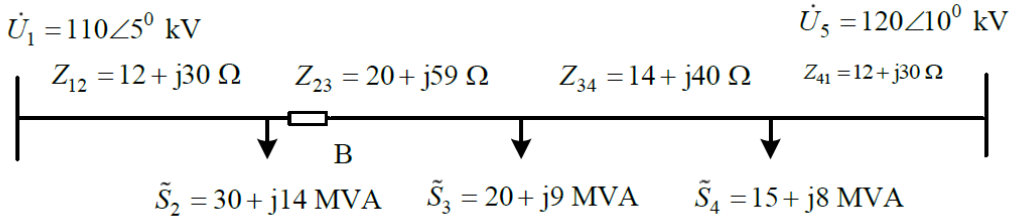
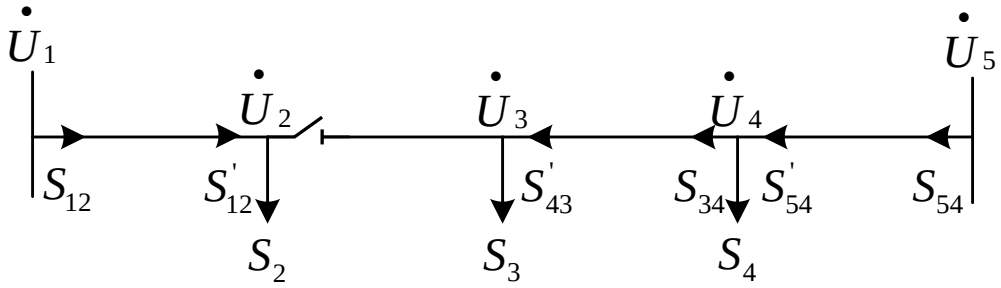
习题 3-17 供电系统如图。试求断路器 B 打开和闭合两种情况下的系统初步功率分布。



i. 在 B 断开时



$$\Delta S_{12} = \frac{P'^2_{12} + Q'^2_{12}}{U_2^2}(R_{12} + jX_{12}) = \frac{30^2 + 12^2}{110^2}(12 + 30j) = 1.087 + 2.717j \quad (\text{MVA})$$

$$S_{12} = S'_{12} + \Delta S_{12} = 30 + 14j + 1.087 + 2.717j = 31.087 + 16.717j \quad (\text{MVA})$$

$$\Delta S_{43} = \frac{P'^2_{43} + Q'^2_{43}}{U_3^2}(R_{34} + jX_{34}) = \frac{20^2 + 9^2}{110^2}(14 + 40j) = 0.557 + 1.590j \quad (\text{MVA})$$

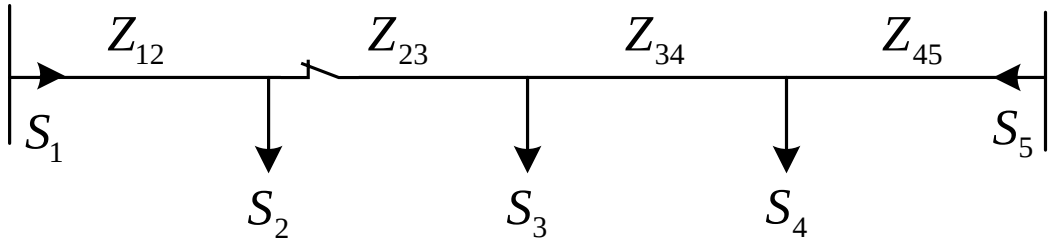
$$S_{43} = S'_{43} + \Delta S_{43} = 20 + 9j + 0.557 + 1.590j = 20.557 + 15.590j \quad (\text{MVA})$$

$$S'_{54} = S_{43} + S_4 = 20.557 + 10.590j + 15 + 8j = 35.557 + 18.590j \quad (\text{MVA})$$

$$\Delta S_{54} = \frac{P'^2_{54} + Q'^2_{54}}{U_4^2}(R_{45} + jX_{45}) = \frac{35.557^2 + 18.590^2}{110^2}(12 + 30j) = 1.597 + 3.991j \quad (\text{MVA})$$

$$S_{54} = S'_{54} + \Delta S_{54} = 35.557 + 18.590j + 1.597 + 3.991j = 37.154 + 22.581j \quad (\text{MVA})$$

ii. .在 B 闭合时



1、计算功率分点

$$\overset{*}{S}_1=\frac{\overset{*}{S}_2(Z_{23}+Z_{34}+Z_{45})+\overset{*}{S}_3(Z_{34}+Z_{45})+\overset{*}{S}_4 Z_{45}}{Z_{12}+Z_{23}+Z_{34}+Z_{45}}+\frac{(\dot{U}_1-\dot{U}_5)U_N}{Z_{12}+Z_{23}+Z_{34}+Z_{45}}$$

$$=\frac{(30-14\mathrm{j})(46+129\mathrm{j})+(20-9\mathrm{j})(26+70\mathrm{j})+(15-8\mathrm{j})(12+30\mathrm{j})}{58+159\mathrm{j}}+\frac{(110\angle 5^\circ-120\angle 10^\circ)\times 110}{58+159\mathrm{j}}$$

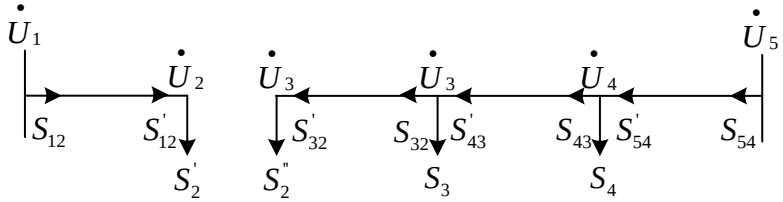
$$=27.190-14.047\mathrm{j}\quad(\mathrm{MVA})$$

$$\overset{*}{S}_5=(\overset{*}{S}_2+\overset{*}{S}_3+\overset{*}{S}_4)-\overset{*}{S}_1=37.810-16.953\mathrm{j}\quad(\mathrm{MVA})$$

$$S_1=27.190+14.047\mathrm{j}\quad(\mathrm{MVA})\qquad S_5=37.810+16.953\mathrm{j}\quad(\mathrm{MVA})$$

功率分点可以设在节点 2

2、计算功率分布



对于节点 1, 2,

$$S'_2=S_1=27.190+14.047\mathrm{j}\quad(\mathrm{MVA})$$

$$S''_2=S_2-S'_2=30+14\mathrm{j}-(27.190+14.047\mathrm{j})=2.810-0.047\mathrm{j}\quad(\mathrm{MVA})$$

$$\Delta S_{12}=\frac{P'^2_{12}+Q'^2_{12}}{U_2^2}(R_{12}+\mathrm{j}X_{12})=\frac{27.190^2+14.047^2}{110^2}(12+30\mathrm{j})=0.929+2.322\mathrm{j}\quad(\mathrm{MVA})$$

$$S_{12}=S'_{12}+\Delta S_{12}=27.190+14.047\mathrm{j}+0.929+2.322\mathrm{j}=28.119+16.369\mathrm{j}\quad(\mathrm{MVA})$$

对于节点 2, 3, 4, 5

$$\Delta S_{32}=\frac{P'^2_{32}+Q'^2_{32}}{U_2^2}(R_{23}+\mathrm{j}X_{23})=\frac{2.810^2+0.047^2}{110^2}(20+59\mathrm{j})=0.013+0.039\mathrm{j}\quad(\mathrm{MVA})$$

$$S_{32}=S'_{32}+\Delta S_{32}=2.810+0.047\mathrm{j}+0.013+0.039\mathrm{j}=2.823+0.086\mathrm{j}\quad(\mathrm{MVA})$$

$$S'_{43}=S_{32}+S_4=2.823+0.086\mathrm{j}+20+9\mathrm{j}=22.823+9.086\mathrm{j}\quad(\mathrm{MVA})$$

$$\Delta S_{43}=\frac{P_{43}'^{2}+Q_{43}'^{2}}{U_3^2}(R_{34}+\mathrm{j}X_{34})=\frac{22.823^2+9.086^2}{110^2}(14+40\mathrm{j})=0.698+1.995\mathrm{j}\quad(\mathrm{MVA})$$

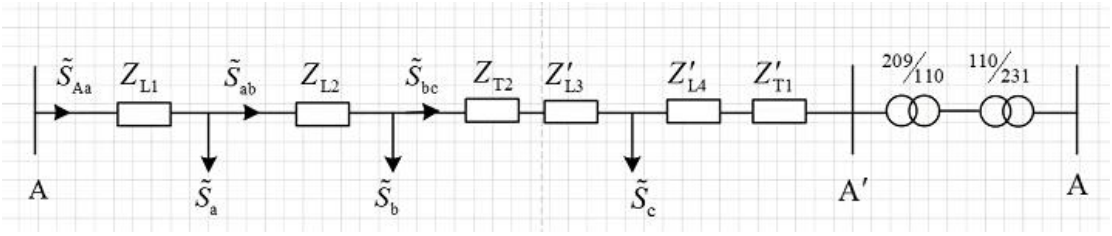
$$S_{43}=S_{43}'+\Delta S_{43}=22.823+9.086\mathrm{j}+0.698+1.995\mathrm{j}=23.521+11.081\mathrm{j}\quad(\mathrm{MVA})$$

$$S_{54}'=S_{43}+S_4=23.521+11.081\mathrm{j}+15+8\mathrm{j}=38.521+19.081\mathrm{j}\quad(\mathrm{MVA})$$

$$\Delta S_{54}=\frac{P_{54}'^{2}+Q_{54}'^{2}}{U_4^2}(R_{45}+\mathrm{j}X_{45})=\frac{38.521^2+19.081^2}{110^2}(12+30\mathrm{j})=1.833+4.582\mathrm{j}\quad(\mathrm{MVA})$$

$$S_{54}=S_{54}'+\Delta S_{54}=38.521+19.081\mathrm{j}+1.833+4.582\mathrm{j}=40.354+23.663\mathrm{j}\quad(\mathrm{MVA})$$

习题 3-19 环形电网如图。线路本位有名值参数为 Z_{l1}=4+j40Ω，Z_{l2}=6+j50Ω，Z_{l3}=1+j18.75Ω，Z_{l4}=0.95+j20Ω；变压器 T1 折算在其低压侧的串联阻抗为 Z_{T1}=0.6+j37Ω；变压器 T2 折算在其高压侧的串联阻抗为 Z_{T2}=1+j25Ω。根节点电压和负荷节点的负荷已在图中标出。采用有名值计算系统潮流。



$$Z_{l3}^{'}=\frac{209^2}{110^2}\cdot Z_{l3} \qquad Z_{l4}^{'}=\frac{209^2}{110^2}\cdot Z_{l4} \qquad Z_{T1}^{'}=\frac{209^2}{110^2}\cdot Z_{T1}$$

$$U_A^{'}=231\cdot\frac{110}{231}\cdot\frac{209}{110}=209 \quad \text{kV}$$

所以 A 与 A’相当于双端供电

$$S_{Aa}^{*}=\frac{S_a^{*}\left(Z_{l2}+Z_{T2}+Z_{l3}^{'}+Z_{l4}^{'}+Z_{T1}^{'}\right)+S_b^{*}\left(Z_{T2}+Z_{l3}^{'}+Z_{l4}^{'}+Z_{T1}^{'}\right)+S_c^{*}\left(Z_{l4}^{'}+Z_{T1}^{'}\right)}{\sum Z}+\frac{\left(U_A-U_A^{'}\right)U_N}{\sum Z}$$

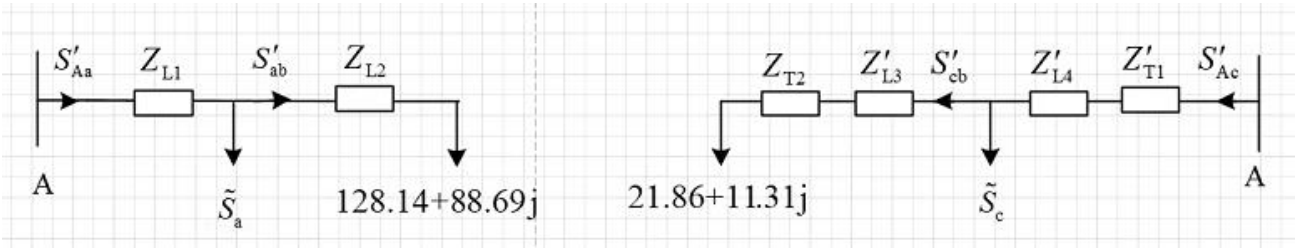
其中 $\sum Z=Z_{l1}+Z_{l2}+Z_{T1}+Z_{l3}^{'}+Z_{l4}^{'}+Z_{T1}^{'}$ 取U_N =220 kV

所以S_{Aa} =178.1408+j118.6918 MVA

$S_{ab}=S_{Aa}-S_a$ =128.1408+j88.6918 MVA

$S_{bc}=S_{ab}-S_b$ =-21.8592-j11.3082 MVA

所以无功分点为 b，从 b 分为两个辐射网。



对于左边 复功率单位为 MVA 线电压单位为 kV

$$S_{ab}^{'}=S_{ab}+\Delta S_{L2}=128.1408+\mathrm{j}88.6918+\frac{128.1408^2+88.6918^2}{220^2}\cdot Z_{l2}=131.1515+\mathrm{j}113.781$$

$$S_{Aa}^{'}=S_{ab}^{'}+S_a+\Delta S_{L2}=181.1515+\mathrm{j}143.781+\frac{181.1515^2+143.781^2}{220^2}\cdot Z_{l1}=185.5721+\mathrm{j}187.9867$$

$$U_a=231-\left(\frac{185.5721\times4+187.9867\times40}{231}+\mathrm{j}\frac{185.5721\times40-187.9867\times4}{231}\right)$$

$$=185.23—\mathrm{j}28.8=197.36\angle-8.41^\circ$$

$$U_b=185.23—\mathrm{j}28.8-\left(\frac{131.1515\times6+113.781\times50}{185.23+\mathrm{j}28.8}+j\frac{131.1515\times50-113.781\times6}{185.23+\mathrm{j}28.8}\right)$$

$$=167.22\angle-18.67^\circ$$

对于右边 复功率单位为 MVA 线电压单位为 kV

$$S_{cb}^{'}=S_{cb}+\Delta S_{T2}+\Delta S_{L3}^{'}=21.8592+j11.3082+\frac{21.8592^2+11.3082^2}{220^2}\cdot\left(Z_{T2}+Z_{l3}^{\prime}\right)=21.917+j12.468$$

$$S_{Ac}^{'}=S_{cb}^{'}+S_c+\Delta S_{T1}^{'}+\Delta S_{L4}^{'}=51.917+j22.468+\frac{51.917^2+22.468^2}{220^2}\cdot\left(Z_{L4}^{'}+Z_{T1}^{'}\right)=52.23+j34.91$$

$$U_c^{'}=209-\left(\frac{52.23\times5.5955+34.91\times205.77}{209}+j\frac{52.23\times205.77-34.91\times5.5955}{209}\right)$$

$$=173.23\text{-}\mathrm{j}50.48=180.44\angle-16.25^\circ$$

$$U_c=\frac{110}{209}\cdot U_c^{'}=94.96\angle-16.25^\circ$$

$$U_b=173.23\text{-}\mathrm{j}50.48-\left(\frac{21.917\times4.61+12.468\times92.6875}{173.23+\mathrm{j}50.48}+j\frac{21.917\times92.6875-12.468\times4.61}{173.23+\mathrm{j}50.48}\right)$$

$$=173.8187\angle-19.85^\circ$$