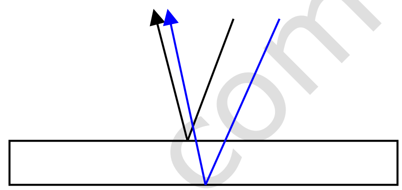
Q- A very thin oil film (n = 1.25) floats on water (n=1.33). What is the thinnest film that produces a strong reflection for green light with a wavelength 500 nm?

The phenomenon is due to reflection from the two surfaces of the thin film. Due to the and hence there is a path difference of 2t between the rays reflected from the upper surface and the lower surface. With that an additional path difference of $\lambda/2$ will be taken for the wave reflected from a denser medium as the reflected wave has a change of phase π if reflected from denser medium.

The wave reflected from the lower surface has to cover a distance 2t (for near normal incidence) in the medium of refractive index μ hence the equivalent path difference will be



$$\delta = \mu * 2t$$

As the refractive index of gasoline is oil is 1.25 and if the thickness of the film is t then the path difference will be 2*1.25*t.

As the ray is reflected from a denser medium at the upper surface (air to oil) and also from the denser medium at the lower surface (oil to water) no additional path difference is required because the total path difference will be $\lambda/2 + \lambda/2 = \lambda$ and the waves are again in phase and hence the total path difference will remain

$$\delta = \mu * 2t$$

For the constructive interference for light of wavelength λ the path difference should be integer multiple of λ and hence we have

$$\delta = \mu * 2t = n\lambda \qquad \{\text{where } n = 1, 2, 3, \ldots\}$$

Gives $t = n\lambda/2\mu$

for t to be minimum and nonzero, n = 1 and we have

$$t = \frac{1*500*10^{-9}}{2*1.25} = 2*10^{-7}\text{m} = 0.2\ \mu\text{m}$$