

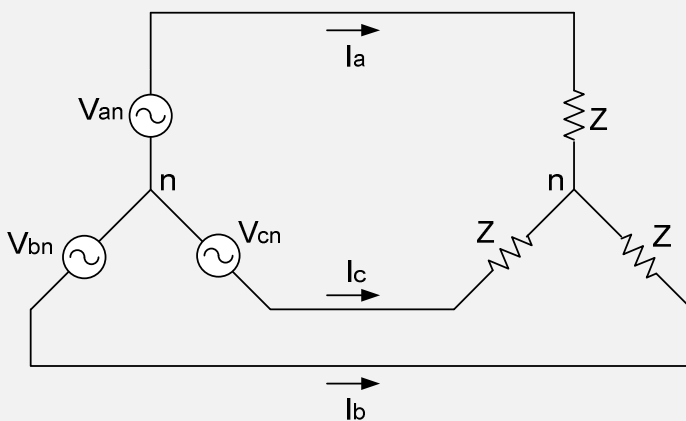
DASAR TEKNIK TENAGA LISTRIK



Perhitungan Tiga Fasa

Wike Handini

SISTEM TENAGA LISTRIK TIGA FASA



Rangkaian Sederhana pada Hubungan Bintang (Star atau Y)

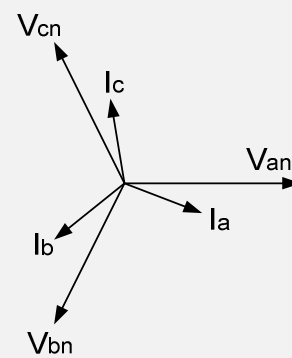
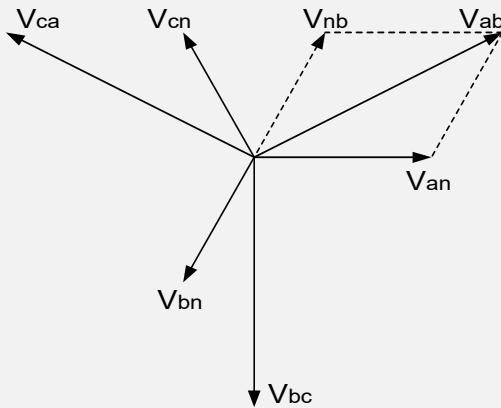


Diagram Fasor Sistem Seimbang

DIAGRAM FASOR TEGANGAN SISTEM SEIMBANG



$$V_{ab} = V_{an} + V_{nb} = V_{an} - V_{bn}$$

$$V_{bc} = V_{bn} + V_{nc}$$

$$V_{ca} = V_{cn} + V_{na}$$

$$V_{ab} = V_{an} \sqrt{3} \angle 30^\circ$$

$$V_{bc} = V_{bn} \sqrt{3} \angle 30^\circ$$

$$V_{ca} = V_{cn} \sqrt{3} \angle 30^\circ$$

$$V_{an} = V_{bn} = V_{cn} = V_{L-N}$$

$$V_{ab} = V_{bc} = V_{ca} = V_{L-L}$$

3

DIAGRAM FASOR TEGANGAN SISTEM SEIMBANG

$$\cos 30^\circ = \frac{N}{V_{an}}$$

$$N = V_{an} \cos 30^\circ$$

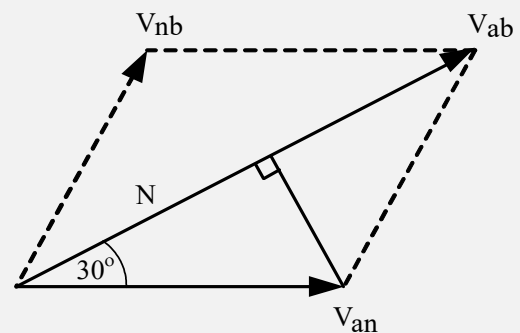
$$V_{ab} = 2 \times N$$

$$V_{ab} = 2V_{an} \cos 30^\circ$$

$$V_{ab} = 2V_{an} \frac{1}{2} \sqrt{3}$$

$$V_{ab} = \sqrt{3} V_{an}$$

$$V_{L-L} = \sqrt{3} V_{L-N}$$



Substitusi

$$\cos 30^\circ = \frac{1}{2} \sqrt{3}$$

4

DAYA → HUBUNGAN BINTANG (Y)

Daya masing-masing fasa beban

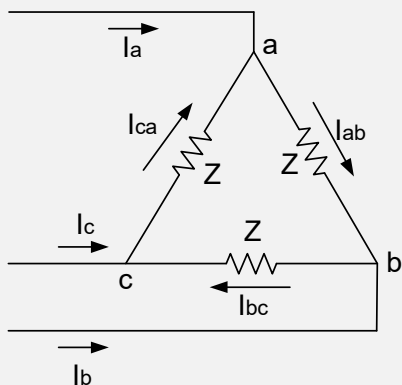
$$P_{1\phi} = V_{L-N} \cdot I \cdot \cos \varphi$$

I adalah arus yang mengalir pada masing-masing fasa beban (untuk sistem seimbang $I = I_a = I_b = I_c$)

$$\begin{aligned} P_{3\phi} &= 3 \cdot V_{L-N} \cdot I \cdot \cos \varphi \\ &= 3 \cdot \frac{V_{L-L}}{\sqrt{3}} \cdot I \cdot \cos \varphi \\ &= \sqrt{3} \cdot V_{L-L} \cdot I \cdot \cos \varphi \end{aligned}$$

5

HUBUNGAN DELTA (Δ)



$$I_a = I_{ab} + I_{ac} = I_{ab} - I_{ca}$$

$$I_b = I_{bc} - I_{ab}$$

$$I_c = I_{ca} - I_{bc}$$

I_a , I_b dan I_c adalah arus saluran ($I_L = I$) sedangkan I_{ab} , I_{bc} dan I_{ca} adalah arus fasa (I_p)

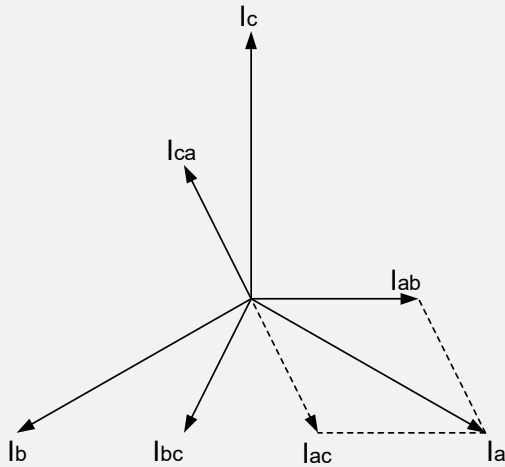
$$I_a = I_{ab} \sqrt{3} \angle -30^\circ$$

$$I_b = I_{bc} \sqrt{3} \angle -30^\circ$$

$$I_c = I_{ca} \sqrt{3} \angle -30^\circ$$

6

HUBUNGAN DELTA (Δ)



$$\cos 30^\circ = \frac{N}{I_{an}}$$

$$N = I_{an} \cos 30^\circ$$

$$I_{ab} = 2 \times N$$

$$I_{ab} = 2I_{an} \cos 30^\circ$$

$$I_{ab} = 2I_{an} \frac{1}{2} \sqrt{3}$$

$$I_{ab} = \sqrt{3} I_{an}$$

$$I_L = \sqrt{3} I_P$$

7

DAYA \rightarrow HUBUNGAN DELTA (Δ)

Daya masing-masing fasa beban

$$P_{1\phi} = V_{L-L} \cdot I_P \cdot \cos \varphi$$

I_P adalah arus yang mengalir pada masing-masing fasa beban (untuk sistem seimbang $I_P = I_{ab} = I_{bc} = I_{ca}$)

$$\begin{aligned} P_{3\phi} &= 3 \cdot V_{L-L} \cdot I_P \cdot \cos \varphi \\ &= 3 \cdot V_{L-L} \cdot \frac{I_L}{\sqrt{3}} \cdot \cos \varphi \\ &= \sqrt{3} \cdot V_{L-L} \cdot I_L \cdot \cos \varphi \\ &= \sqrt{3} \cdot V_{L-L} \cdot I \cdot \cos \varphi \end{aligned}$$

8

CONTOH

Suatu sistem tenaga tiga fasa 20 kV memasok beban sebesar 10 MW. Jika faktor daya 0,9 lagging hitunglah arus beban, daya semu dan daya reaktif.

Solusi

Diketahui:

$$V_{L-L} = 20 \text{ kV} \\ = 20.000 \text{ V}$$

$$P_{3\phi} = 10 \text{ MW} \\ = 10.000.000 \text{ W}$$

$$\cos \phi^\circ = 0,9$$

Ditanya: I, S dan Q

$$P_{3\phi} = \sqrt{3} \cdot V_{L-L} \cdot I \cdot \cos \phi$$

$$I = \frac{P_{3\phi}}{\sqrt{3} \cdot V_{L-L} \cdot \cos \phi}$$

$$I = \frac{10000000}{\sqrt{3} \cdot 20000 \cdot 0,9}$$

$$I = \frac{10000000}{31176,91}$$

$$I = 320,75 \text{ A}$$

9

CONTOH

$$P = S \cos \phi^\circ$$

$$S = \frac{P}{\cos \phi^\circ}$$

$$S = \frac{10}{0,9}$$

$$S = 11,11 \text{ MVA}$$

$$\cos \phi^\circ = 0,90$$

$$\phi^\circ = \cos^{-1} 0,90$$

$$\phi^\circ = 25,842$$

$$\sin 25,842^\circ = 0,436$$

$$Q = S \sin \phi^\circ$$

$$Q = 11,11 \times 0,436$$

$$Q = 4,84 \text{ MVAr}$$

Arus beban adalah 320,75 A, daya semu 11,11 MVA dan daya reaktif sebesar 4,84 MVAr

10