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DC Transmission and distribution

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Abstract
Transmission and distribution of D.C. power; By transmission and distribution of electric power is meant its conveyance from the central station where it is generated to places, where it is demanded by the consumers like mills, factories, residential and commercial buildings, pumping stations etc.

Keywords: transmission and distribution of dc power, power transmitted by two methods, voltage drop and t efficiency, methods of distributor, distributor fed with equal voltages

Introduction

Electric Power May Be Transmitted by Two Methods

By underground system

Underground system is especially suited for densely populated areas though it is somewhat costlier than the first method. In over-head system, power is conveyed by bare conductors of copper or aluminium which are strung between wooden or steel poles erected at convenient distances along a route. The bare copper or aluminium wire is fixed to an insulator which is itself fixed onto a cross-arm on the pole.

The number of cross-arms carried by a pole depends on the number of wires it has to carry. Line supports consist of (1) pole structures and (2) tower.

A good system whether overhead or underground should fulfil the following Requirements

The voltage at the consumer's premises must be maintained within ± 4 or ± 6% of the declared voltage, the actual value depending on the type of load*.

1. The loss of power in the system itself should be a small percentage (about 10%) of the power transmitted.
2. The transmission cost should not be unduly excessive.
3. The maximum current passing through the conductor should be limited to such a value as not to overheat the conductor or damage its insulation.
4. The insulation resistance of the whole system should be very high so that there is no undue leakage or danger to human life.

It may, however, be mentioned here that these days all production of power is as A.C. power and nearly all D.C. power is obtained from large A.C. power systems by using converting machinery like synchronous or rotary converters, solid-state converters and motor-generator sets etc. There are many sound reasons for producing power in the form of alternating current rather than direct current. (i) It is possible, in practice, to construct large high-speed a.c. generators of capacities up to 500 MW. Such generators are economical both in the matter of cost per kWh of electric energy produced as well as in operation. Unfortunately, d.c. generators cannot be built of ratings higher than 5 MW because of commutation trouble. Moreover, since they must operate at low speeds, it necessitates large and heavy machines. (ii) A.C. voltage can be efficiently and conveniently raised or lowered for economic transmission and distribution of electric power respectively. On the other hand, d.c. power has to be generated at comparatively low voltages by units of relatively low power ratings. As yet, there is no economical method of raising the d.c. voltage for transmission and lowering it for distribution. Fig. 40.1 shows a typical power system for obtaining d.c. power from a.c. power. Other details such as instruments, switches and circuit breakers etc. have been omitted. Two 13.8 kV alternators run in parallel and supply power to the station bus-bars. The voltage is stepped up by 3-phase transformers to 66 kV for transmission purposes** and is again stepped down to 13.8 kV at the sub-station for distribution purposes. Fig. 1 shows only three methods commonly used for converting a.c. power to d.c. power at the sub-station.

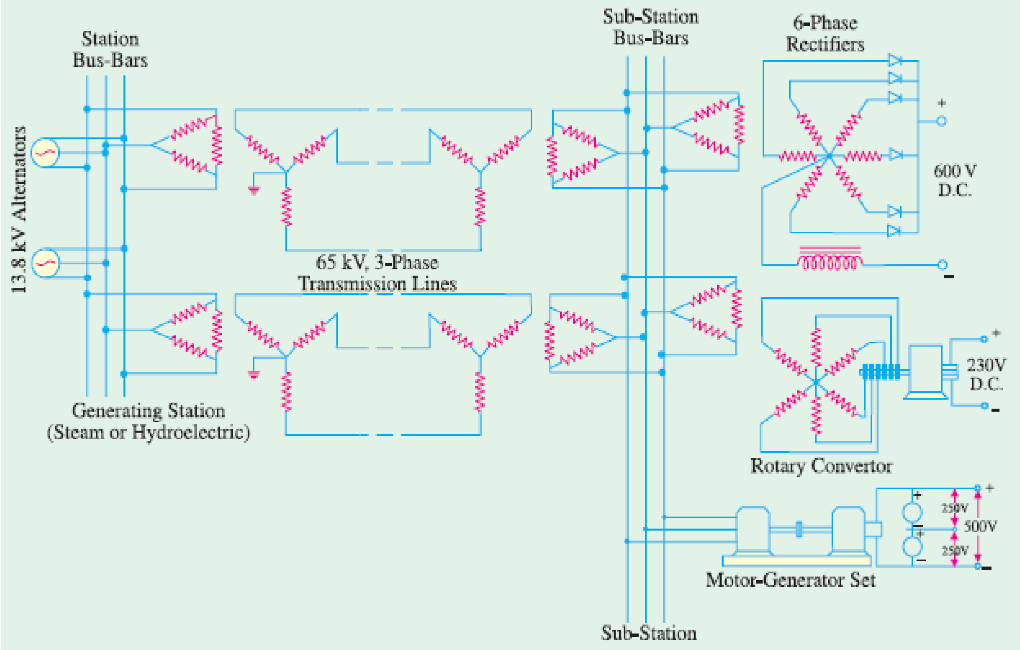

Fig 1: Two-wire and Three-wire Systems

Voltage Drop and Transmission Efficiency

Consider the case of a 2-wire feeder (Fig. 40.6). AB is the sending end and CD the receiving end. Obviously, the p.d. at AB is higher than at CD. The difference in potential at the two ends is the potential drop or 'drop' in the cable. Suppose the transmitting voltage is 250 V, current in AC is 10 amperes, and resistance of each feeder conductor is 0.5 Ω, then drop in each feeder conductor is 10 × 0.5 = 5 volt and drop in both feeder conductor is 5 × 2 = 10 V.

∴ P.d. at Receiving end CD is = 250 − 10 = 240 V

Input power at AB = 250 × 10 = 2,500 W

Output power at CD = 240 × 10 = 2,400 W

∴ Power lost in two feeders = 2,500 − 2,400 = 100W

The above power loss could also be found by using the formula

Power loss = 2 I2R = 2 × 102 × 0.5 = 100 W

The efficiency of transmission is defined, like any other efficiency, as the ratio of the output to input

∴ efficiency of transmission = power delivered by the line/ power received by the line In the present case, power delivered by the feeder is

= 2500 W and power received by it as 2400 W.

∴η = 2400 × 100/2500 = 96%

In general, if V1 is the voltage at the sending end and V2 at the receiving end and I the current delivered, then

Input = V1I, output = V2 I

∴η = V2 I /V1 I = v2/v1

Now; V2 = V1 – drop in both conductors

=V1 − IR, where R is the resistance of both conductors

∴η =V1- IR / V1

or % efficiency =100× (1-IR/V1)=100-(IR/V1× 100)

Now, (IR/V1) × 100 represents the voltage drop in both conductors expressed as a percentage of the voltage at the sending end. It is known as percentage drop.

∴ % η = 100 − % drop

Methods of Feeding a Distributor

Different methods of feeding a distributor are given below:

1. Feeding at one end
2. Feeding at both ends with equal voltages
3. Feeding at both ends with unequal voltages
4. Feeding at some intermediate point

Distributor Fed at Both Ends with Equal Voltages It should be noted that in such cases

1. the maximum voltage drop must always occur at one of the load points and
2. if both feeding ends are at the same potential, then the voltage drop between each end and this point must be the same, which in other words, means that the sum of the moments about ends must be equal.

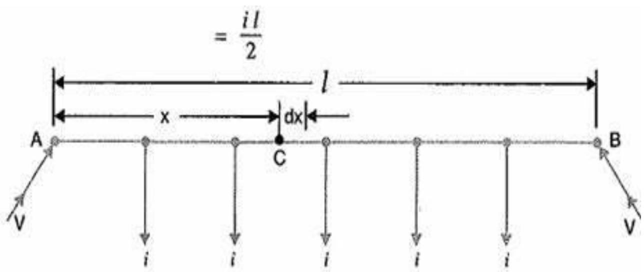

Fig 2

In Fig. 2 is shown a distributor fed at two points F1 and F2 with equal voltages. The potential of the conductor will gradually fall from F1 onwards, reach a minimum value at one of the tapping, say, A and then rise again as the other feeding point F2 is approached. All the currents tapped off between points F1 and A will be supplied from F1 while those tapped off between F2 and A will be supplied from F2. The current tapped at point A itself will, in general, be partly supplied by F1 and partly by F2. Let the values of these currents be x and y respectively. If the distributor were actually cut off into two at A-the point of minimum voltage, with x amperes tapped off from the left and y amperes tapped off from the right, then potential distribution would remain unchanged, showing that we can regard the distributor as consisting of two separate distributors each fed from one end only, as shown in Fig. 40.11 (b). The drop can be calculated by locating point A and then values of x and y can be calculated. This can be done with the help of the following pair of equations: x + y = i4 and drop from F1 to A1 = drop from F2 to A2.

Conflict of interest

The authors declare no conflict of interest.

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