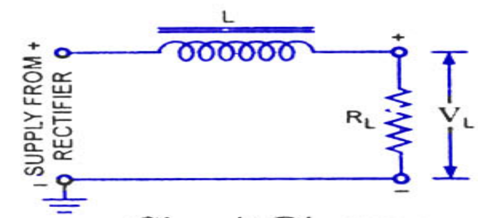
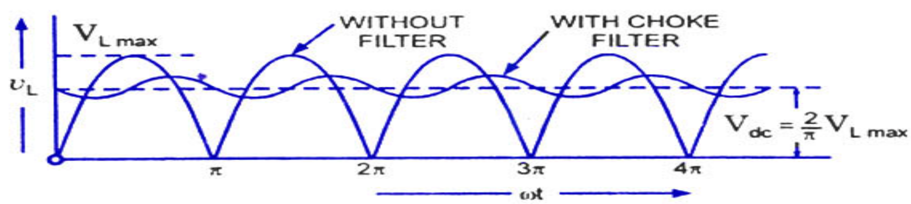
INDUCTOR FILTER

When output of rectifier passes through inductor filter it blocks the ac component and allows dc component.

Circuit diagram of full wave rectifier with inductor filter :



Circuit Diagram



Output Voltage Waveforms
Full-Wave Rectifier With Series Inductor Filter

Output current waveform :

From fourier series analysis, the output current in full wave rectifier is given by

$$i = I_m \left[\frac{2}{\pi} - \frac{4}{\pi} \sum_{\substack{k\ even \\ k \neq 0}} \frac{\cos k\omega t}{(k+1)(k-1)} \right]$$

$$= \frac{2I_m}{\pi} - \frac{4\,\mathrm{Im}}{\pi} \left[\frac{1}{3}\cos 2\omega t + \frac{1}{15}\cos 4\omega t + \frac{1}{35}\cos 6\omega t + \cdots \right]$$

Dc component $I_{dc} = \dfrac{2I_m}{\pi}$

Assuming 3rd and higher terms contributes little output power, neglect these terms. Except 2nd harmonic all other higher harmonics are effictively blocked by inductor practically and these are neglected.

$$= \frac{2I_m}{\pi} - \frac{4\,\mathrm{Im}}{3\pi}\cos 2\omega t$$

The diode, inductor and transformer resistances can be neglected as compared with load resistance.

$$\therefore I_m = \frac{V_m}{R_L}$$

The second harmonic component respresents the ac component (ripple). Impedence of series combinarion of L and R_L which is given by

$$z = \sqrt{R_L^{\ 2} + (2\omega L)2}$$

$$I_m = \frac{V_m}{z}$$

a.c. component $I_m = \frac{V_m}{z} = \frac{V_m}{\sqrt{R_L^{\ 2} + 4\omega^2 l^2}}$

current $i = \frac{2}{\pi}\frac{V_m}{R_L} - \frac{4}{3\pi}\frac{V_m}{\sqrt{R_L^{\ 2} + 4\omega^2 L^2}}\cos(2\omega t - \phi)$

where ϕ is the phase angle between load current and applied voltage and $\phi = \frac{2\omega L}{R_L}$

Here load current lags voltage

Ripple factor, $\gamma = \frac{I'_{rms}}{I_{dc}}$

i.e., ratio of rms vaue of ac component in output to dc value.

$$I'_{rms} = \frac{\dfrac{4V_m}{3\pi\sqrt{R_L{}^2 + (2\omega L)^2}}}{\sqrt{2}}$$

$$I_{dc} = \frac{2V_m}{\pi R_L}$$

$$I'_{rms} = \frac{4V_m}{3\sqrt{2}\pi\sqrt{R_L{}^2 + (2\omega L)^2}} \times \frac{\pi R_L}{2V_m}$$

$$= \frac{2R_L}{3\sqrt{2}\pi\sqrt{R_L{}^2 + (2\omega L)^2}}$$

$$= \frac{\sqrt{2}}{3}\frac{1}{\sqrt{1 + \dfrac{4\omega^2 L^2}{R_L{}^2}}}$$

i) for no load condition $\left(R_L \to \infty, \, open\right)$

$$\gamma = \frac{\sqrt{2}}{3} = 0.472(\approx 0.482)e$$ (ripple factor of FWR with out filter)

(This is a case of poor filtering)

i) If R_L is small, $\frac{4\omega^2 L^2}{R_L} >> 1$, then we can neglect1

$$r = \frac{\sqrt{2}}{3}\frac{R_L}{2\omega L}$$

$$\boxed{r = \frac{R_L}{3\sqrt{2}\omega L}}$$

The ripple factor is directly proportional to R_L and inversely proportional to inductance. But changing load resistance is easy than chagnign L.

Smaller the load resistance smaller the ripple factor. Inductor filter is effective only when load resistance is low i.e., load current is high.

Advantage :

This filter is very effective for small load resistances

Drawbacks :

Inductors are costly, bulky and more power consuming. If load resistance is infinity (high resistance) this filter has poor filtering because ripple factor has near by value of FWR with out filter.