## DISTRIBUTION FACTOR FOR THREE-PHASE WINDINGS

| COILS PER GROUP | STANDARD WINDING | CONSEQUENT-POLE WINDING | CONCENTRIC WINDING |
|---|---|---|---|
| 1 | 1.000 | 1.000 | The distribution factor is always equal to 1.0 |
| 2 | .966 | .866 | |
| 3 | .960 | .844 | |
| 4 | .958 | .837 | |
| 5 | .957 | .833 | |
| 6 or more | .956 | .831 | |

The "Coils Per Group" in the table are for windings with an even coil grouping. The distribution factor for windings which do not have an even coil grouping is determined by the reduced slot/group ratio.

Reduce the number of slots per pole per phase to a fraction where numerator and denominator are both whole numbers containing no common factor.

Example: 3 phase, 8-pole standard winding, 36 slots; coil grouping: 1 and 2 coils per group.

$$\frac{\text{Slots}}{\text{Poles x Phase}} = \frac{36}{8 \times 3} = \frac{36}{24}$$

which can be reduced to $\frac{3}{2}$

Then numerator = 3

The distribution factor for this winding which does not have an even coil grouping is the same as for that of a standard winding with numerator = 3 coils per group (even coil grouping). Therefore, the distribution factor from the table is .960.

## (i) Distribution factor ($K_d$)

A winding with only one slot per pole per phase is called a concentrated winding. In this type of winding, the e.m.f. generated/phase is equal to the arithmetic sum of the individual coil e.m.f.s in that phase. However, if the coils/phase are distributed over several slots in space (distributed winding), the e.m.f.s in the coils are not in phase (i.e., phase difference is not zero) but are displaced from each by the slot angle $\alpha$ (The angular displacement in electrical agrees between the adjacent slots is called slot angle). The e.m.f./phase will be the phasor sum of coil e.m.f.s. The distribution factor $K_d$ is defined as:

$$K_d = \frac{\text{e.m.f. with distributed winding}}{\text{e.m.f. with concentrated winding}}$$

$$= \frac{\text{phasor sum of coil e.m.f.s/phase}}{\text{arithmetic sum of coil e.m.f.s/phase}}$$

Note that numerator is less than denominator so that $K_d < 1$.

Expression for $K_d$

Let $\alpha = \text{slot angle} = \frac{180° \text{ electrical}}{\text{No. of slots/pole}}$

$n$ = slots per pole per phase

The distribution factor can be determined by constructing a phasor diagram for the coil e.m.f.s. Let n = 3. The three coil e.m.f.s are shown as phasors AB, BC and CD [See Fig. (10.7 (i))] each of which is a chord of circle with centre at O and subtends an angle $\alpha$ at O. The phasor sum of the coil e.m.f.s subtends an angle n $\alpha$ (Here n = 3) at O. Draw perpendicular bisectors of each chord such as Ox, Oy etc [See Fig. (10.7 (ii))].

$$K_d = \frac{AD}{n \times AB} = \frac{2 \times Ax}{n \times (2\,Ay)} = \frac{Ax}{n \times Ay}$$

$$= \frac{OA \times \sin(n\,\alpha/2)}{n \times OA \times \sin(\alpha/2)}$$

$$\therefore \quad K_d = \frac{\sin(n\,\alpha/2)}{n\,\sin(\alpha/2)}$$

Note that n $\alpha$ is the phase spread.

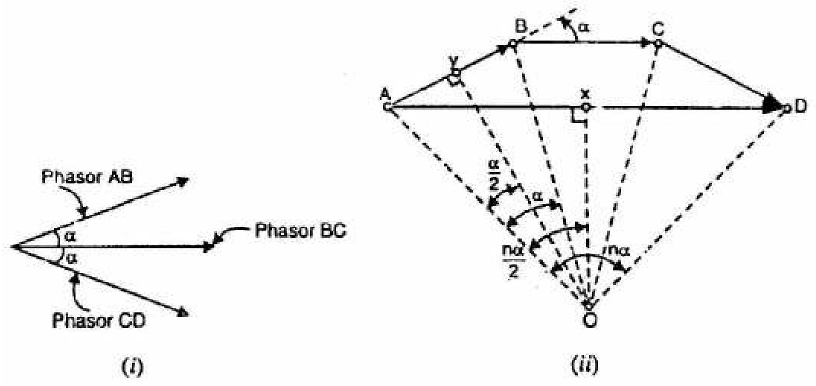


**Fig.(10.7)**