Advance Physics Letter

Improve Transient and Dynamic Stability By Using DC Supply in HVAC Line and Analysis it's Fault Operation and Their Recovery Method

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Abstract—The modern transmission system has in the based on the application of the power electronic technology, which existing ac transmission system the use of power electronics improves the stability and efficiency to reach the power transmission is very close to the its thermal limits. Here we are talking about to the Simultaneous AC-DC power transmission is which was before proposed to the ac transmission line with the uni-polar DC link and to the ground as returned path was used for their it's transmission operation. The major limitations of a ground as a returned path is due to the it's fact that they may be used to the ground may be corrode or any metallic materials if it comes to its path. The value of the each one or particular conductors voltage with respect to the ground becomes is high, then due to the addition of the DC voltage on AC line and hence the more insulators discs have to be added the with each or particular insulator strings so that the it can be withstand this increased the voltage. But the condition is that the conductor separation distance was keeping the constant as a line-to-line voltage must to be unchanged. This method is converting the ac line the composite into the AC-DC power transmission line without altering the it's any original line conductors, towers, insulator strings and tower structure. That the economic factors such that the higher cost of the long lines and also the revenue from the delivery of the additional powers is provided a strong incentives to the explore at all economically and the technically it is feasible means of the its raising stability limits. The development of the effective ways of the basic proof is justifying at the, feasibility of simultaneous AC–DC power transmission has been reported on major concept. The improvement of the transient stability by the utilizations of the inherent built-in the short-term of the overloads the capacity of the DC system and the rapidly modulating the DC power is converted into the simultaneous AC–DC line. A single machine infinite bus is connected to AC line and converted for simultaneous AC–DC power transmission has be studied to the transmission angle is wide ranging up to case of simultaneous AC–DC power transmission system. So the system this reason the effective performance and increasing the efficiency of power transmission capability of the power system.

Keywords— EHV-DC Transmission, EHV-AC Transmission, Facts Power System Stability, fact devices, transmission efficiency, Alternating Current (AC) and Direct Current (DC) Calculation, MATLAB, Simultaneous ac-dc power transmission.

I. INTRODUCTION

This research work is aimed to enhance the transient steadies of power strategy by established simultaneous AC–DC power transmission through a transmission line. We know that the it is defaulting a load to the long extra high voltage (EHV) ac line against their thermal limits, because of the volatility incident in a power system. With the strategy suggested in the paper, it is the possible to the load of this lines is very close to the thermal limits and the conductors is to be permitted to take the common ac along dc superimposed on it.

This design is helpful in advancing the dynamic stability and Transient steadiness and damp out oscillations. In this paper we presented to the method of operation simultaneous ac-dc power transmission system. We know that the in a EHV-AC Transmission system if the long extra high voltage (EHV) ac lines is loaded to their thermal limits, so large amounts of power loading results large instability occurs in transmission system, that affects the whole power system. It is difficult operation to load transmission lines to their it's sufficient margin of thermal limits.[3] By using this method , it will be possible to loaded transmission lines to the maximum values of their thermal limits. In this method the transmission lines allow to take a ac along with dc supply superimposed on it. The conductor bears ac along with the dc supply. Here this system gives conversion of line ac transmission line into the composite parallel to the ac-dc transmission line system thus the halving of advantages to the transient stability dynamic stability and the damp out oscillation. In this method the simulation operation performed in based on the MATLAB software package having simulink software. The power system is dependent of a stable and reliable control of active power and reactive power to kept its integrity, loosing this commands may be lead to a system collapse.[1] we know that it is defaulting to a load the long extra high voltage (EHV) in ac lines against its thermal limits, because of volatility incident in the power system. The aim of this method is to be enhanced the transient steadies of power strategy by established a simultaneous AC–DC power transmission is throughout a transmission lines. By the scheme suggested in this method, it is more likely to be loaded these lines is very closed to their its thermal limits. The benefit of the simultaneous ac-dc transmission system for up gradation of transient steadies and the dynamic steadies and the damp-out oscillations has been established.

II. PROBLEM IDENTIFICATION

A. Why Simultaneous AC-DC Transmission

In modern power system 78% of total power is transmitting by EHV-AC scheme and 22% is by HVDC. The simultaneous AC-DC power transmission system is one of the scheme in power system which improves the reliability and efficiency of transmission up to their peak level. If we use HVDC transmission in place of EHV-AC we have to replace all the tower structure and conductor of EHV-AC scheme. But we can use the simultaneous AC-DC transmission in place of EHV-AC without altering conductor and tower structure which gives the same advantageous operation like HVDC.

B. High Voltage AC Transmission

In Industrial minded countries to the world required a huge amount of the energy which is electrical energy in the forms of the major fraction. When the world has to be already consumed the major portion of the it's natural resources and it is looking for sources of the energy also other than hydro and the thermal to the cater fora rapid rate of consumption of energy which is outpacing the discovery of new resources. They will not slow down w.r. to the time and its therefore the exists a needs to reduced the rate of the annual increasing in energy consumption by any intelligent society if the resources have to the preserved for posterity and this requires the very high voltages for a transmission. This is the very speedy stride taken by the developments of the dc transmission since the 1950 is playing a major character in a extra-long distance in the transmission and complementing or supplementing Extra High Voltage of the AC transmission. [8]It have a roles play to a country must to be make a intelligent assessment of both in order to the decided which is to be suited for the its country's economy.

C. Problems arises in using HVAC

1) Increased Current Density due to the increasing in line loading by using series capacitors.

2) Use of bundled conductors.

3) Effect of high surface of the voltage gradient on the conductor.

4) Corona problem It gives audible noise and a radio Interference, Energy Loss and Carrier Interference, TV Interference.

5) Effect of high electrostatic field under the line conductor.

6) Switching Surge Over voltage's which because more HVAC to air-gap insulation than the lightning or power frequency voltages.

7) In case of fault gives Increasing Short-Circuit currents and having possibility of Ferro resonance conditions.

8) Shunt compensation and usage of series capacitors.

9) Condition of Synchronous resonance and high short circuit currents.

D. High Voltage DC Transmission

[6]The evolution of the high voltage valves and it was possible to be transmitted dc power at a high voltages and the overall a long distances and hence the giving to the rises on HVDC transmission. Since the first commercial installation process in the 1954 a vast amount of the HVDC transmission systems has to be installed around of the world.

In recent years concerning major issues such as environmental factors and control, HVDC results have become more suitable for the following causes:

1) Environmental advantages.

2) Economical (cheapest solution).

3) Asynchronous interconnections.

4) Power flow control.

5) The Added to benefits transmissions (quality, power, stability, etc.).

E. Inherent Problems Associated With HVDC

1) Expensive converters:

Expensive converters stations are required to each one end of a D.C. transmission link, where only transformer stations are required for an A.C. link.

2) Reactive power requirement:

Converters require reactive power in their operation, both in process of rectification also in inversion. when each converter of the reactive power consumed may be as much as 50% of then the active power rating of the D.C. link. The reactive power necessity is partially supply by the filter capacitance and partially by the synchronous or static capacitors that require to be installed for the purpose.

3) Generation of harmonics:

Converters generate to the lots of harmonics both side of on the D.C. as well as A.C. side. Here filters are used to A.C. side to reduces harmonics transferred to the A.C. system. In the D.C. system the smoothing reactors are used and these components add to the cost of the converter.

4) Difficulty of the circuit breaking:

Circuit breaking is difficults due to the absence of a natural current zero with D.C. This is not a foremost problem in single HVDC link, This system as a circuit breaking can be accomplished by a very speedy absorbing of the energy back in the A.C. system. (The blocking mode of action of thyristors is much faster than the operation of MCB (Miniature Circuit Breakers). However the deficiency of HVDC circuit breakers cramp multi-terminal operation.

5) Difficulty of the voltage transformation:

Power is generally used on a low voltage in transmission system, but here reasons of the efficiency must be transmitted at high voltage. The absence of the equivalent of D.C. transformers makes it essential for voltage transformation to carry out in ac side of the system and stops a purely D.C. system being used.

6) Difficulty of a high power generation:

The problems of commutation along with D.C. machines, speed and size, voltage are limited. There for comparatively lower power can be produced with D.C.

III. PROBLEM FORMULATION

Fig3.1 showed the basic model of the simultaneous AC-DC power transmission. The line commutated 6-pulse converter rectifier bridge is used in the conventional HVDC system, at the DC power is injected to the neutral point of the transformer zigzag connected secondary to the sending end of the transformer and then it recovered back to AC again by the line commutated 6-pulse bridge inverter to the receiving end side of the transformer and which is also connected to the neutral point of the zigzag connected winding of receiving end side of transformer. The AC lines are carriers both as AC power and DC power. The DC current flows throughout the rectifiers and gets equally divided in to the all three conductors of the three phases as the resistances of the three conductors are is approximately equal.

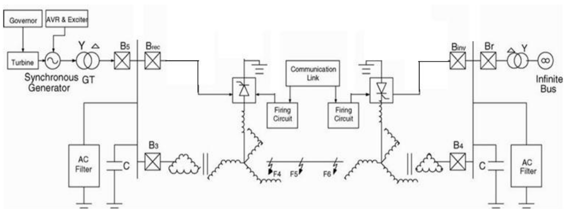

Fig 3.1: Basic model for simultaneous AC-DC Transmission

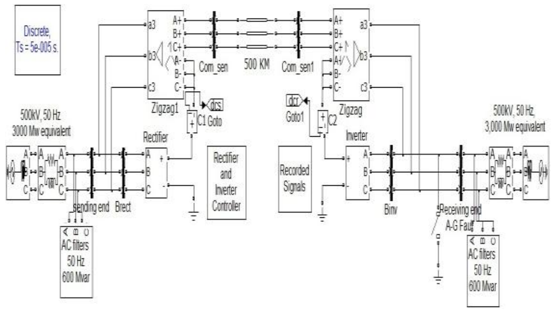

Fig 3.2:Simulation Model for Simultaneous AC-DC Power Transmission & Their Performance In Faulty Operation

Ground as the return path provide for the dc current. saturation of transformer due to flow of DC current can be avoided by using a zigzag connected winding at both ends of transformer. The windings of zigzag transformer are differently connected. The flux produced by the DC current$\left(\frac{I_d}{3}\right)$ is flowing through particular winding of the core to a zigzag connected transformer have an equal magnitude and it is opposite in direction, and hence the canceled to each other so that to the net dc flux becomes zero, when the saturation of the core to the transformer due to DC current is to be removed. To reduce ripples in DC current series reactor X_d is used that also reduce the rate of rise of fault current, thus it also allows to a sufficient times for the circuit breakers for its operation. The triplex harmonics and the zero sequence components to the currents are also greatly to be suppressed by in presence of the series reactors. In these scheme[4] we are using the monopolar DC link where we can give the AC supply and converter converts the AC into DC and after that receiving side it converts DC into AC so here we are using single transmission line and ground as a return path.

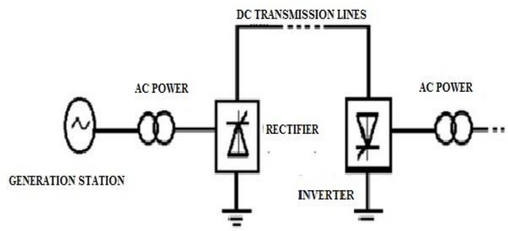

Fig 3.3: Monopolar HVDC Link

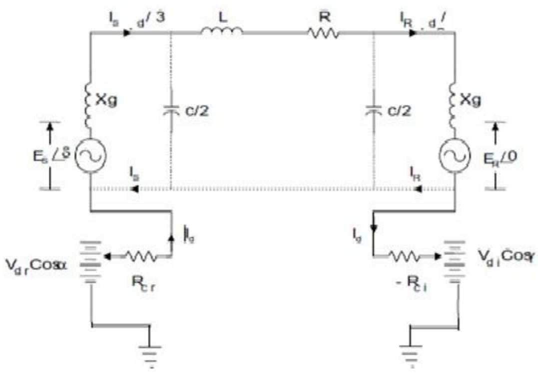

Fig 3.4: Equivalent Circuit Diagram

Assuming the constant current control of the rectifier side and the constant extinction angle of control of the inverter side, the equivalent circuit of the model considered the single ac line to the under normal condition or steady-state operating condition is given by in the Figure 3.4. AC current return path or back current is denoted by the brisk line shown in the figure. Ground acts as the return path for dc current and each one conductors of the line to be carries$\left(\frac{I_d}{3}\right)$along with the ac current in per phase of the line and the maximum values of the rectifier side and also to the inverter side of dc voltages are to be V_{dro} and V_{dio} as respectively. When the line parameters are each phase of every lines R, L and C. The α is the firing angle and R_{cr} , R_{ci} are the commutating resistances and γ is the extinction angles of the converter rectifier and inverter respectively.

IV. MATHEMATICAL REPRESENTATION OF SCHEME

The AC current flowing will be restricted between the zigzag connected windings of the transformers and three conductors to the transmission line of the nonappearance to the zero sequence and 3rd harmonics voltage or it's multiple harmonics voltages. If this these components of voltages are present then they only to be the able to produced the negligible current throughout to the ground due to the high dc reactance of X_d.[1]

An expressions for the AC voltage ,current and the power equations, and it is in the terms of A, B, C and D considerations of particular each one line, when its resistive drop in the transformer winding and the line conductors of the system due to DC current are to be neglect show it can be write as:

Sending end voltage and Sending end current:-

$$V_s = A * V_R + B * I_R \quad (4.1)$$

$$I_s = C * V_R + D * I_R \quad (4.2)$$

Sending end power:

$$P_{s+jQS} = \frac{-V_s V_R^*}{B^*} + \left(\frac{D^*}{B^*}\right)Vs^2 \quad (4.3)$$

Receiving end power:

$$P_{R+jQS} = \frac{V_s^* V_R}{B^*} - \left(\frac{A^*}{B^*}\right)V_R{}^2 \quad (4.4)$$

The expressions for DC and power at the time, when the resistive drop of the ac in the line and the transformer are neglected to the DC current:

$$I_d = (V_{dr}\cos\alpha - V_{di}\cos\gamma)/(R_{er} + \left(\frac{R}{3}\right) - R_{ci}) \quad (4.5)$$

Power in inverter:

$$P_{id} = V_{di} \times I_d \quad (4.6)$$

Power in rectifier:

$$P_{dr} = V_{dr} \times I_d \quad (4.7)$$

Let as the R is the line resistance of each conductors in transmission line and R_{cr} and R_{ci} is the commutating resistances, firing and extinction angles are α and γ of a converter rectifier and inverter of the line and V_{dr} and V_{di} are the max. DC voltages to a rectifier side and inverter side. Values of the V_{dr} and V_{di} is 1.35 times is line to line tertiary winding of the transformer is AC voltages of the respective sides. Reactive powers vital by the converters are:

$$Q_{di} = P_{di} \tan\theta_I$$

$$Q_{dr} = P_{dr} \tan\theta_r \quad (4.8)$$

$$\cos\theta_I = (\cos\gamma + \cos(\gamma + \mu_i))/2$$

$$\cos\theta_r = (\cos\alpha + \cos(\alpha + \mu_r))/2 \quad (4.9)$$

Where μ_i and μ_r is the commutation angles, of the converters inverter and rectifier respectively and the total active power and reactive powers is two ends of the transmission line:

$$P_{st} = P_s + P_{dr} \text{ and } P_{rt} = P_s + P_{di} \quad (4.10)$$

$$Q_{st} = Q_s + Q_{dr} \text{ and } Q_{rt} = Q_s + Q_{di} \quad (4.11)$$

Total transmission line loss is:

$$P_L = (P_s + P_{dr}) - (P_R + P_{di}) \quad (4.12)$$

I_a being the r.m.s. ac current of per conductors at the any point of the transmission line the total r. m. s. current for each conductor becomes:

$$I = \text{sqrt}\left(I_a^2 + \left(\frac{I_d}{3}\right)^2\right) \text{ and } P_L \cong 3I^2R \quad (4.13)$$

If the rated conductor current corresponding to the, its temperature is rise the I-th and $I_a = X * I_{th}$ X is less than unity,of the dc current as:

$$I_a = 3 \times (\text{sqrt}(1 - x^2))I_{th} \quad (4.14)$$

The total current I in any conductor is asymmetrically but the two natural zero crossing in particular cycle in the current wave are is obtained for $(I_d/3I_a) < 1.414$.

The instant worth of particular conductor's voltage is with respect to the ground and becomes the DC voltage V_d is the superimposed sinusoid ally varying with ac voltages having its rms value is E_{ph} and it's top or peak value being:

$$E_{max} = V + 1.414E_{ph} \quad (4.15)$$

Each conductor are insulated forE_{max}. When the line to line voltage (L-L) in no DC component presented and$E_{LL(max)} = 2.45\, E_{ph}$. Then the conductor to conductor separation distance is determined in the system to only the rated AC voltage in the transmission line.

Assume

$$V_d/E_{ph} = k$$

$$P_{dc}/'P_{ac} \cong (V_d * I_d)/(3 * E_{ph} * I_a * \cos\theta) = (k * \text{sqrt}(1 - x^2))/(x * \cos\theta) \quad (4.16)$$

In the case of the faults of transmission strategy gate signal to the all SCRs by pass the SCRs are released to protect the converter rectifier bridge and inverter bridges. The CB are when the tripped to both terminals to isolate then the complete system. As mentioned earlier if the $(I_d/3I_a) < 1.414$,CBs connected at the two ends of the transmission line the interrupt current at natural current zeroes and no special DC-CB is essential. To the double-check proper procedure of the transmission line CBs tripping to the signals of the system and to this CBs may be given only after feeling to zero crossing of the current by the zero crossing indicators. Then otherwise CBs attached the delta edge of the transformers and may be utilized to separate the fault.

V. UNDER FAULTY CONDITION WHEN LINE TO GROUND FAULT OCCURRENCE IN SYSTEM

Under fault conditions a reactive power required increasing as it can be inferred because of graph. Here a reactive power are utilize to the circuit when the reactive power at the receiving end side of transmission line is to be lowered to a negative value and the single line circuit model uses ground as return path. Hence use of uni-polar DC link for simultaneous AC-DC transmission can pose threats to the equipments located nearby in the ground since using ground as return path can corrode the metallic material if it is in its path. Another thing is the sluggishness on the system is removed, if we consider an EHV line and occurrence of a fault the transient response of the system for a example to the voltage profile or current or sudden surge in reactive power requirement has inherent sluggishness the system requires time for recovery. But by using simultaneous AC-DC transmission scheme the transient response is increasing and hence the system is in transient stability.[6]

An stability is the enhanced because of quickly current control mechanism is the HVDC blocks which is the inverter and rectifier blocks. The control mechanism here both a master controls and it's separately there is rectifier and inverter protection it is works on V_{DCOL} current control procedures. When the voltage dips occurrence of a fault the current is restricted, so the fault currents is also decrease and also the most significant thing it is that the it has a very small time constant that is the it's works very fast operation .

A suitable value of the ac and dc filters is utilized in the HVDC system may be attached on delta side of the system and zigzag neutral correspondingly to the filter out of the upper harmonics from ac and dc supplies. Whenever the filters may be omitted for very small values of the V_d and I_d. the neutral terminals of zigzag connected winding of the dc current and voltages may be measuring by adopting common methods are used in HVDC strategy. Accepted cvts is utilized in a EHV AC lines are utilized to assess ac components in transmission line voltage.

VI. SIMULATION RESULTS

The simulation results shows the three phase supply combining AC with DC, resulting pulsating DC at all three phases in supply side as well as load side. Thus it acts as a DC and gives the characteristics advantages same as DC power. We can see that the combined supply voltage AC and DC gives the value of the voltage high with respect to ground. Simulation is carried out using MATLAB 2012a.

Fig 6.1: Three Phase AC sending end and receiving end line voltage in (RMS)

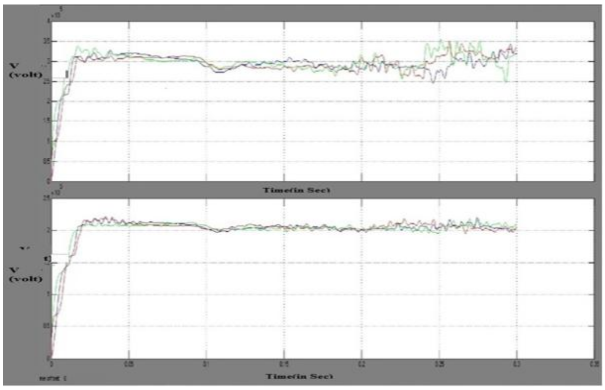

Fig 6.2: Sending end and receiving end line voltages in case of simultaneous AC-DC Power supply in (RMS)

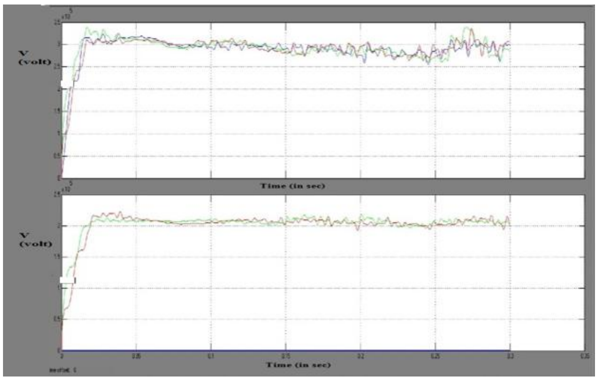

Fig 6.3: Sending and receiving end line voltage in case of simultaneous AC-DC Power supply [line to ground fault (L-G)condition] in(RMS)

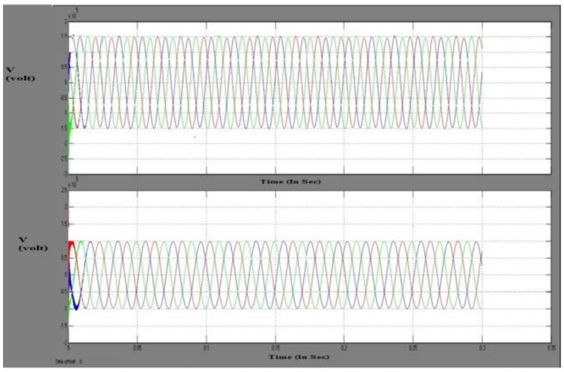

Fig 6.4:Three phase AC sending and receiving end phase voltage

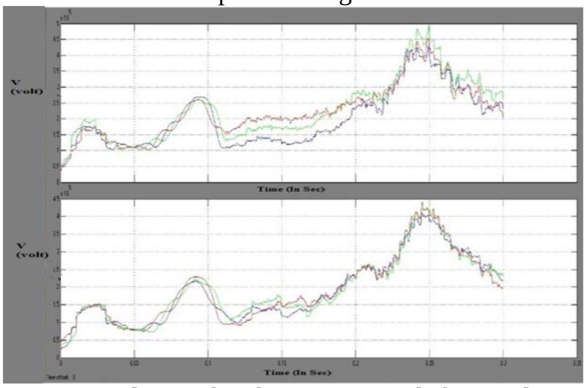

Fig 6.5: Sending end and Receiving end phase voltages in case of simultaneous AC-DC Power supply

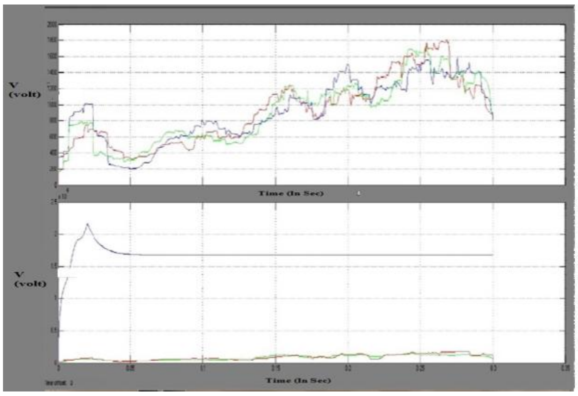

Fig 6.6: Sending and receiving end phase voltage in case of simultaneous AC-DC Power supply in case of line to ground fault

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