The interference patterns of Thin Film

Numerical

Thin film having :

Thickness	- t	**Wavelength**	- λ
Refraction angle	- r	**Refractive index**	- μ

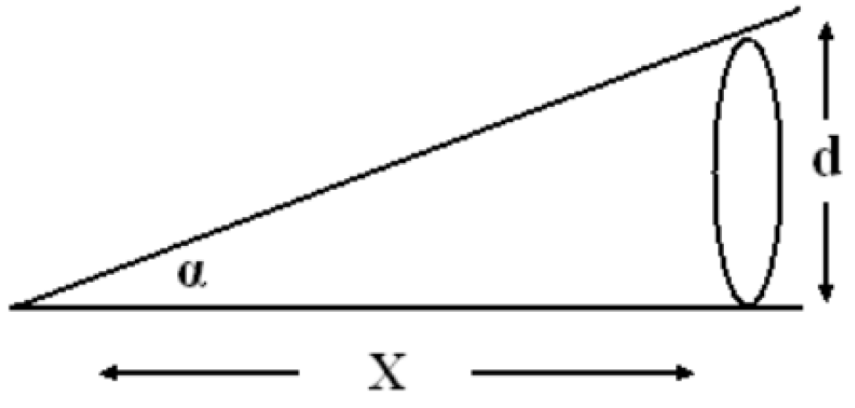
For Constructive Interference $$2\mu t cos r \pm \frac{\lambda}{2} = 2n\frac{\lambda}{2}$$

For Destructive Interference $$2\mu t cos r \pm \frac{\lambda}{2} = (2n \pm 1)\frac{\lambda}{2}$$

Note that, depending upon the situation, that is relative denseness of the film with respect to the medium on the top or bottom,
the factor $\pm\,\lambda/2$ may or may not be present on LHS.

X - Distance between thin wire and edge

d - Diameter of the wire



Width of the Fizau's fringes $$fw = \frac{\lambda}{2\mu \tan\alpha}$$

$$d = X \tan\alpha$$

- **Example (1):** A thin film spread on a road which is optically denser than the film. Thickness of the film is 0.55 μm, while its refractive index is 1.34. Why does the film appear greenish, when viewed in the reflected mode at 68^o? The wavelength of the green light is ~5500 A^o

Solution:

The equation for the P.D. for reflected rays is $P.D_{R,\,I,\,II} = 2\mu t \cos r$

The film will appear greenish, if constructive interference occurs for the green color Thus,

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

As the film is thin, considering least possible value of n (=1)

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

Angle of viewing is same as angle of incidence, thus

$$2\mu t \cos i = \lambda$$

$$2 \times 1.34 \times 5500 \cos i = 5500$$

$$i = 68^o$$

Thus constructive interference occurs in this case when the angle of viewing is 68^o.
The film thus appears greenish, when viewed at 68^o.
The film, at the same angle but from the opposite side will appear less greenish i.e. more purplish.

Example (2):

A thin film of CCl_4 having refractive index 1.46 and thickness 0.1068 μm is spread on water having refractive index 1.33. If viewed at 45^o which color will be seen enhanced?

Solution Angle of viewing = angle of incidence

$$\mu = \frac{sini}{sinr}$$

$$\Rightarrow 1.46 = \frac{sin45}{sinr}$$

$$\Rightarrow sinr = \frac{sin45}{1.46}$$

$$\Rightarrow sinr = 0.48$$

$$\Rightarrow r = 28.97^o$$

We have

$$2\mu t cos r \pm \frac{\lambda}{2} = 2n\frac{\lambda}{2} \text{ (Constructive interference)}$$

$$\Rightarrow 2\mu t cos r = (2n \pm 1)\frac{\lambda}{2}$$

As the film is thin, we will choose the smallest value of n for which the RHS will be nonzero. The n = 0. Subsequently, we will prove that n = 1 is not possible

$$\Rightarrow 2\mu t cos r = \frac{\lambda}{2}$$

$$\Rightarrow 2 \times 1.46 \times 1068 \times cos 28.97 = \frac{\lambda}{2}$$

$$\lambda = 5456\ A^o \Rightarrow \text{Green color will be enhanced}$$

Let us choose n = 1

$$2\mu t cos r = (2n \pm 1)\frac{\lambda}{2}$$

$$\Rightarrow 2 \times 1.46 \times 1068 \times cos28.97 = \frac{3}{2}\lambda$$

$$\Rightarrow \lambda = 1818.89\ A^o$$

This wavelength is beyond the visible spectrum, therefore it is necessary choose n=0. Here $n \geq 1$ has no significance.