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EFFICIENCY IMPROVEMENT OF TRANSMISSION LINES WITH SIMULTANEOUS AC-DC TRANSMISSION

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ABSTRACT
The power system is dependent on a stable and reliable control of active and reactive power to keep its integrity. Loosing this command may lead to a system collapse. It is difficult to load the long extra high voltage ac lines against their thermal limits because of volatility incident in the power system. The aim of this paper is to enhance the transient steadiness of power scheme by establishing simultaneous AC– DC power transmission through a transmission line. With the scheme suggested in this paper, it is more likely to load these lines very close to their thermal limits. The benefit of simultaneous ac-dc transmission is for up gradation of transient steadiness and dynamic steadiness. Damp out oscillations have been established. Simulations have been done in MATLAB software package (Simulink Model).

KEYWORDS: EHV, simultaneous AC–DC power transmission.

INTRODUCTION
In latest years, environmental, right-of-way (Row), and financial anxieties have delayed the building of a new transmission line. The demand of electric power has shown stable development but geographically it is proposed through a single circuit ac transmission line.

In these proposals Mono-polar dc transmission with the growing load centers but at isolated locations. The ground as return path was used [1]-[4]. There were certain regulatory policies, ecological acceptability, and the limitations due to use of ground as return path economic anxieties involving the accessibility of Moreover, the instantaneous value of each conductor power are some of the factors that work out the voltage with respect to ground becomes higher by the location. amount of the dc voltage, and more discs are to be added. Now due to steadiness concerns, the transmission added in each insulator string to withstand this of the available power through the living ac lines has increased voltage. However, there was no change in an upper limit. the conductor separation distance, as the line-to-line[5] and [6]. Therefore, it is tough to load long extra high voltage remains unchanged. In this paper, the voltage (EHV) ac lines to their thermal bounds as a feasibility study of conversion of a double circuit ac sufficient margin is kept against transient in- line to composite ac–dc line without altering the steadiness & dynamic steadiness as well as to damp original line conductors, tower structures, and out oscillations in power system. Insulator strings has been presented. In this scheme, In order to efficiently utilize the available energy, the dc power flow is point-to point bipolar new concepts come into existence considering the transmission system. Clericiet et. al. [7] Suggested the system availability and security. conversion of ac line to dc line for substantial power The improvement of effective ways to use upgrading of existing ac line. However, this would transmission scheme close to its thermal limit has require major changes in the tower structure as well captivated much attention in recent years. as replacement of ac insulator strings with high The progress in the area of power electronics has creep age dc insulators. Already started to leverage the power industry.

PROPOSED METHODOLOGY

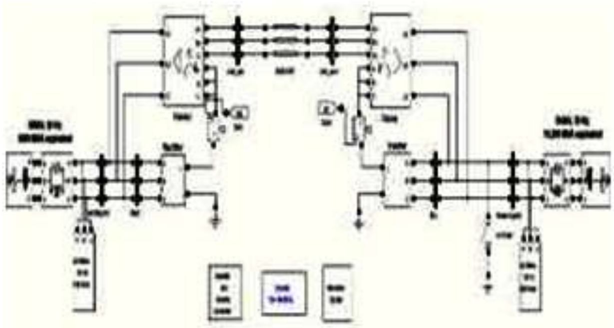

Figure 1 : Basic model for simultaneous AC-DC transmission

The novelty of our proposed scheme is that the transformer which is obtained by the rectifier bridge, power transfer enhancement is achieved without any again it is reconverted to ac by the inverter bridge at alteration in the existing EHV ac line. The inverter bridge is again object is to gain the advantage of parallel ac–dc attached to the neutral of zigzag connected winding of transmission and to load the line close to its thermal the receiving end transformer. But for higher supply limit voltage. We can also use Star connected primary A. High Voltage AC Transmission windings in place of delta-connected windings. Both Industrial-minded countries of the world require a 3 –phase ac and dc power is carried out by single vast amount of energy of which electrical energy circuit transmission line. A part of the total ac power forms a major fraction. The world has already is converted into dc by the winding of the transformer consumed major portion of its natural resources and is connected to rectified bridge, at the sending end. looking for sources of energy other than Hydro and Then at the receiver end, the tertiary winding Thermal to cater for the rapid rate of consumption connected to the inverter bridge, again convert the which is outpacing the discovery of new resources. Same dc power into ac. Each conductor of the line This will not slow down with time and therefore there carries one third of the total dc current along with ac exists a need to reduce the rate of annual increase in current Ia. But the return path of the dc current is energy consumption by any intelligent society if ground. The saturation of transformer due to dc resources have to be preserved for posterity. This current flow id handled by Zigzag connected winding requires very high voltages for transmission. The very A high value of reactor, X d is used to reduce rapid stride taken by development of dc transmission harmonics in dc current. since 1950 is playing a major role in extra-long-distance transmisson, complementing or supplementing E.H.V. ac transmission. They have their roles to play and a country must make intelligent assessment of both in order to decide which is best suited for the country's economy. B. Problems posed in using HVAC a. Increased Current Density because of increase in line loading by using series capacitors' [8] . Use of bundled conductors. High surface voltage gradient on conductors'. Corona problems: Audible Noise, Radio Interference, Corona Energy Loss, Carrier The ac current flow will be restricted between the Interference, and TV Interference[9]. Zigzag connected windings and the three conductors. High electrostatic field under the line. of the transmission line in the nonappearance of zero. Switching Surge Over voltage's which sequence and third harmonics or its multiple because more havoc to air-gap insulation harmonic voltages. If this these components of than lightning or power frequency voltages are present then they only be able to produce voltages. A negligible current through the ground due to high of g. Increased Short-Circuit currents and X_d possibility of Ferro resonance conditions. h. Use of gapless metal-oxide arresters [10]-[11]. The expressions for ac voltage and current and the replacing the conventional gap-type power equations in terms of A,B,C and D Silicon Carbide arresters, for both considerations of each line when the resistive drop in lightning and switching-surge duty. transformer winding and in the line conductors due to i. Shunt reactor compensation and use of dc current are neglected can be written as: series capacitors, resulting in possible sub synchronous resonance conditions and Sending end voltage

$$V_S = AV_R + BI_R \qquad (1)$$

high short circuit currents.

The DC power is injected to the neutral point of Sending end current: the zigzag connected secondary of sending end

Total transmission line loss is

$$P_L = (P_S + P_{dr}) - (P_R + P_{di}) \qquad (2)$$

Sending end power

$P_{S+JQS} = (-V_S V_R^*) / B^* + (D^*/B^*)V_S^2$ (10)

being the rms ac current per conductor at any point of the line, the total current for each conductor becomes

$I = sqrt (I^2_\alpha + (I_d / 3)^2)$ and $P_L = 3I^2R$

Receiving end power

$P_{S+JQS} = (V_S V_R^*) / B^* - (A^*/B^*)V_R^2$ (11)

If the rated conductor current corresponding to its (4)
allowable temperature rise is I-th and
The expressions for dc current and the dc power at the being less than unity, the dc current as

$I\alpha = 3 x (sqrt (1 – x^2) I_{th}$

time when the ac resistive drop in the line and transformer are neglected

Dc current

$I_d = (V_{dr}Cos\alpha – V_{di}Cos\Upsilon) / (R_{er} + (R/3) – R_{ci})$

The total current I in any conductor is asymmetrical but two natural zero-crossings in each cycle in current wave are obtained for

The instant worth of each conductor voltage with respect to the ground becomes the dc voltage with Power in inverter

$P_{id} = V_{di} x I_d$

a superimposed sinusoid ally varying ac voltage having rms value and the peak value being

$E_{max} = V + 1.414 E_{ph}$ (6)

Power in rectifier

$P_{dr} = V_{dr} x I_d$

The electric field produced by any conductor voltage possesses a dc component superimposed with sinusoid ally varying ac component. However, the instant electric field polarity changes its sign twice in Where R is the line resistance per conductor, and cycle if. Therefore, the higher commutating resistances, and firing and creep age distance requirement for insulator discs extinction angles of a rectifier and inverter used for HVDC lines are not required. respectively and are the maximum dc Each conductor is to be insulated for but the voltages of a rectifier and inverter side respectively. line to line voltage has no dc component and Values of and are 1.35 times line to line. Therefore, conductor to tertiary winding ac voltages of the respective sides. Reactive powers vital by the converters are

$Q_{di} = P_{di} \tan \Theta_1$

$Q_{dr} = P_{dr} \tan \Theta_r$

$Cos \Theta_1 = (Cos \Upsilon + Cos (\Upsilon + \mu_i)) / 2$

$Cos \Theta_r = (Cos \alpha + Cos (\alpha+\mu_r)) / 2$

conductor separation distance is determined only by rated ac voltage of the line. Assuming

$V_d/E_{ph} = k$

$P_{dc}/P_{ac} = (V_d *I_d) / (3 * E_{ph} * I_\alpha * Cos\Theta)$

$= (k * sqrt(1 – x^2) / (x * Cos\Theta)$

$P_t = P_{dc} / P_{ac} = (1 + [k * sqrt (1 – x^2)] / (x * Cos\Theta)) * P_{ac}$ (8)

Where and are commutation angles of inverter (14) and rectifier respectively and total active and reactive powers at the two ends are

$P_{st} = P_s + P_{dr}$ and $P_{rt} = P_s + P_{di}$

$Q_{st} = Q_s + Q_{dr}$ and $Q_{rt} = Q_s + Q_{di}$

In case of faults in the transmission scheme, gate signals to all the SCRs are jammed that to the by passs are released to protect rectifier and inverter bridges. CBs are then tripped at both terminals to isolate the complete system.

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Table 1 :- Rating of Equipments used in Simulation

S.No.	Name of Equipments	Ratings
1	Genarator	500KV ,50Hz
2	Zigzag Transformer	100MVA,50 Hz
3	AC Harmonic Filter	600 MVAR , 50Hz
4	Three phase rectifier	500 KV, with internal barrier of 0.0025 and 0.01oh
5	Three Phase Bridge Inverter	500 KV, internal barrier of 0.0025 and 0.01 ohm
6	Load	500KV,50Hz
7	Length of line	600 km
8	HVDC link	Monopolar

RESULTS

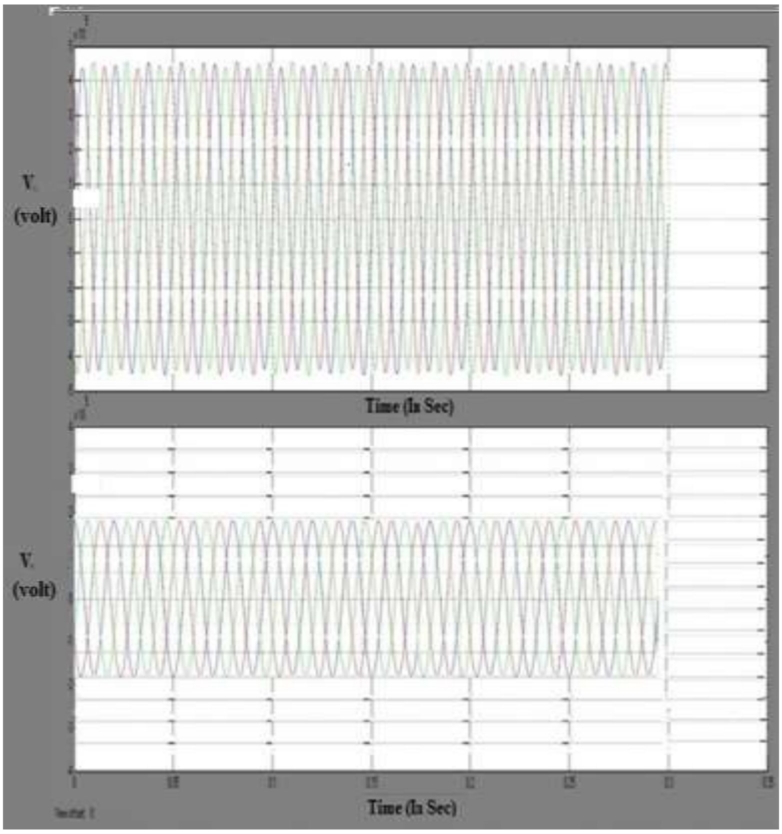

Figure 2: Three Phase AC sending and receiving end line voltage (RMS)

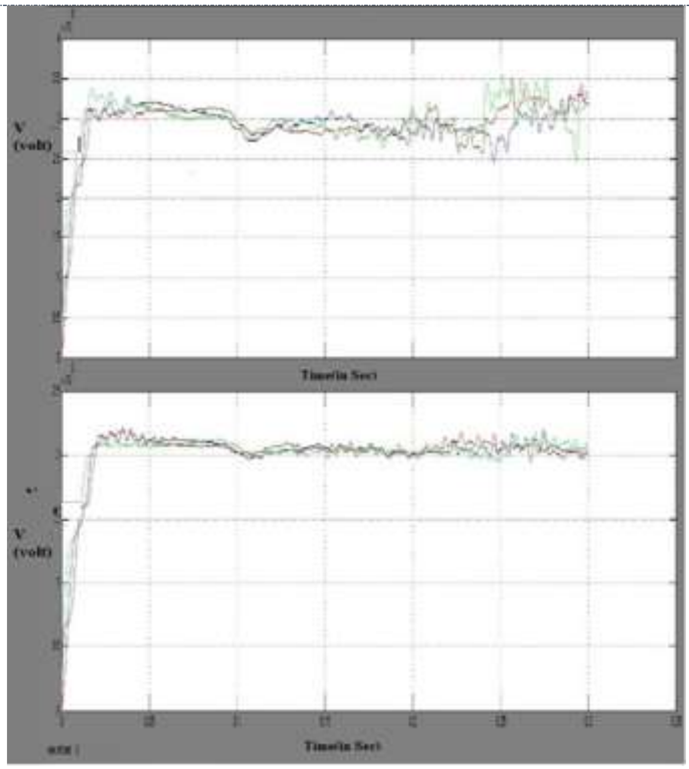

Figure 3: Sending and receiving end line voltages in case of simultaneous AC-DC Power supply (RMS)

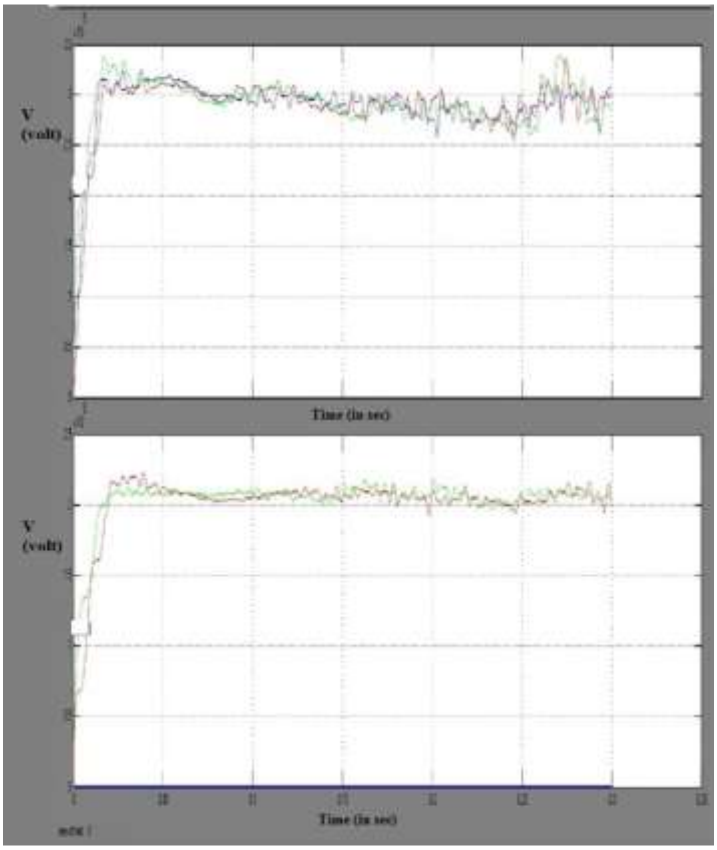

Figure 4: Sending and receiving end line voltages in case of simultaneous AC-DC Power supply (line to ground fault condition)(RMS)

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

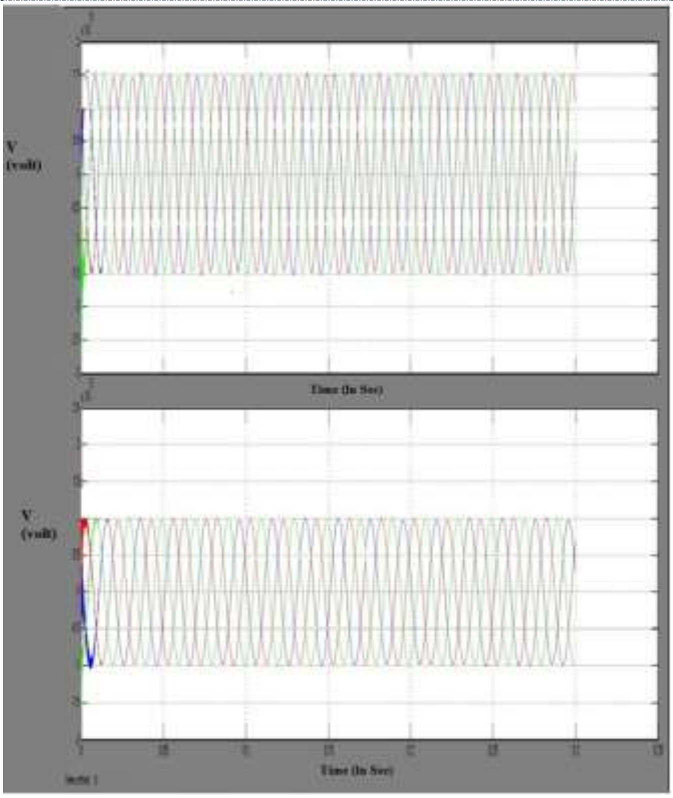

Figure 5: Three Phase AC sending and receiving end phase voltages

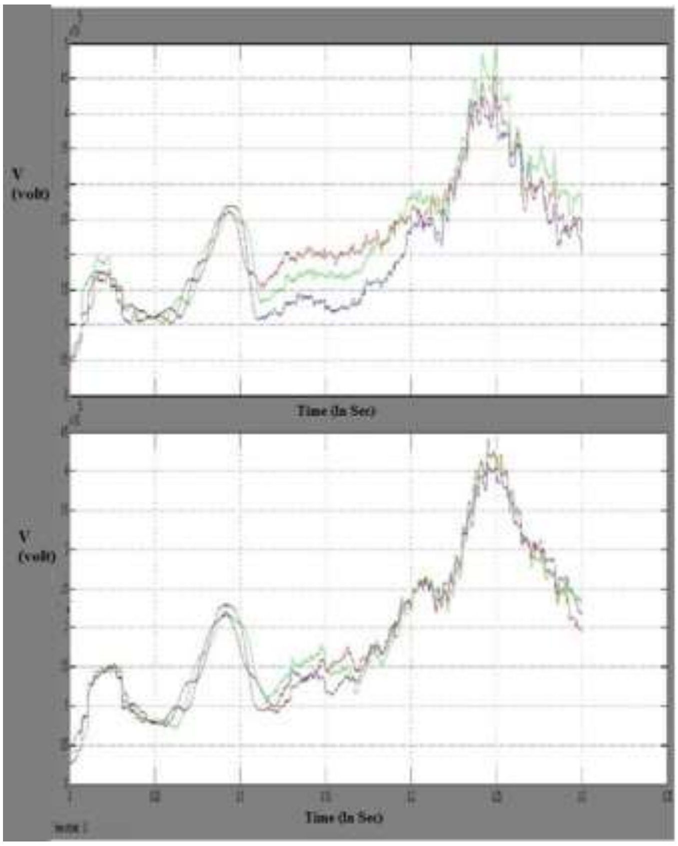

Figure 6: Sending and Receiving end phase voltages in case of simultaneous AC-DC Power supply

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CODEN: IJESS7

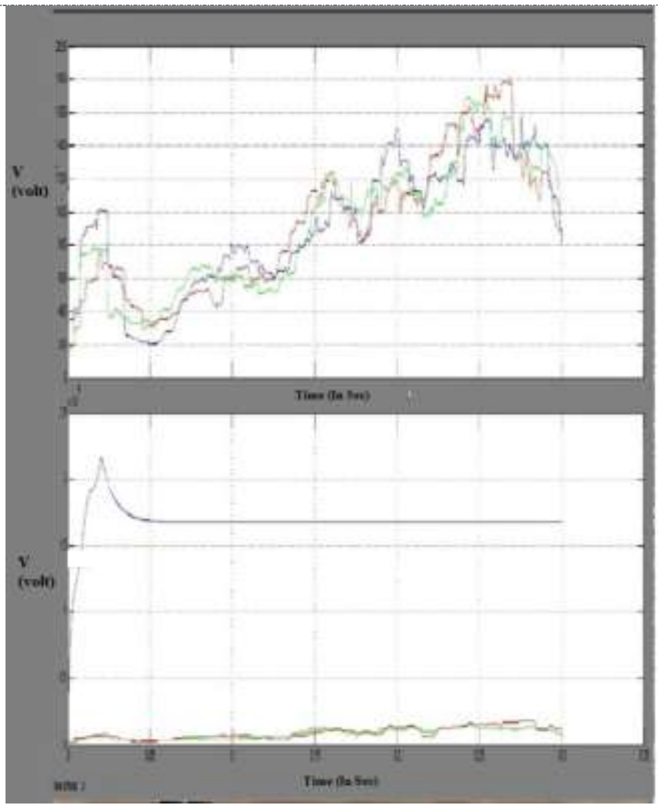

Figure 7: Sending and receiving end phase voltage in case of simultaneous AC-DC Power supply (in case of line to ground fault)

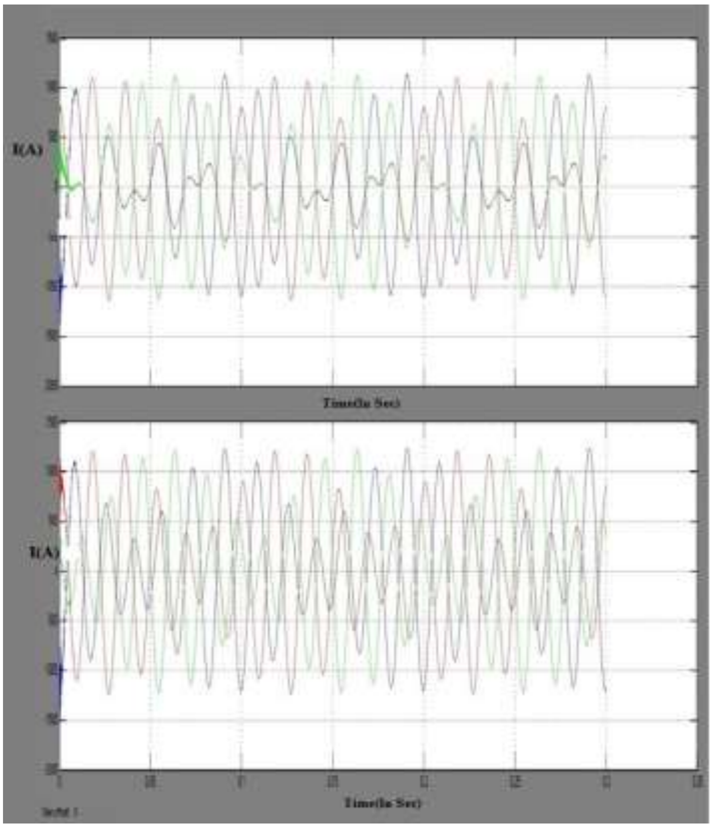

Figure 8: Three Phase AC Sending and receiving end phase currents

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Impact Factor: 4.116
CODEN: IJESS7

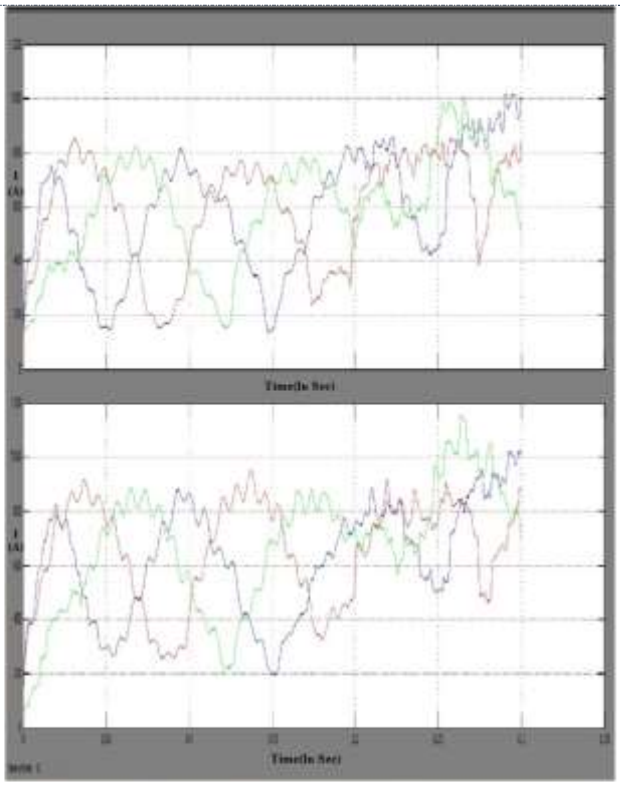

Figure 9: Sending and receiving end line currents in case of simultaneous AC-DC Power supply (RMS)

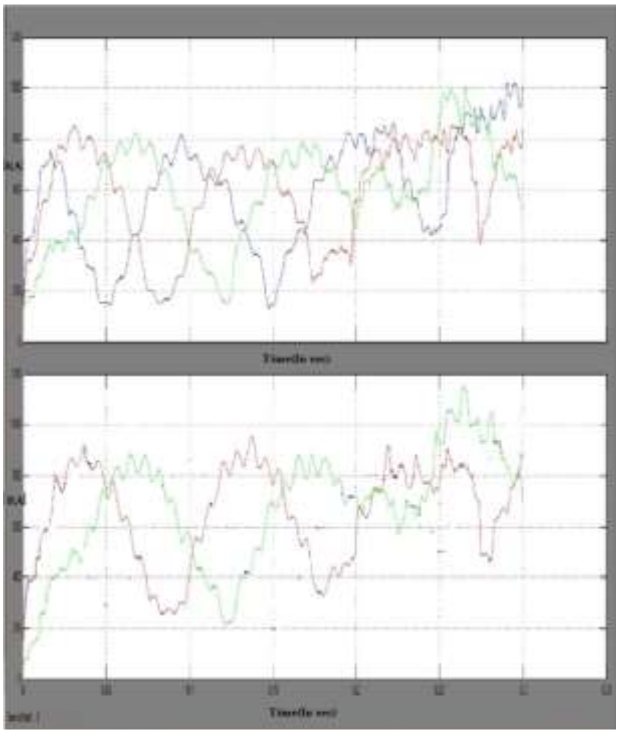

Figure 10: Sending and receiving end line currents in case of simultaneous AC-DC Power supply (Line to ground Fault)(RMS)

CBs connected at the two ends of the transmission line interrupt current at natural current zeroes and no special dc CB is essential. To double-check proper procedure of transmission line CBs tripping signals to these CBs may only be given after feeling the zero crossing of current by zero crossing indicators. Otherwise CB's

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attached to the delta edge of transformers may be utilized to separate the fault. Saturation of transformer core, if any, because of irregular fault current decreases line side current however rises the primary current of the transformer. Delta edge CBs, planned to clear transformers terminal faults and winding faults, treat these faults easily. Suitable values of ac and dc filters as utilized in the HVDC system may be attached to the delta side and zigzag neutral correspondingly to filter out the upper harmonics from dc and ac supplies. However, filters may be omitted for low values of At neutral terminals of zigzag winding dc current and voltages may be measured by adopting common methods used in HVDC scheme. Accepted cvts as utilised in EHV ac lines are utilised to assess ac component of transmission line voltage. The overlaid dc voltage on the transmission line does not touch the working of cvts. Linear couplers with high air-gap core may be engaged for the estimation of ac constituent of line current as a dc constituent of line current is not adept to saturate high air-gap cores. Electric signal handling circuits may be utilized to develop a composite line voltage and current waveforms from the signals gained for dc and ac components of voltage and current. Those signals are used for protection and control purposes.

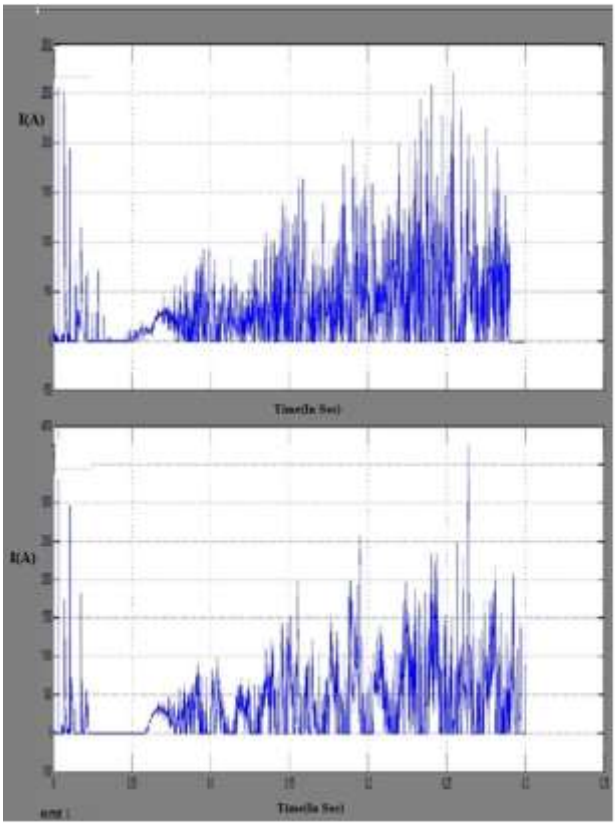

Figure 11: Sending end receiving end phase current case of simultaneous AC-DC Power supply

CONCLUSION

The EHV ac lines, because of integral transient stability difficulty cannot be loaded to their supreme thermal boundary. With the present simultaneous ac-dc transmission it is practicable to load these lines close to thermal edges specified in the data sheets. For the specific system researched, there is a substantial increase in the load-ability of the line. The line is laden to its thermal limit with the superimposed dc current.

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