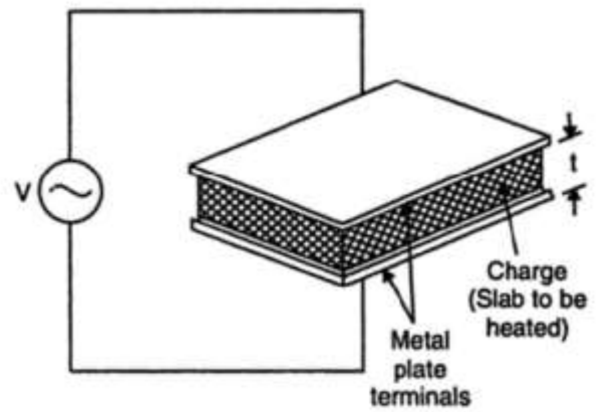
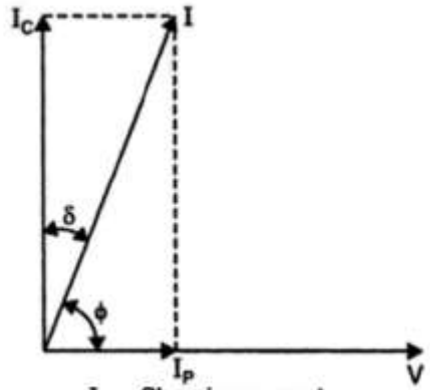
3.4 DIELECTRIC HEATING

Dielectric heating is also sometimes called as high frequency capacitance heating. If non-metallic materials i.e., insulators such as wood, plastics, china clay, glass, ceramics etc are subjected to high voltage ac current, their temperature will increase in temperature is due to the conversion of dielectric loss into heat. The dielectric loss is dependent upon the frequency and high voltage. Therefore, for obtaining high heating effect high voltage at high frequency is usually employed. The metal to be heated is placed between two sheet type electrodes which forms a capacitor as shown in fig. The equivalent circuit and vector diagram are also shown in figure. When A.C supply is connected across the two electrodes, the current drawn by it is leading the voltage exactly 90˚. The angle between voltage and current is slightly less than 90˚ But at high frequencies, the loss becomes large, which is sufficient to heat the dielectric.



Parallel-plate capacitor
-Dielectric heating



Vector diagram of the
parallel-plate capacitor

Figure 3.4.1 Dielectric heating

[Source: "Utilisation of Electrical Power" by R. K. Rajput, Page: 97]

$$Power\ drawn\ from\ supply = VI\cos\phi$$

$$I_C = I = \frac{V}{X_C} = \frac{V}{1/2\pi fC} = 2\pi fCV$$

$$P = V(2\pi fCV)\cos\phi = 2\pi fCV^2\cos\phi$$

$$\phi = (90^o - \delta), \cos\phi = \cos(90^o - \delta) = \sin\delta = \tan\delta = \delta$$

where, δ is very small and is expressed in radians

$$P = 2\pi fCV^2\delta$$

Here,

$$C = \frac{\varepsilon_0 \varepsilon_r A}{t}$$

where

t and A are the thickness and area of the dielectric slab respectively

ϵ_r is the relative permittivity of dielectric

ϵ_0 is the absolute permittivity of vacuum = 8.854×10^{-12} F/m

Advantages:

- Uniform heating is obtained.
- Running cost is low.
- Non conducting materials are heated within a short period.
- Easy heat control.

Applications:

- For food processing.
- For wood processing.
- For drying purpose in textile industry.
- For electronic sewing.