1-Phase Thyristor Converter

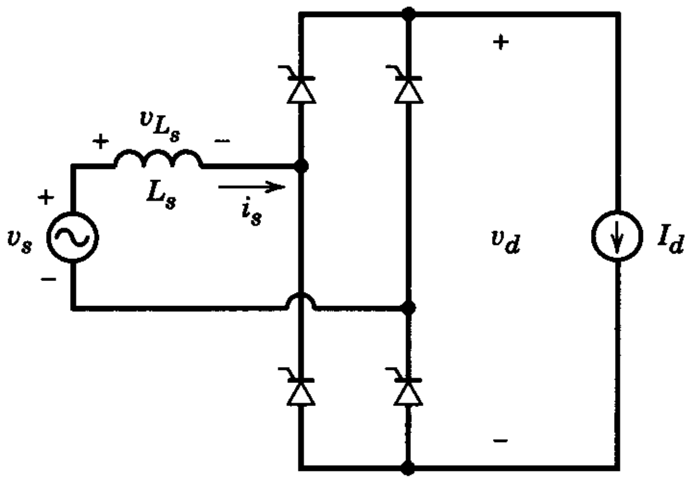

Figure 6-9 Single-phase thyristor converter with a finite L_s and a constant dc current.

- AC side inductance is included, which generally cannot be ignored in practical thyristor converters.
- For a given delay angle, there will be a finite commutation interval
- Commutation process is similar to that in diode bridge rectifiers
- During the commutation interval, all four thyristors conduct, and therefore, v_d=0, and the voltage v_{Ls}=v_s.

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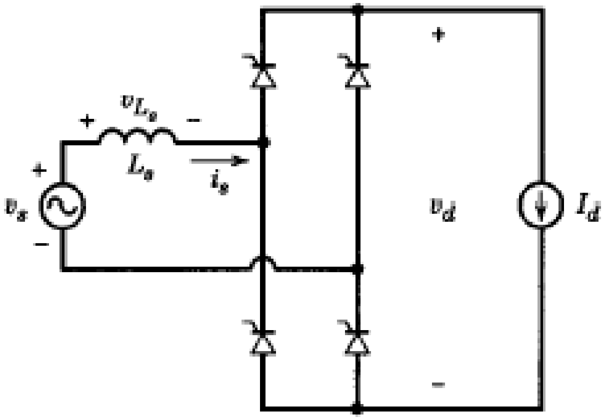
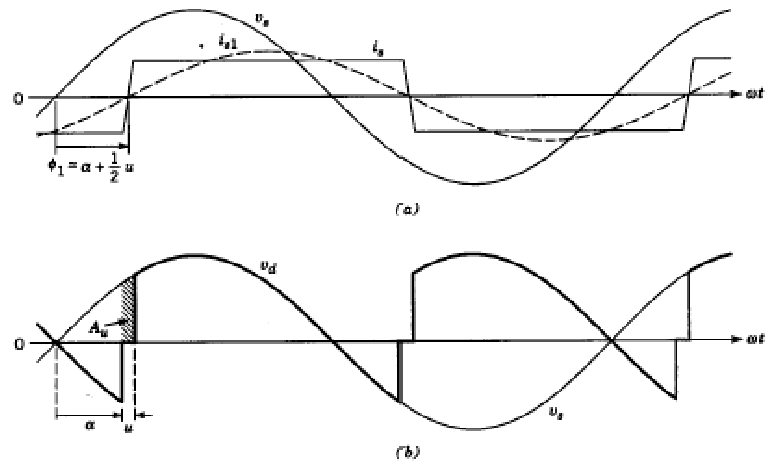




- During the commutation interval, all four thyristors conduct, and therefore, v_d=0, and the voltage v_{Ls}=v_s.

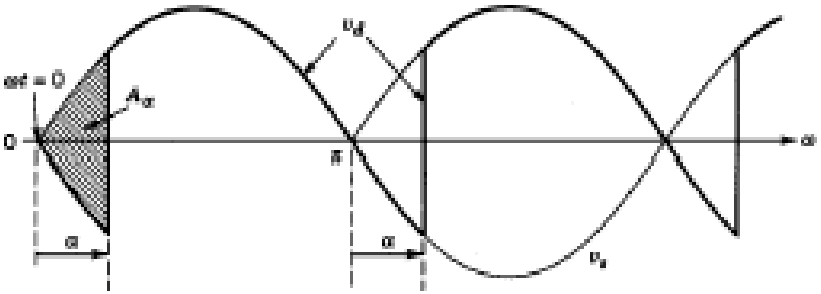
$$v_s = v_{L_s} = L_s \frac{di_s}{dt}$$

$$\therefore \quad A_\mu = \int_{\alpha}^{\alpha+\mu} \sqrt{2}V_s \sin(\omega t)dt = \omega L_s \int_{-I_d}^{I_d} di_s = 2\omega L_s I_d$$

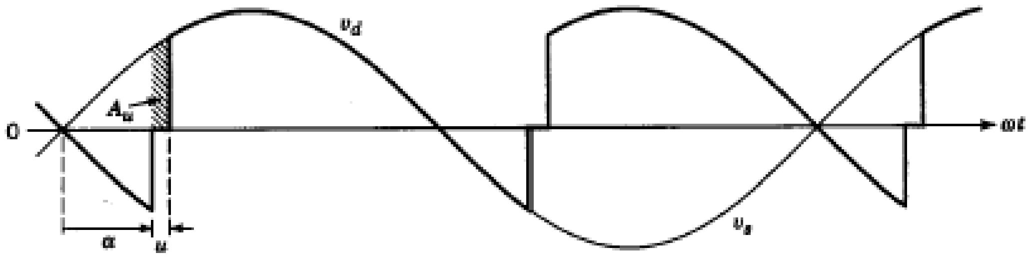
$$\therefore \quad A_\mu = \int_{\alpha}^{\alpha+\mu} \sqrt{2}V_s \sin(\omega t)dt = \sqrt{2}V_s\left[\cos\alpha - \cos(\alpha+\mu)\right] = 2\omega L_s I_d$$

$$\therefore \quad \mu = \cos^{-1}\left[\cos\alpha - \frac{2\omega L_s I_d}{\sqrt{2}V_s}\right] - \alpha$$

1-Phase Thyristor Converter: with and without L_s



without L_s



with L_s

- Voltage drop due to the inclusion of L_s.

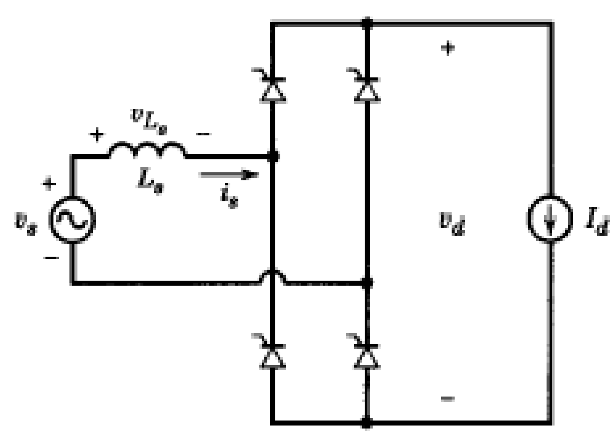
$$\Delta V_{d\mu} = \frac{A_\mu}{\pi} = \frac{2\omega L_s I_d}{\pi}$$

$$V_{d[\mu=0]} = 0.9V_s \cos\alpha$$

$$V_{d[\mu\neq 0]} = 0.9V_s \cos\alpha - \frac{2\omega L_s I_d}{\pi}$$

Example

In the converter circuit, L_s is 5% with the rated voltage of 230 V at 60 Hz and the rated volt-ampere of 5 kVA. Calculate the commutation angle μ and V_d/V_{d0} with the rated input voltage, power of 3 kW, and α=30º.



Solution

$$I_{rated} = \frac{5000}{230} = 21.74\ A$$

$$Z_{base} = \frac{V_{rated}}{I_{rated}} = 10.58\ \Omega$$

$$L_s = \frac{0.05\, Z_{base}}{377} = 1.4\, mH$$

$$\alpha = 30^0$$

$$P_d = V_d I_d = \left[0.9 V_s \cos\alpha - \frac{2}{\pi}\omega L_s I_d\right] I_d = 3000$$

$$I_d = 17.3\ A$$

$$\mu = \cos^{-1}\left[\cos\alpha - \frac{2\omega L_s I_d}{\sqrt{2} V_s}\right] - \alpha = 5.9^0$$

$$V_d = 0.9 V_s \cos\alpha - \frac{2}{\pi}\omega L_s I_d = 173.5\ V$$