ENHANCEMENT OF POWER SYSTEM STABILITY BY SIMULTANEOUS AC-DC POWER TRANSMISSION

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Abstract
It is difficult to load extra high voltage (EHV) ac lines to their thermal limits as a sufficient margin is kept against transient instability.This paper proposed a model in which it will be possible to load these lines close to their thermal limits.The trasmission lines are allowed to carry usual AC along with DC superimposed on it. The advantage of parallel ac-dc trasmission for improvement of transient stability and dynamic stability and damped out oscillations has been eatablished. Simulation has been carried out in MATLAB software package (Simulink Model).
Keywords: EHVAC Transmission, EHV DC Transmission FACTS, Power System Stability, Transmission Efficiency, Alternating Current and Direct Current Calculation, MATLAB, Simultaneous ac-dc Power Transmission.

I. INTRODUCTION

We know that whole world require the large amount of power with low loss because year by year the growth of all industries, commercial and residential part of the world demanding power for their growth. The demand of electric power having steady growth power is but the availability of power often not available at the increasing load centers and remote locations. On the environmental acceptability, and the economic concerns also giving the availability of energy are the factors which determining all these locations. Here because of stability considerations, the transmission having available energy through its existing ac lines having in upper limit. So it is very difficult to load long extra high voltage (EHV) ac lines to their thermal limits as given proper margin which kept against transient instability. The modern world having the situations that is full utilization of available energy which applying the new concepts to the old power transmission theory with a view the system availability and their security.

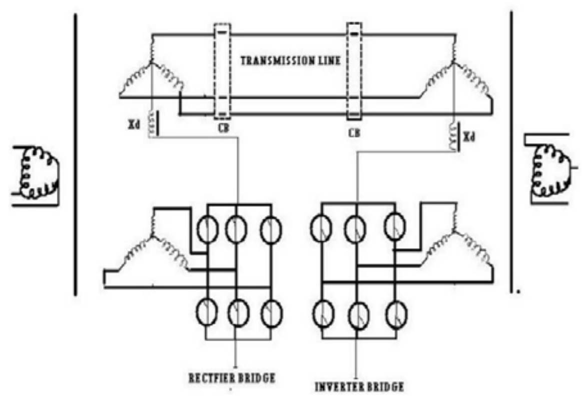


Fig.1.Basic Circuit of AC-DC transmission

The flexible ac transmission system has based on the application of power electronic technology which existing ac transmission system, the role of power electronics improves stability and efficiency to reach power transmission close to its thermal limit. Here we are talking about Simultaneous ac–dc power transmission which was earlier proposed through a single circuit ac transmission line with uni-polar dc link with ground as return path was used for their transmission operation .The Major limitations of ground as return path is due to the fact that the use of ground may corrode any metallic material if it comes in its path. The conductor voltage with respect to ground Three becomes higher due to addition of dc voltage on ac line, hence more insulator discs have to be added with each insulator string so that it can withstand this increased voltage. But condition is that the conductor separation distance was kept constant, as the line-to-line voltage must be unchanged [1]. This paper gives us the method of converting a double circuit ac line into composite ac–dc power transmission line without altering the original line conductors, insulator strings and tower structure. Economic factors such as the high cost of long lines and revenue from the delivery of additional power provide strong incentives to explore all economically and technically feasible means of raising the stability limit. The development of effective ways [3].

Basic proof justifying the feasibility of simultaneous AC–DC transmission has been reported in these papers. In this paper, the improvement of transient stability by utilization of the inherent built-in short-term overloads capacity Of the DC system and rapidly modulating the DC power converted into simultaneous AC–DC line. A single machine infinite bus connected by a double circuit AC line, converted for simultaneous C–DC power transmission has been studied. The transmission angle is varied up to case of simultaneous AC–DC power transmission system. So that cause the effective performance and increasing the efficiency of power transmission capability of power system.

II. TRANSMISSION SCHEME AND THEIR TRENDS

We know that the world require a large amount of energy of which electrical energy used by whole world. We have already consumed major portion of its natural resources like coal, fuels, petroleum and we are looking for renewable sources like solar and wind energy other than Hydro and Thermal to cater for the rapid rate of consumption. It will not slow down with year and therefore there exists a need to reduce the rate of annual increase in energy consumption by any intelligent society if resources have to be preserved for posterity. It requires very high voltages for transmission. The very rapid stride taken by development of dc transmission since 1950 is playing a major role in extra-long-distance transmission, complementing E.H.V. ac transmission. They have 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. The high voltage ac transmission gives the large amount of corona loss, skin effect and use of bundled conductor and compensation require for power transmission.

ADVANTAGES OF HVDC

(1) No corona loss.
(2) No necessary use of bundled conductors.
(3) No surface voltage gradient on conductors.
(4) It does not having the problem of Audible Noise, Radio Interference, Carrier Interference, and TV Interference. High electrostatic field under the line.
(6) . It prevents by Increased Short-Circuit currents and possibility of Ferro resonance conditions.
(8) . It does not require any compensation or use of any capacitive circuit.

III. METHODOLOGY

Here for the operation of simultaneous ac-dc power flow through a dual circuit ac transmission line we want to add the dc supply with ac supply.

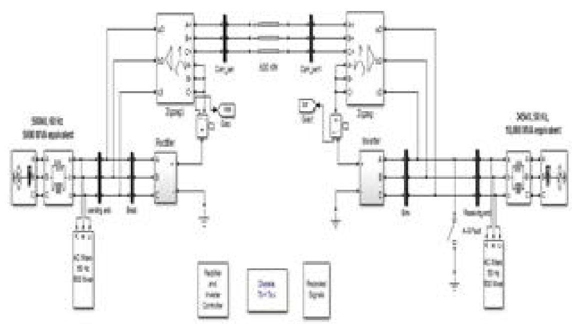


Fig.2.Simulation Model of Simultaneous AC-DC Power Transmission

In these method we are using Line commutated 12-pulse rectifier bridge for HVDC and the dc power is connected to the neutral point of the zigzag transformer of sending end and we get the recovered back to ac again by using the line commutated 12-pulse bridge inverter on the receiving end side hence we get the both part of the power ac as well as dc on the receiving end side that means the same supply on sending end side the inverter bridge is also connected to the neutral of zigzag connected winding of the receiving end transformer to recover the dc current by using the inverter. The dc current on the neutral point is dividing on all the three phases and then each conductor of each transmission line carries one third of the total dc current with ac current superimposed on transmission conductor [8].

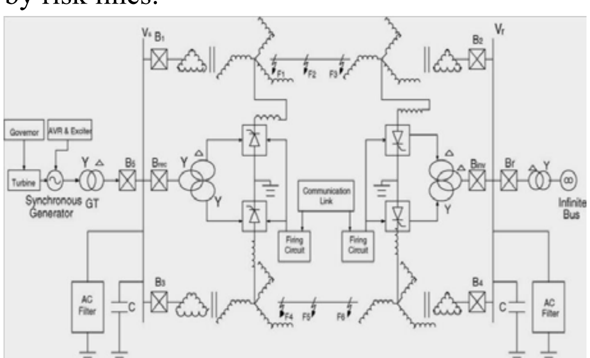
The division of current in all phases depends upon the resistance of conductor and then the value of dc current depends upon resistance of conductor Since the resistance is equal in all the three phases of secondary winding of zigzag transformer and the three conductors of the line, the dc current is divided in all the three phases.

The conductor of the second transmission line provides return path for the dc current to flow. If we are talking about the saturation of transformer then the saturation of transformer due to dc current can be removed by using zigzag connected winding at both ends of transformer.

So the production of fluxes by the dc current (Id / 3) flowing through each winding of the core of a zigzag transformer gives equal magnitude and give opposite in direction and hence cancels.

At any instant of time the total dc flux becomes zero. Thus, dc saturation of core is removed. Here higher value of reactor used to harmonics in dc current. In the absence of harmonics (3rd) or it's multiple and zero sequence, under normal operating conditions, the ac current flowing in each transmission line gets restricted between the zigzag connected windings and the conductors of the transmission line [9].

The presence of these components are producing negligible current through the ground due to higher value of Xd. Here if we are assuming constant current control of rectifier and constant extinction angle control of inverter, the equivalent circuit of the model considering single ac line under steady-state operating condition. The ac current return path is denoted by risk lines.



The second transmission line acts as the return path for dc current, and each conductor of the line carries (Id / 3) along with the ac current per phase and the maximum values of rectifier and inverter side dc voltages are Vdro 11 and Vdio respectively.so that are useful values to analysis the increasing of efficiency on transmission lines.

IV. MATHEMATICAL REPRESENTATION OF SCHEME

Here the strategy to resolve the equations area unit given below that we tend to area unit neglecting the resistive voltage drops and therefore the role of dc currents giving a collection of algebraically expressions for ac voltage and current, and conjointly giving for active and reactive powers in terms of A, B, C, D parameters of every line. These is also given by:

Es = AEr + BIr---------------- (1)
Is = ER + DIr ---------------- (2)
Ps + jQs = -Es*Er*/B* + D*Es2/B* ----- (3)
Pr + jQr = Es*Er/B* - A*Er2/B* ----------(4)

Hence neglect the resistive voltage drops within the zigzag transformers and therefore the tie lines, the dc current Id, dc power Pdr and Pdi of every rectifier and electrical converter is also expressed as:

Id= [Vdro Cosϕ - Vdio Cos ϕ] / [Rcr +Req - Rci] ---- (5)
Pdr = Vdr*Id ------------ (6)
Pdi = Vdi*Id ------------- (7)

Reactive powers needed by the converters are:

Q dr = Pdr *tan ϕ r -------- (8)
Q di = Pdi *tan ϕ i --------- (9)
cos_r = [cos ϕ + cos(ϕ + μr)]/2 ------ (10)
cos_i = [cos ϕ + cos(ϕ + μi)]/2 ------- (11)

μi denotes the commutation angles of electrical converter and μr denotes the commutation angle of rectifier and therefore the total active and reactive powers at each the ends are:

Pst = notation + Pdr and Prt = Pr + Pdi ------ (12)
Qst = Qs + Qdr and Qrt = Qr + Qdi -------(13)

Here transmission loss for every line is:

Pl = (Ps + Pdr) – (Pr + Pdi) ------------------ (14)

Ia is that the RMS AC current through the conductor at any a part of the road, the RMS current per conductor of the road becomes:

I = [Ia2 + (Id/3)2]1/2;

Power loss for every line = PL nine 3I2R.

The total current I in any of the conductors is offset from zero. Currently by setting Infobahn current through the conductor the same as its thermal limit (I^{th}):

I^{th} = [Ia2 + (Id/3)2]1/2 ------------ (15)

Let Vp be per part RMS voltage of the initial ac line. conjointly allow us to think about Va be the per part voltage of the ac a part of synchronic ac-dc tie line with constant dc voltage Cupid\'s itch composed thereon. Because the insulators area unit unchanged, the height voltage within the 2 cases should be equal. If the rated conductor current with relation to its allowable temperature increase is Ith and Iowa = X * Ith; X (too but unity) therefore the dc current becomes:

Id = three x (sqrt (1-x2)) Ith -------- (16)

The worth of voltage in conductor that's section to ground voltage can written because the dc voltage contagion with a composition of sinusoidal varied ac voltages that has RMS worth Eph and also the peak value being:

Emax = V + one.414 Eph

Electric field that of the composite AC-DC line that consists of the sphere made by the dc line that feeding power and also the ac line that making a superimposed result of electrical fields. This will be simply see that the sharp changes in field polarity happens which changes its sign doubly in a very single cycle if (Vd/Eph) < one.414.Here we have a tendency to see that the gap for nonconductor discs employed in HVDC lines. every conductor has got to be insulated for the utmost Emax however the very fact is line to line voltage has no element of dc voltages and ELL(max) = a pair of.45 Eph. Therefore, we have a tendency to come back to the conclusion that conductor to conductor separated distance is observed solely by ac voltage of the road in place of the entire superimposed one.

Detailed analysis of the filter and instrumentation networking that square measure needed for the planned

theme and conjointly short current ac style for protecting theme is out the scope of gift work, however preliminary analysis qualitatively bestowed below says that usually used techniques in HVDC and AC composite system may be adopted exclusively for this purpose. completely different values of ac filters and dc filters square measure employed in HVDC system and also these could also be connected to the delta facet of the electrical device and zigzag neutral severally to separate out higher harmonics fourteen that’s (n*p+1)th order and the (n*p)th order from dc and ac provides. Moreover, filters conjointly could also be omitted for terribly low values of contagion and Id. within the neutral terminals of zigzag electrical device winding dc current and dc voltages may be observed by incorporating common ways that square measure employed in HVDC system.

Standard CVTS or electrical phenomenon voltage electrical device as employed in EHV ac lines to live stepped down AC element of line voltage. The composite ac-dc voltage within the line does the operating of covets. Linear couplers that has high air-gap core could also be used for activity ac element of line current because the dc element of line current cannot saturate high air-gap cores.

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

Under fault conditions the causation of sending side voltage and receiving side voltage suddenly dips of original wave form when fault is cleared. The causation and receiving finish currents rises to a precise spike then recovers step by step. Normally the voltage of across the rectifier and electrical converter dips on the prevalence of fault whereas this level spikes beneath fault conditions. The on top of results square measure obtained by employing a single line to ground fault within the distributed parameters for the one circuit line model.

The results stay nearly similar beneath dc fault. Beneath fault conditions the reactive power demand will increase as is inferred from the graph. Because the reactive power is employed within the circuit thus the reactive power at the receiving finish aspect is lowered to a negative value. The one line circuit model uses ground as return path.

Hence use of unipolar dc link for simultaneous ac-dc transmission can pose threats to the equipment located nearby in the ground since using ground as return path can corrode the metallic material if it is in its path.[7] Another thing is that the sluggishness in the system is removed, if we consider an EHV line and on occurrence of a fault the transient response of the system for example the voltage profile or the current or the sudden surge in the reactive power requirement has inherent sluggishness, the system requires a long time to recover. But by using the simultaneous ac-dc model the transient response is increased and hence the transient stability.

The stability is additional increased owing to faster current management mechanism of HVDC blocks that's the rectifier and electrical converter blocks. Within the management mechanism there's a master management and on an individual basis there's electrical converter and rectifier protection that works on VDCOL management procedures. Whenever the voltage dips on prevalence of a fault this is restricted therefore the fault current is additionally diminished and also the most vital factor is that it's terribly little time constant that's it works in time.

VI. SIMULATION RESULTS

We see the simulation result for the simultaneous C- C power transmission the overall result for sending end voltages, receiving end voltages that shows the combined supply graph for AC with DC supply.

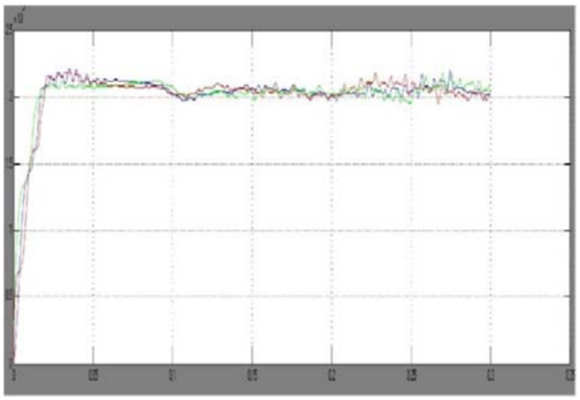


Fig.4.Receiving End Voltage at No fault condition

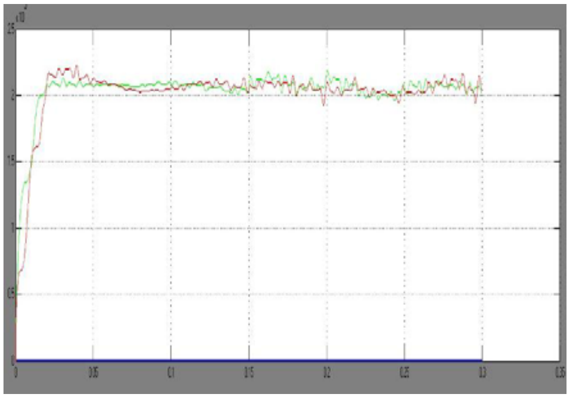


Fig.5. Receiving End Voltage at Fault condition

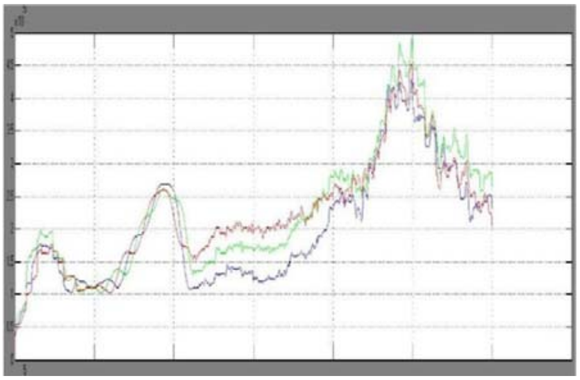


Fig.6 Receiving End Current at No Fault

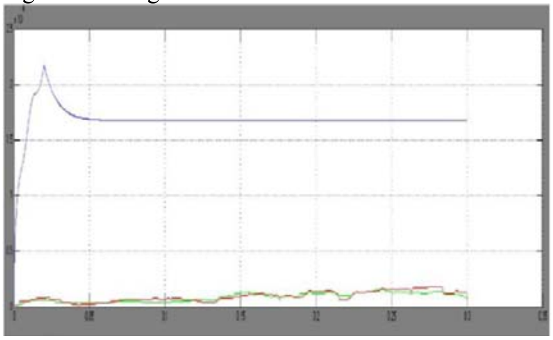


Fig.7. Receiving End Current in case of Fault

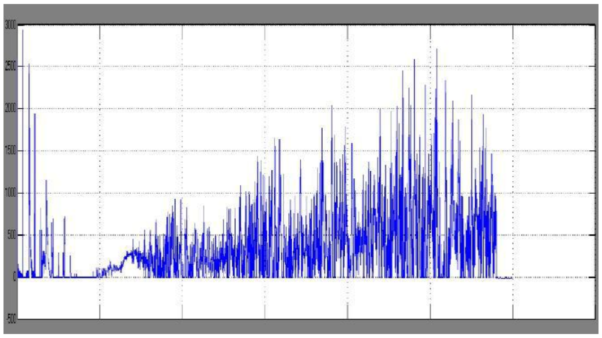


Fig.8.Sending End Line Voltage in case of No Fault

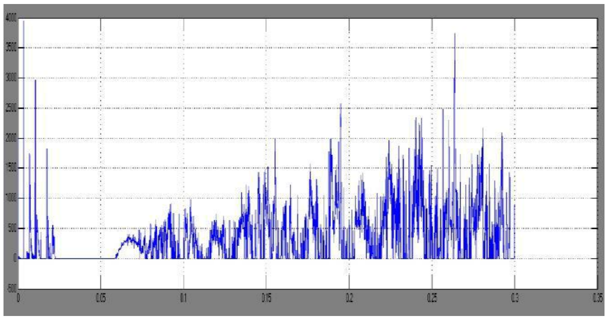


Fig.9.Sending End Line Voltage in case of Fault

Conclusion

The results show the stability of power system both for natural response and response under faulty Conditions.

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