**UPGRADING THE POWER OF ELECTRICAL SYSTEM BY COMBINING AC-DC TRANSMISSION LINE**

 **Mr. C. J. Sharma**

Department of Electrical Engineering

K.D.K.C.E,

Nandanvan, Nagpur.

**Gauri B. Padgelwar**

Department of Electrical Engineering

K.D.K.C.E,

Nandanvan, Nagpur.

gauri.padgelwar@gmail.com

***Abstract:*** Long extra high voltage (EHV) ac lines cannot be loaded to their thermal limits in order to keepsufficient margin against transient instability. With the scheme proposed in this project, it is possible to load theselines very close to their thermal limits. The conductors are allowed to carry usual ac along with dc superimposedon it.The added dc power flow does not cause any transient instability. This paper gives the feasibility of converting adouble circuit ac line into composite ac–dc power transmission line to get the advantages of parallel ac–dctransmission to improve stability and damping out oscillations. Simulation and experimental studies are carriedout for the coordinated control as well as independent control of ac and dc power transmissions. No alterations of conductors, insulator strings, and towers of the original line are needed. Substantial gain in the load ability of the line is obtained. Master current controller senses ac current and regulates the dc current orders for converters online such that conductor current never exceeds its thermal limit

.

***Key words:*** Flexible ac transmission system (FACTS) ,Extra high voltage (EHV) transmission, Simultaneous ac-dc power transmission.

**I. INTRODUCTION**

In recent years,environmental, right-of-way, and cost concerns havedelayed the construction of a new transmission line,while demand of electric power has shown steadybut geographically uneven growth. The power is often available at locations not close to the growingload centers but at remote locations.These locationsare largely determined by regulatory policies,environmental acceptability, and the cost ofavailable energy. The wheeling of this availableenergy through existing long ac lines to load centershas a certain upper limit due to stabilityconsiderations. Thus, these lines are not loaded totheir thermal limit to keep sufficient margin againsttransient instability.The present situation demands the review of traditional power transmission theory and practice, on the basis of new concepts that allow fullutilization of existing transmission facilities withoutdecreasing system availability and security. Theflexible ac transmission system (FACTS) concepts,based on applying state-of-the-art power electronictechnology to existing ac transmission system,improve stability to achieve power transmissionclose to its

**Yugeshwari V. Brahmankar**

Department of Electrical Engineering**,**

K.D.K.C.E,

Nandanvan, Nagpur

yuga.vs22@gmail.com

thermal limit. The basic proof justifying the simultaneous ac–dc power transmission is explained in an IEEE paper “Simultaneous ac-dc power transmission,” by K. P. Basu and B. H. Khan. In the above reference, simultaneous ac–dc power transmission was first proposed through a single circuit ac transmission line. In these proposals Mono-polar dc transmission with ground as return path was used. There werecertain limitations due to use of ground as returnpath. Moreover, the instantaneous value of each conductor voltage with respect to ground becomes higher by the amount of the dc voltage, and more discs are to be added in each insulator string to withstand this increasedvoltage. However, there was no change in the conductor separation distance.



**Fig.1. Basic scheme for composite ac–dc transmission.**

**II. SIMULTANEOUS AC-DC TRANSMISSION**

Fig. 1 depicts the basic scheme for simultaneous ac–dc power flow through a double circuit ac transmission line. The dc power is obtained through line commutated 12-pulse rectifier bridge used in conventional HVDC and injected to the neutral point of the zigzag connected secondary of sending end transformer and is reconverted to ac again by the conventional line commutated 12-pulse bridge inverter at the receiving end. The inverter bridge is again connected to the neutral of zig-zag connected winding of the receiving end transformer.The double circuit ac transmission line carriers both three-phase ac and dc power. Each conductor of each line carries one third of the total dc current along with ac current. Resistance being equal in all the three phases of secondary winding of zig-zag transformer as well as the three conductors of the line, the dc current is equally divided among all the three phases. The three conductors of the second line provide return path for the dc current. Zig-zag connected winding is used at both ends to avoid saturation of transformer due to dc current. Two fluxes produced by the dc current (Id / 3) flowing through each of a winding in each limb of the core of a zig-zagtransformer are equal in magnitude and opposite in direction. So the net dc flux at any instant of time becomes zero in each limb of the core. Thus, the dc saturation of the core is avoided. A high value of reactor Xd is used to reduce harmonics in dc current.

In the absence of zero sequence and third harmonics or its multiple harmonic voltages, under normal operating conditions, the ac current flow through each transmission line will be restricted between the zig-zag connected windings and the three conductors of the transmission line. Even the presence of these components of voltages may only be able to produce negligible current through the ground due to high value of Xd. Assuming the usual constant current control of rectifier and constant extinction angle control of

inverter as mentioned later, the equivalent circuit of the scheme under normal steady-state operating condition is given in Fig. 2. The dotted lines in the figure show the path of ac return current only. The second transmission line carries the return dc current, and each conductor of the line carries (Id / 3)along with the ac current per phase and Vdro and Vdio are the maximum values of rectifier and inverter side dc voltages and are equal to 3 times converter ac input line-to-line voltage. R, L and C are the line parameters per phase of each line. Rcr and Rci are commutating resistances, and, α, γ are firing and extinction angles of rectifier and inverter, respectively.

**III. HIGH VOLTAGE DC TRANSMISSION**

It has been widely documented in the history of the electricity industry, that the first commercial electricity generated (by Thomas Alva Edison) was direct current (DC) electrical power. The first electricity transmission systems were also direct current systems. However, DC power at low voltage could not be transmitted over long distances, thus giving rise to high voltage alternating current (AC) electrical systems. Nevertheless, with the development of high voltage valves, it was possible to once again transmit DC power at high voltages and over long distances, giving rise to HVDC transmission systems. Since the first commercial installation in 1954 a huge amount of HVDC transmission systems have been installed around the world. In today electricity industry, in view of the liberalization and increased effects to conserve theenvironmentHVDC solutions have become more desirable for the following reasons:

1. Environmental advantages

2. Economical (cheapest solution)

3. Asynchronous interconnections

4. Power flow control

5. Added benefits to the transmission

**IV. PROBLEM DEFINATION**

The main object of my paper is to show that by superimposing DC in AC transmission, the capacity of the transmission line can be increased by nearly 70 % of that if only AC is transmitted. In our existing transmission system, long extra high voltage (EHV) ac lines cannot be loaded to their thermal limits in order to keep sufficient margin against transient instability. With the scheme proposed in this project, it is possible to load these lines very close to their thermal limits. The conductors are allowed to carry usual ac along with dc superimposed on it.

**V.PROPOSED APPLICATIONS**

1. Long EHV ac lines cannot be loaded to their thermal limit to keep sufficient margin against transient instability and to keep voltage regulation within allowable limit, the simultaneous power flow does not imposed any extra burden on stability of the system, rather it improves the stability. The resistive drop due to dc current being very small incomparison to impedance drop due to ac current, there is also no appreciable change in voltage regulation due to superimposed dc current.

2. Therefore one possible application of simultaneous ac-dc transmission is to load the line close to its thermal limit by transmitting additional dc power. Figure4 shows the variation of Pt/Pac for changing values of k and x at unitypower factor. However, it is to be noted that additional conductor insulation is to be provided due to insertion of dc.

3. Necessity of additional dc power transmission will be experienced maximum during peak load period which ischaracterized with lower than rate voltage. If dc power is injected during the peak loading period only with V dbeing in the range of 5% to 10% of E ph, the same transmission line without having any enhanced insulation level may be allowed to be used For a value of x=0.7 and V d =0.05 E ph or 0.10 E ph, 5.1% or 10.2% more power may be transmitted.

4. By adding a few more discs in insulator strings of each phase conductor with appropriate modifications in cross arms of towers insulation level between phase to ground may be increased to a high value, which permits proportional increase in Emax, Therefore higher value of Vd may be used to increase dc and total power flow through the line. This modification in the exiting ac lines is justified due to high cost of a separate HVDC line.

5. The independent and fast control of active and reactive power associated with dc, superimposed with the normal acactive and reactive power may be considered to be working as another component of FACTS.

6. Simultaneous ac-dc power transmission may find its application in some special cases of LV and MV distribution system. When 3-phase power in addition to dc power is supplied to a location very near to a furnace or to a work place having very high ambient temperature, rectification of 3-phase supply is not possible at that **7**

**VI. CONCLUSION**

The feasibility to convert ac transmission line to a composite ac–dc line has been demonstrated. For the particular system studied, there is substantial increase (about 83.45%) in the loadability of the line. The line is loaded to its thermal limit with the superimposed dc current. The dc power flow does not impose any stability problem. The advantage of parallel ac–dc transmission is obtained. Dc current regulator may modulate ac power flow. There is no need for any modification in the size of conductors, insulator strings, and towers structure of the original line. The optimum values of ac and dc voltage components of the converted composite line are ½ and 1/√2 times the ac voltage before conversion, respectively.

**VII.REFERENCES**

1. N. G.Hingorani, “FACTS—flexible A.C. transmissionsystem,” in Proc. Inst. Elect. Eng. 5th. Int. Conf.A.C. D.C. Power Transmission, London, U.K.,1991.

2. P. S.Kundur, Power System Stability and Control. NewYork: Mc-Graw-Hill, 1994.

3. K. P.Basu and B. H. Khan, “Simultaneous ac-dc powertransmission,” Inst. Eng. (India) J.-EL, vol. 82, pp.32–35, Jun. 2001.

4. H.Rahman and B. H. Khan, “Enhanced power transfer

by simultaneous transmission of AC-DC: a newFACTS concept,”in Proc. Inst. Elect. Eng. Conf.Power Electronics, Machines, Drives, Edinburgh,U.K., Mar. 31–Apr. 2 2004, vol. 1, pp. 186191.

5. Padiyar*, HVDC Power Transmission System*. New Delhi,

India: Wiley Eastern, 1993.