⑦ A drop of liquid of volume 0.2 cc is spread over the whole surface of tank of water of area 1 sq. m forming a thin film. When white light is incident normally on the film, a dark band corresponding to the wavelength 5500 Å is seen in the spectrum. Find the refractive index of the liquid.

normally $\mu_l > \mu_w$ (air → liquid → water)

Volume = 0.2 cc = 0.2×10^{-6} m^3

Area = 1 sq m

$\therefore t = \frac{\text{volume}}{\text{area}} = 0.2 \times 10^{-6}$ m

for reflected system, $\delta = 2\mu t \cos r + \frac{\lambda}{2}$

for dark $\delta = (2n+1)\frac{\lambda}{2}$

$\therefore 2\mu t \cos r = n\lambda \longrightarrow ①$

$r = 0, \cos r = 1$

$\therefore$ from ① $2\mu t = n\lambda$

$$\mu = \frac{n\lambda}{2t} = \frac{1 \times 5.5 \times 10^{-7}}{2 \times 0.2 \times 10^{-6}}$$

$$\mu = 1.375$$

⑧ A parallel beam of sodium light ($\lambda = 5890\text{Å}$) strikes a film of oil floating on water. When viewed at an angle of 60° from the surface, 8th dark band is seen. If the RI of oil is 1.46. Find the thickness of the film.

$\lambda = 5.890 \times 10^{-7}$ m [air - oil - water; rarer - denser - rarer]

$i = 30°$,

$n = 8$, dark, $\mu = 1.46$, $t = ?$

for reflected system, $\delta = 2\mu t \cos r + \frac{\lambda}{2}$

for dark, $\delta = (2n+1)\frac{\lambda}{2}$

$\therefore 2\mu t \cos r = n\lambda$

$\therefore t = \frac{n\lambda}{2\mu \cos r}$ → ①

$\mu = \frac{\sin i}{\sin r} \Rightarrow \sin r = \frac{\sin i}{\mu} = \frac{1/2}{1.46} = 0.3424$

$\therefore r = 20.02° \Rightarrow \boxed{\cos r = 0.9395}$

from ① $t = \frac{8 \times 5.89 \times 10^{-7}}{2 \times 1.46 \times 0.9395}$

$t = 1.7176 \times 10^{-6}$ m

$t = 17176$ Å

⑨ A parallel beam of light falls normally on an oil film of R.I 1·2 having uniform thickness which spread on water (RI 1·33). Brightness is obtained for wavelengths 5000 Å and 7500 Å and for no wavelength in between. Find the thickness of an oil film.

air - oil - water

rarer - denser - more denser

for reflected system,

$\delta = 2\mu t \cos r \left(\pm \frac{\lambda}{2}\right)$ → will not come

$\delta = 2\mu t \cos r$

for bright, $\delta = n\lambda$

$\therefore 2\mu t \cos r = n\lambda$ → ①

$\lambda_1 < \lambda_2$ Succ. order

n (n+1) or (n-1)

$\therefore 2\mu t \cos r = (n+1)\lambda_1$ → ②

$2\mu t \cos r = n\lambda_2$ → ③

solve $n = 2$

from ② $t = \frac{(n+1)\lambda_1}{2\mu \cos r}$ ($\cos r \to 1$)

$= 6.25 \times 10^{-7}$ m

$= 6250$ Å