International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 5, August 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Design of 230 kV Twin Bundle Double Circuit Overhead Transmission Line

Hnin Yu Lwin, U Hla Myo Htay

Lecturer, Electrical Power Department, Technological University, Mandalay, Myanmar

How to cite this paper: Daw Hnin Yu Lwin | U Hla Myo Htay "Design of 230 kV Twin Bundle Double Circuit Overhead Transmission Line" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.1967-1970, **https://doi.org/10.31142/ijtsrd27830**

IJTSRD27830

ABSTRACT

The purpose of this paper is to study and design of 230 kV twin bundle double circuit overhead transmission line. In design consideration, the selection of economic voltage, choice of conductor size, number of insulators, maximum sag of conductor and minimum height of conductor are considered. The electrical transfer of energy from one place to another over long distance with standard regulations is one of the major problems in the field of electrical power engineering. The parameters of overhead transmission line are resistance, inductance and capacitance. The bundle conductors are used for reducing the reactance on the line, corona losses, radio interference and surge impedance.

KEYWORDS: *twin bundle double circuit, overhead transmission line, resistance, inductance and capacitance*

1. INTRODUCTION

The electrical transfer of energy from one place to another over long distances with standard regulations is one of the major problems in the field of electrical power engineering. A transmission line is that part of an electrical power system whose function is the transfer of electrical energy from the station where it is generated to a substation where it is distributed.

In order to transmit heavy power efficiently for any considerable distance, comparatively high voltage is required. So, economic choice of voltage should be considered for any power transmission line.

The selection of size of the conductor is also important in order to carry the amount of enough current that flows on the line due to the transfer of power. Moreover, the amount of power losses and voltage drop on the line should be in an acceptable range as in the standard regulations.

In transmission system, there are two kinds of transmission line, namely overhead lines and underground cables. Overhead line transmission system is cheaper than underground cable system. But maintenance cost for underground transmission line is higher than that of the overhead line.

The parameters of overhead transmission line are resistance, inductance and capacitance. The resistance of an overhead line produces the power loss and the capacitance will affect the voltage of sending end and the receiving end. To reduce the reactance on line and the corona loses bundle conductor are used. If the lines have very much capacitance effect, the reactors must be used to compensate the capacitance effect. The inductance of an overhead transmission line may interfere to the nearby communication channel.

In highly induction line, the mutual induce voltage in the telephone line is dangerous for the people who use the telephone. Therefore for the three-phase line, the choice of spacing of conductors is very important and the lines must be transposed to compensate the mutual inductance if needed.

2. LITERATURE REVIEW

A Transmission line is a device for the transfer of electric energy. It can transfer the energy over long or short distance, at different voltages. The transmission line of very high voltage, such as; 66kV, 132kV, 220kV, 500kV, are part of a national grid. There are two types of transmission lines

1. Overhead transmission line
2. Underground transmission line

2.1. Overhead Transmission Line

In this type of system, long steel towers are erected on the surface or earth and with the help of cross arms and insulators. The naked wires are turned overhead at a height that not less than 10meter from the ground. The invention of the strain insulator was a critical factor in allowing higher voltage to be used. Transmission level voltages are usually considered to be 110 kV and about. Lower voltage such as; 66kV and 33kV are usually considered sub-transmission voltages but are occasionally used on long line with light load. Voltages less than 33kV are usually used for distribution. Voltages above 230 kV are considered extra high voltage and require different design compared to equipment used as lower voltages. Overhead transmission lines are un-insulated wire, so design of these line required minimum clearances to be observed to maintain safety. During adverse weather condition of high wind and low temperature, overhead conductor can exhibit wind induced oscillations with can encroach on their design clearances. Depending on the frequency and amplitude of oscillation, the motion can be termed gallop or flutter. The first consideration in the design of an overhead line is, of course, its electrical properties. The mechanical factor influencing the design must they be considered, the material chosen for the conductor must also be strong enough to withstand the forces to which it is subject as must also be the supports. The tension in the conductor should be adjusted so that it is well within the breaking load of the material, this will mean in practice that an appreciable amount of sag must allowed for, i.e., the high of the conductor at points between the support will be lower than its high at the point of support, and adequate clearance for earthed objects must be obtained throughout the length of the conductor in all circumstances.

3. DESIGN THEORY OF TRANSMISSION LINE

The supply power and the line length will be given, the most economic voltage can be determined by the following equation.

$$V = 5.5 \times \sqrt{\frac{L_t}{1.6} + \frac{P \times 10^3}{\cos\varphi \times N_c \times 150}}$$

Where,
Nc = No. of circuit
Lt = Total Line Length
P = Transmitted Power
V = Economic Voltage

In resistance calculation the following formula should be used to consider the skin effect,
Rac = K Rdc (3.5)

Where K is a function of X

$$X = 0.63598\sqrt{\frac{\mu f}{R_{dc}}}$$

where,
f = system frequency in Hz
μ = permeability =1.0 for non–magnetic material
Rdc = dc resistance in Ω/mile

When the conductors of a three–phase line are not equilaterally spaced. The line to neutral capacitance is

$$C = \frac{2\pi k}{GMR_C} \quad \text{F/m to neutral}$$

$$\text{where,} \quad GMR_C = \sqrt[3]{r_A \times r_B \times r_C}$$

r = radius of the conductor
k = 8.85 × 10-12 F/m
and capacitive reactance is

$$X_C = \frac{1}{2\pi f C_n}\ \Omega$$

For a three-phase line, the charging current is found by multiplying the voltage to neutral by the capacitive susceptance to neutral. The phasor charging current in phase a is

$$I_{ch} = j\omega C_n V_{an} \text{ A/mile}$$

The average inductance per-phase can be expressed by the following equation,

$$L = 2\times10^{-7} \ln\frac{GMD}{GMR_L} \text{ mH/km}$$

To find the GMD between each phase group,

$$D_{AB} = \sqrt[4]{D_{ab}D_{ab'}D_{a'b}D_{a'b'}}$$

$$D_{BC} = \sqrt[4]{D_{bc}D_{bc'}D_{b'c}D_{b'c'}}$$

$$D_{CA} = \sqrt[4]{D_{ac}D_{ac'}D_{a'c'}D_{a'c}}$$

To find Geometric Mean Distance can be expressed as

$$GMD = D_{eq} = \sqrt[3]{D_{AB} \times D_{BC} \times D_{CA}}$$

The GMR of two-bundle conductor can be expressed as,

$$D_s^b = \sqrt{D_s \times d}$$

Where,
d= bundle spacing, Ds=GMR of each sub conductor

4. DESIGN CALCULTATION OF TRANSMISSION LINES

Design Calculation

Line Information Data,
Total Line Length, L = 77.16 miles (124.18 km)
Transmission Power, P = 280 MW
Power Factor, p.f = 0.9
No. of circuit, Nc = 2 circuits
Phase Spacing = 6 m
Economic Voltage Selection,

$$V_{eco} = 5.5 \times \sqrt{\frac{L_t}{1.6} + \frac{P \times 10^3}{\cos\varphi \times N_c \times 150}}$$

$$\text{Target Withstand Voltage} = \frac{\text{max : System Voltage (kV)}}{\sqrt{3}} \times 1.2$$

Economic Size of Conductor,

$$C = 0.013 \times \sqrt{\frac{a.p}{q}}$$

a = percent annual expense to the construction cost of conductor
p = price of conductor (kyat/kg)
q = cost of electricity (kyat/kwh)

$$\text{Loat Current, I} = \frac{\mu.p}{\sqrt{3} \times V \times p.f \times N_c \times N_b}$$

Consideration for Choice of Two Bundle Conductor by Corona Voltage,

$$V_C = \sqrt{3} \times m_0 m_1 \times \delta^{\frac{2}{3}} \times 48.8 \frac{nr}{1 - \frac{2(n-1)}{S} \times \sin\frac{\pi}{n}} \times \left(1 + \frac{0.301}{\sqrt{rd}}\right) \times \log\frac{D}{r^{\frac{1}{n}}.S^{\left(\frac{n-1}{n}\right)}}$$

Line Constant Calculation

A. Resistance
B. Inductance
C. Capacitance, C
D. Parallel Admittance
E. For Station1-to Station-2 Transmission Line

Line Load Ability Calculation

$$P = \frac{V_s V_R}{X_L} \sin\delta$$

Surge Impedance Loading

$$Z_0 = \sqrt{X_L X_C}$$

Mechanical Design Calculation
Critical Span

$$W_h = \sqrt{(W_P^2 + W^2)}$$

Maximum Sag of Conductor

$$K = \frac{T_0}{S} - \frac{W_x^2 E}{24T_0^2} L^2$$

$$M = \frac{W^2 E}{24S^2} L^2$$

$$M = \left(\frac{T}{S}\right)^2 \left(\frac{T}{S} - K + AtE\right)$$

Maximum Sag of Conductor for Equal Level
The fundamental equations for sag calculation are as follow;

$$\text{Maximum sag of conductor, } D = \frac{WL^2}{8T}$$

$$\left(\frac{T}{S}\right)^2 \left(\frac{T}{S} - K + AtE\right) = M$$

$$K = \frac{T_0}{S} - \frac{W x^2 E}{24 T_0^2} L^2$$

$$M = \frac{W^2 E}{24 S^2} L^2$$

where,

L = actual standard span

D = sag at span L (ft)

T = tension at span L (ft)

W = weight of conductor (lb)

S = cross sectional area of conductor (sq-in)

A = temperature coefficient of linear expansion (˚ F)

t = temperature different (˚ F)

E = Young's modulus (lb/ft2)

T0 = mximum working tension of conductor (lb)

Wx = loading, the high temperature loading Wh for the span (l) more than the critical span and low temperature loading W1 for less than the critical span.

Specifications	Symbol	Design Value	Unit
Economic Voltage	V_{eco}	184	kV
Number of Insulators	-	13 (for 210 kN)	discs
	-	12 (for 300 kN)	discs
Length of insulator String	-	2.28 (7.5 ft)	meter
Economic Cable Size	C	477 (squab)	MCM
Corona Critical Voltage	V_c	467.58 (Line to Line)	kV
Resistance	$R_{dc(50)}$	0.10585	Ω/km
	R_{ac}	0.10508	Ω/km
Inductance	L	0.6742	m H/km
Inductive Reactance	X_L	0.2118	Ω/km
Capacitance	C	0.024582	μf/km
Sending end current	I_s	$780.96\angle-25.84$	A
Receiving end current	I_R	$888.44\angle-38.43$	A
Receiving end voltage	V_R	$212.117\angle-3.867$	kV
Receiving Power	P_R	268.8	MW
Power losses	P_L	11.2	MW
% of losses	-	4	%
Voltage Regulation	-	8.4	%
Efficiency	η	96	%
Wind pressure at temperature 75°F	-	18	lb / ft²
Wind pressure at temperature 41°F		10	lb / ft²
Wind load at 75°F	W_p	0.9528	lb/ft
Wind load at 41°F	W_p'	0.5293	ft
Weight of conductor	W	0.9522	lb/ft
Diameter of conductor	D	0.0827	ft
Area of Steel	-	0.11101	sq. in
Area of Aluminum	-	0.4758	sq. in
Total area	S	0.58681	sq. in
Young's modulus	E	13.317×10^6	lb/sq. ft
Temperature coefficient of linear expansion	A	10.24 10-6	/°F
Critical span	-	1343.08	ft
Actual standard span	-	1056	Ft
Tension in conductor at center of span	T	94.33	lb
Maximum sag of conductor	D	15.625	ft
clearness between line and earth	-	25	ft
Length of insulator string	-	7.5	ft
Maximum height of cross-arm of tower	-	14.78	m

Design Data Sheet of the 230 kV Twin Bundle Double Circuit Overhead Transmission Line

5. CONCLUSIONS

Mostly, all of the possible aspects are at most considered in this paper for the design of a new high–voltage, 230 kV twin bundle double circuit overhead transmission line, 280 MW hydropower generation. In this paper, to design 230 kV high–voltage the environmental impact of AC transmission line should be considered and calculated. In this paper, these effects are not considered and calculated. These effects can damage human resources and radio wave, etc. By considering these effects, designing of 230 kV twin bundle double circuit overhead AC transmission line will be perfect design. So for future study, these effects should be considered for high–voltage AC transmission line. Other designers will quickly build up personal experience and improved design procedures to suit local circumstances.

6. ACKNOWLEDGEMENTS

The author deeply wants to express special appreciation and heart-left thanks to Dr. Yadana Aung, Professor and Head the Department of Electrical Power Engineering, Technological University (Mandalay) for her willingness to share her ideas and helpful suggestions on this paper writing.

7. REFERENCES

[1]. [05KEP] KEPCO: *Feasibility Study and Basic Design for the 500 kV Transmission System in Myanmar*, Final Report and Appendix, Korea Electric Power Corporation, (2005).

[2]. [00Des] Deshpande, M.V.: *Electrical Power System Design*, McGraw. HillPulishing Company Limited, (2000).

[3]. [99Nag] Nagrath, I J. and Kothari, D P.: *Modern Power System Analysis*, McGraw. Hill Publishing Company Limited, Second Edition, (1999).

[4]. [94Gra] Grainger, John J and Stevenson, Jr., William D.: *Power System Analysis*, Singapore; McGraw-Hill, Inc, (1994).

[5]. [93Ano] Anonymous, IEEE Standard (1313-1993): *Insulation Coordination for High Voltage Switchgears*. New York, U.S.A, IEEE. (1993).

[6]. [88Tur] TuranGonen: *Modern Power System Analysis*, (1988).

[7]. [85Cot] Cotton, H. and Barber, H.: *Transmission and Distribution of Electric Energy*, Hodder and Stoughton, (1985).

[8]. [82Hil] Hillview: *345kV and above Transmission Line Reference Book*, USA. General Electric Company, Second Edition, Electric Power Research Institute, (1982).

[9]. [67Eva] Evans, Robert D.: *Transmission and Distribution Reference Book*, Oxford and IBH Pulishing Company, Third Edition, (1967).

[10]. [63Gra] Gracey, G. C.: *Overhead Electric Power Lines*, Ernest Benn Limited, (1963).

[11]. [62Nip] Nippon Koei.: *Completion Report of 230 kV Lawpita-Taungoo-Yangon*