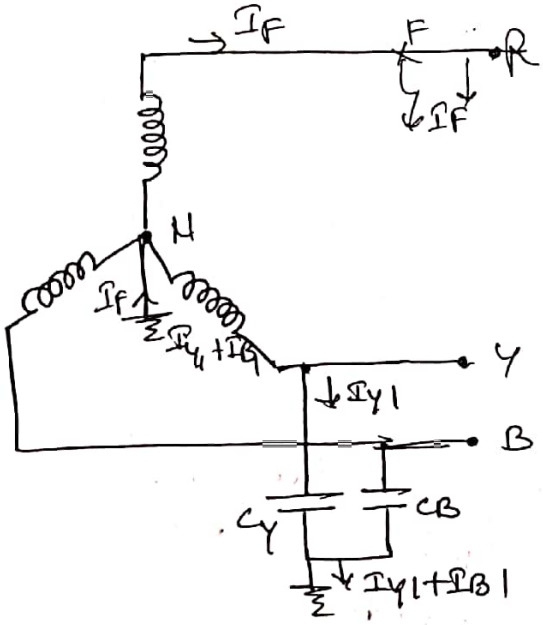


fig: Resistance grounding system with ground fault on phase R

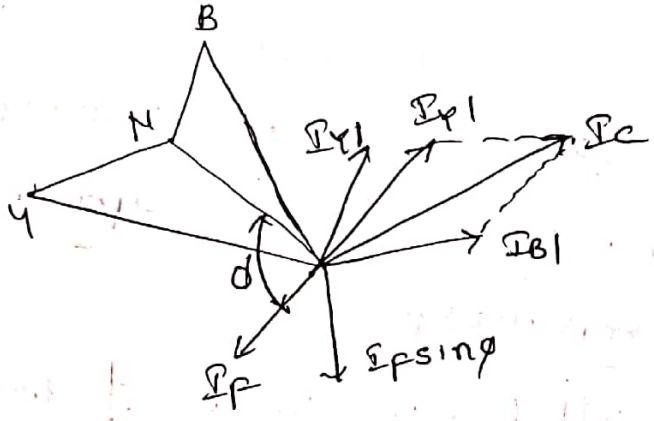


fig: phasor diagram

Let us consider that an earth fault has taken place in phase 'R' as shown in above figure. The phasor diagram for such condition is shown in above diagram. The capacitive currents flowing in the healthy phases be I_{Y1} and I_{B1}. These currents leads V_{RY} and V_{RB} by 90° fault current I_f lags behind the phase voltage of the faulted phase by an angle ϕ, which depends upon the grounding resistance and impedance of the system upto the fault point F. The current I_f can be resolved into two components, one in phase with the faulty phase voltage and other lagging the faulty phase voltage by 90°. The component of $I_f \sin\phi$ is in phase opposition of the I_c. By adjusting the value of R to a sufficient low value it is possible to nullify the effect of I_c so that no transient oscillations due to arcing ground may occur.

The resistance earthing is commonly used for the system operating at voltages between 2.2 KV and 33 KV and the power source capacity exceeds 5,000 KVA.

Advantages:

→ It permits the use of discriminative protective gear.
→ The ground faults are readily relayed.
→ It minimizes the hazards of arcing grounds
→ The line voltage drop caused by the occurrence of earth fault is reduced.
→ It improves the stability of the system

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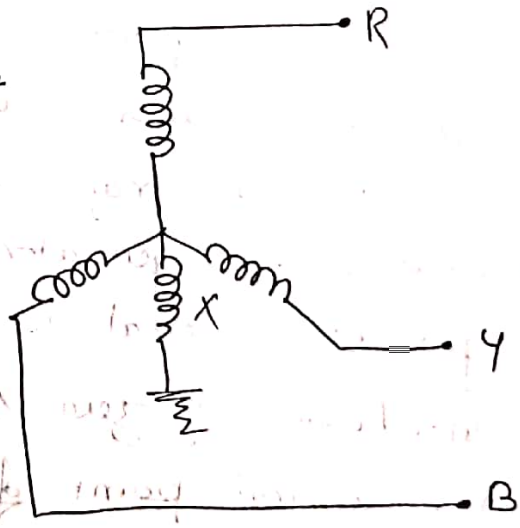
Disadvantages

→ This system is costlier than the solidly grounded system.

→ There is enormous energy loss in neutral ground resistance due to dissipation of faulty energy.

Reactance Grounding :

Reactive grounding means grounding through impedance which is highly inductive and is shown in below figure. If resistance is used, fault current is limited and system reactance provides the necessary phase opposition between capacitive ground current and fault current. The reactance grounding provides additional reactance which provides a lagging current that neutralizes the capacitive ground current. Hence for circuits where high charging currents are involved such as transmission lines, underground cables, etc. reactance grounding is provided.



The main characteristics of reactance grounding

→ Ground fault current is reduced, but it is much larger than capacitive fault current.

→ The voltage across healthy phase is between 0.8 to 1 per unit of line-to-line voltage.

→ Arcing grounds are avoided.

→ Transient ground faults are converted into controlled current faults.

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→ Ground faults relaying is simple and satisfactory.
→ Since ground fault current is reduced inductive interfere with parallel communication circuits is also reduced.

Advantages:-
→ satisfactory relaying
→ partial grading of the apparatus insulation
→ Reduced interference to neighbouring communication circuit as compared with that in solidly earthed systems.

Disadvantages
→ The fault current required to operate the protective device is higher than when compared to resistance ground
→ Very high transient over-voltage appear under fault condition.

Neutral grounding practice:-
→ Generally one-neutral ground is provided at each voltage level Between generation and distribution there are several voltage levels. one ground is provided at each voltage level.
→ Ground at power source and not at load.
→ Ground each major source bus section.
→ where several generators are operating in parallel, only one generator neutral is earthed. This is done to avoid the interference of zero sequence currents.
→ The neutral point of star side of power transformer is usually grounded for protection purpose.
→ The star-connected secondary sides of protective CTs and PTs are grounded at one point. This ensures stable neutral

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