1.5 Some losses in optical fibres

The optical fibre does not experience the loss in terms of intensity of light. However, the presence of impurities, scattering at the edges, geometry of structure and dispersion of light causes some losses.

Transmission loss/attenuation (α)

If the intensity of light at the second end of the optical fibre be I_{out} and intensity at first end be I_{in}

The attenuation, $\alpha = -\log\left(\frac{I_{out}}{I_{in}}\right)$

In decibel the attenuation, $\alpha = -\frac{10}{L}\log\left(\frac{I_{out}}{I_{in}}\right)dB$

Other possible losses in optical fibre

The possible losses are absorption, scattering, radiation losses and geometric losses.

The absorption loss

The absorption losses appears as

- Extrinsic losses
- Intrinsic losses
- Atomic defect losses

Extrinsic losses

The extrinsic loss appears due to presence of impurities which absorbed the light. The impurities may be due to presence of Fe, Cr, Co and Cu in the core material. The impurities could absorb the energy that may reemit the absorbed energy during the de excitation in different wavelength which causes loss of intensity to original light of specific wavelength.

Intrinsic loss

Since, the fibre core itself absorbs some quantity of energy which is known as intrinsic loss.

Scattering and radiation losses

Since, optic fibre contains glass as core, where impurities are present. The scattering of light at these impurities causes Raleyeigh scattering where the energy of scattered wave directly proportional to 4^{th} power ($E = 1/\lambda^4$) of wavelength. Therefore, small change of energy causes 4^{th} power of wavelength. The loss of energy at couplers and interfaces are known as radiative losses.

Geometrical loss

Due to bending of optical fibres there are 2 types of losses from macroscopic bending and microscopic bending. If the fibre be rounded as big circle of known radius of curvature, the loss may be less called macroscopic bending loss.

For small bending of fibre the loss of energy in microscopic bending is larger. Some time the irregularities in the dimensions cause geometrical losses.

Dispersion loss

In the transmission of light through optical fibres the pulse width varies due to dispersion of light through the core. The loss of intensity caused as result of dispersion of light is due to

- Material dispersion
- Waveguide dispersion
- Inter modal dispersion

Material dispersion

The refractive index of core causes the changes in the wavelength/frequency called material dispersion. If narrow pulse passes trough fibre, causes broadening of pulse width due to material property. It can be overcome by highly monochromatic source of light. The single mode fibre could reduce the material dispersion to maximum extent.

Waveguide dispersion

The optical fibre can be considered as circular wave guide where refractive index varies with modes of propagation with wavelength causes wave guide dispersion.