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**Power Factor and Power Factor Correction**

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Power Factor (pf)

$$pf = \frac{\text{Average Power}}{\text{Apparent Power}} = \frac{P_{\text{ave}}}{|S|} = \frac{P_{\text{ave}}}{V_{\text{eff}} I_{\text{eff}}}$$

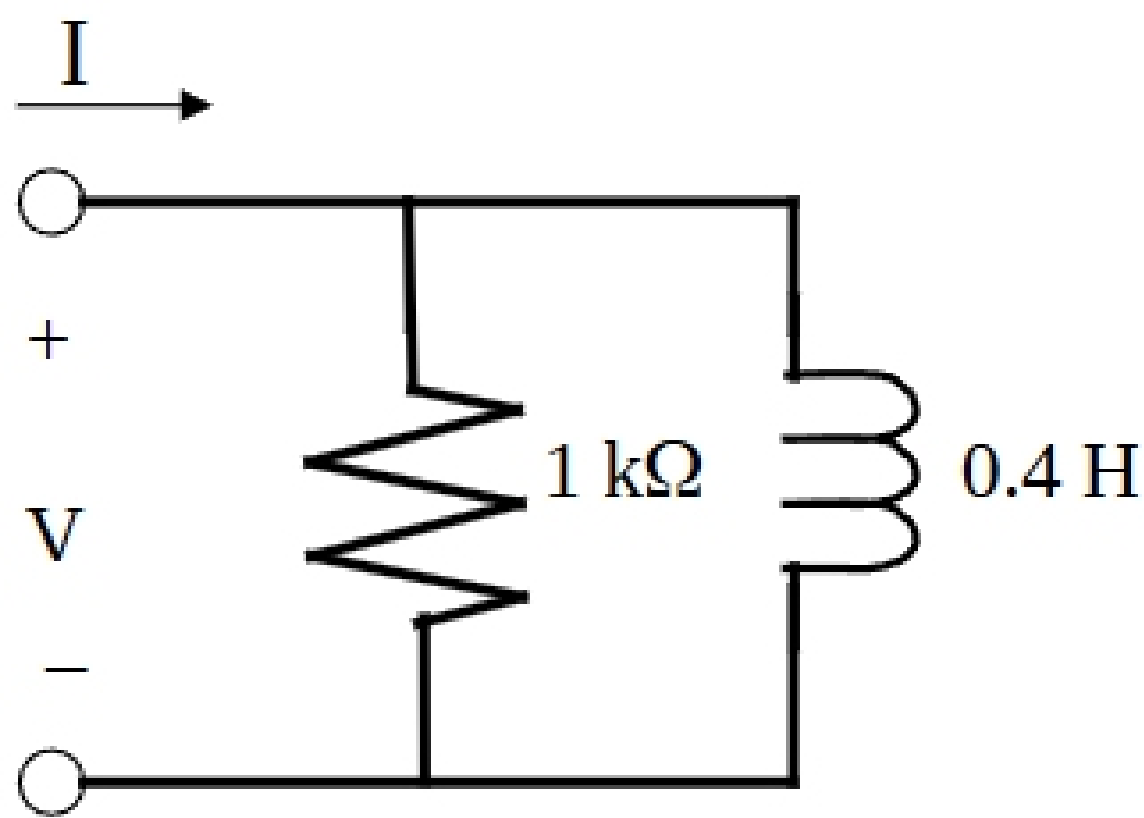
$$pf = \cos(\underbrace{\Theta_v - \Theta_i}_{\text{Power factor angle (pfa)}})$$

Power factor angle (pfa)

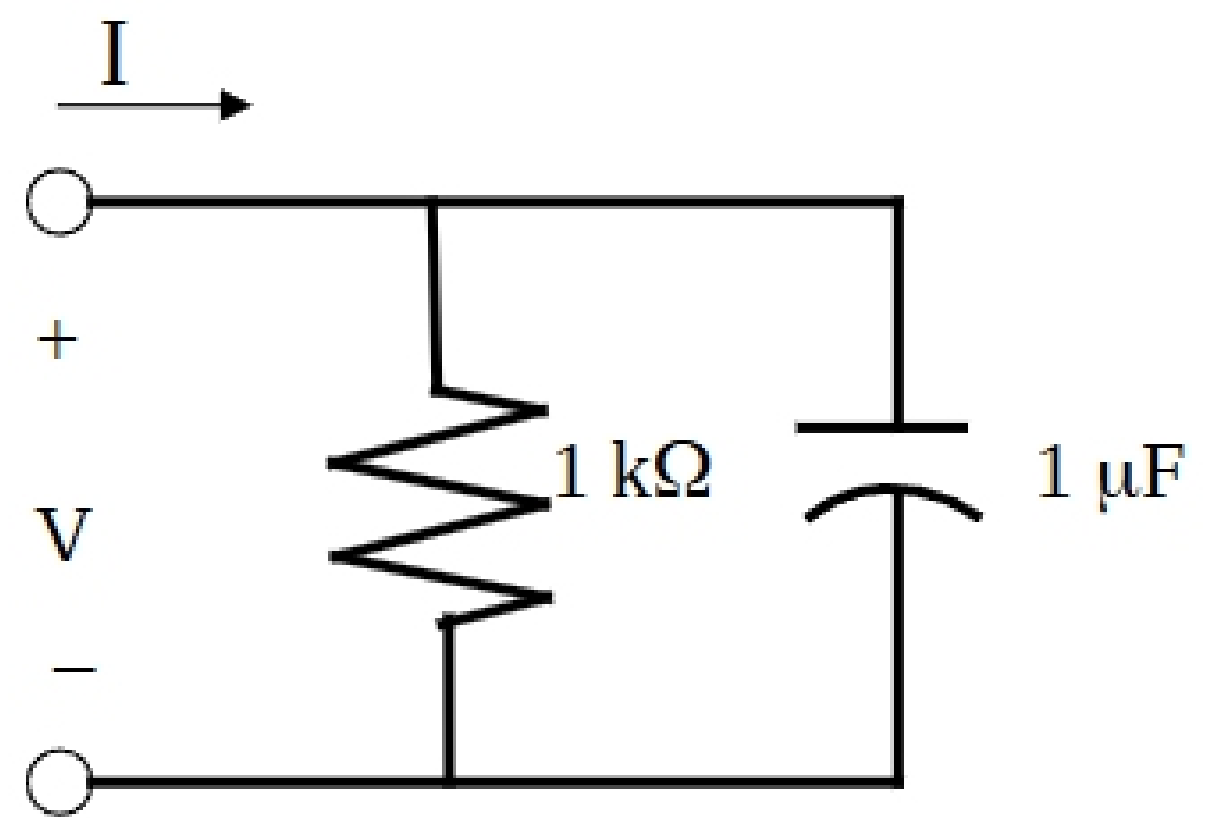
Terminology:

$$\text{pf lagging} - 0 < (\Theta_v - \Theta_i) < 180^\circ$$

$$\text{pf leading} - 0 < (\Theta_i - \Theta_v) < 180^\circ$$



(a)



(b)

(a) Parallel RL circuit illustrating lagging pf.

(b) Parallel RC circuit illustrating leading pf.

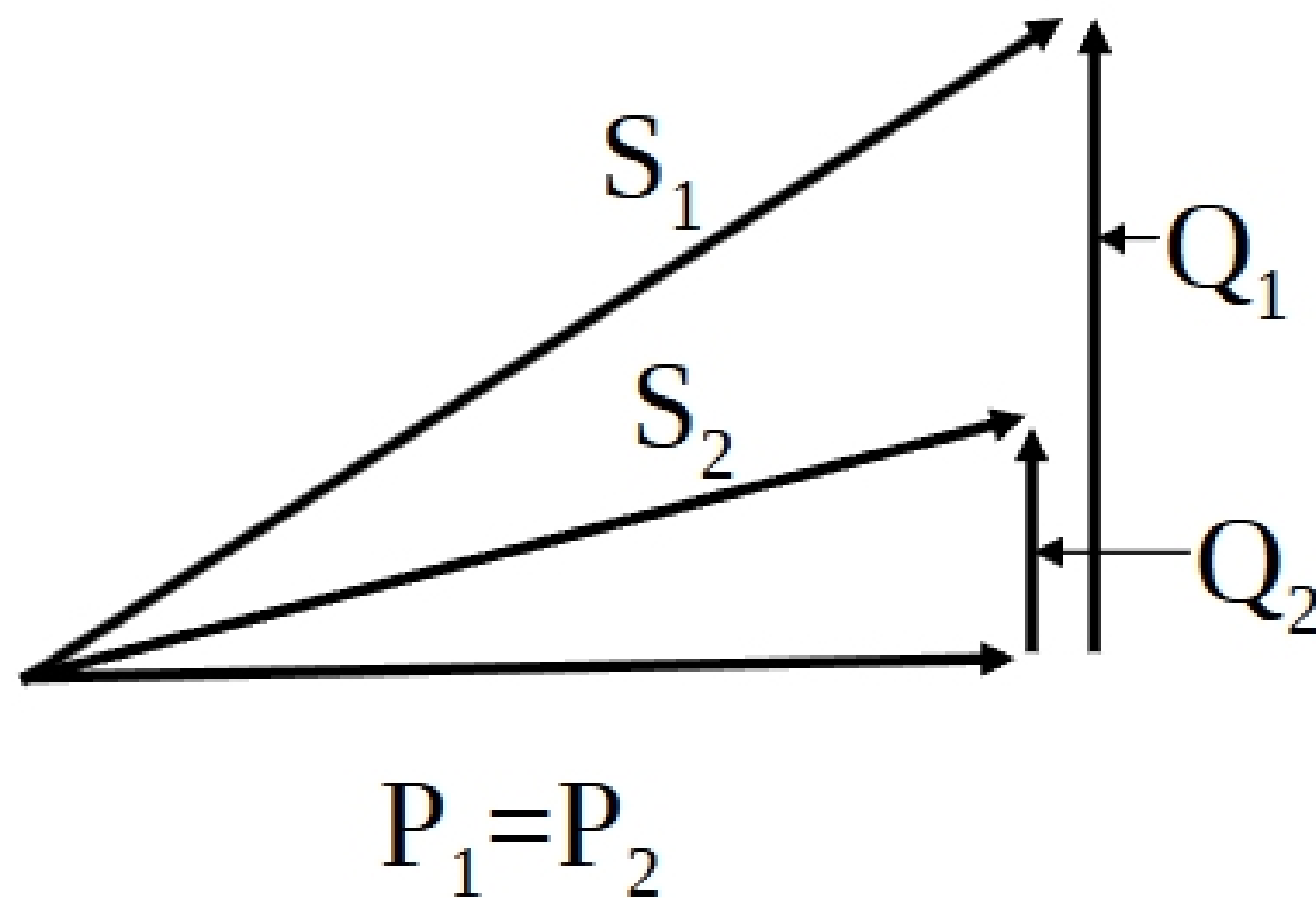
$$pf = \frac{P}{|S|} = \frac{P}{|P + jQ|} = \frac{P}{\sqrt{P^2 + Q^2}}$$

Solving for Q

$$Q = \pm P \sqrt{\frac{1}{pf^2} - 1}$$

$Q > 0$  pf lagging;  $Q < 0$  pf leading

Comparison of systems with same average power but different apparent power.



$S_1$ : low pf, large  $Q$ , Large losses

$S_2$ : high pf, small  $Q$ , Small losses

Conclusion: System with  $S_1$  is inefficient.