4.2 LASER FOR MEASUREMENT OF LENGTH

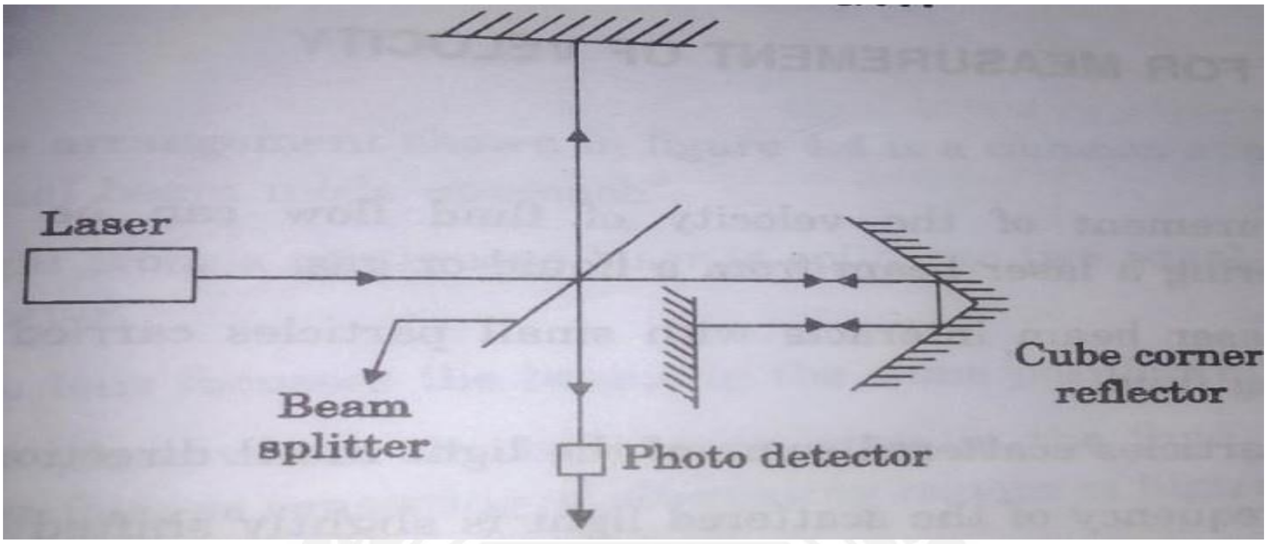

Figure 4.2.1 Laser-based Length Measurements

[Source: "Optical Fibre Communications" by J.M.Senior, Page:522]

The large coherence length and high output intensity coupled with a low divergence enables the laser t find applications in precision length measurements, using interfermetric techniques. Here the laser beam is split into two parts, and they are made to interfere after traversing two different paths. One of the beam emerging from the beam splitter is reflected by a fixed reflector and the other by a cube corner reflector. The two reflected beam interfere to produce either constructive or destructive interference.

As the reflecting surface is moved one would get alternatively constructive and destructive interference which can be detected with the help of a photo detector. Since the change from a constructive to a constructive and destructive interference corresponds to a change of a distance of half a wave length. One can measure the distance transverse by the surface on which the reflector is mounted by counting the number of fringes which have crossed the photo detector.

Accuracies upto 0.1µm can be obtained by using such a technique. This technique is used can be obtained by using such a technique. This technique is used for accurate positioning of aircraft components

On a machine tool, for calibration and testing of testing of machine tools, for comparision with standards.

LASER FOR MEASUREMENT OF VELOCITY

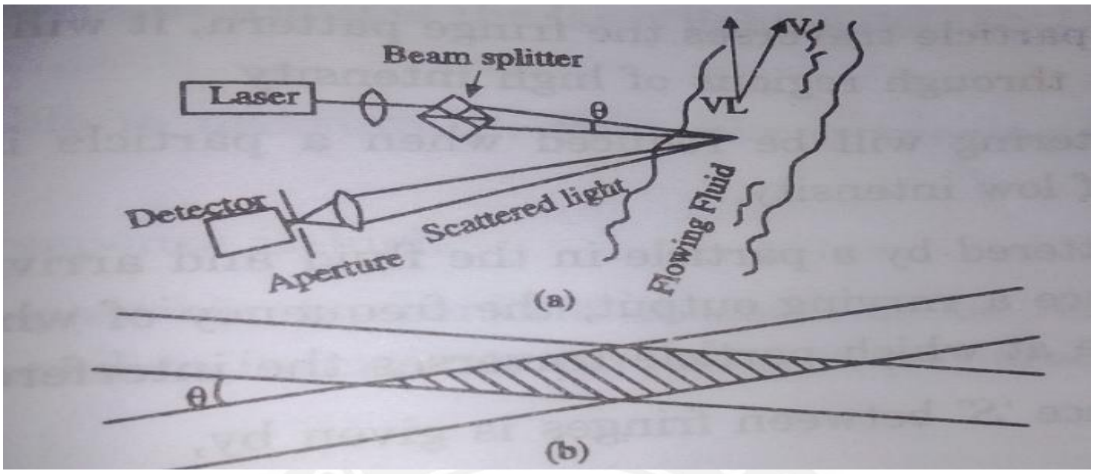

Figure 4.2.2 Laser-based Velocity Measurements

[Source: "Optical Fibre Communications" by J.M.Senior, Page:524]

Principle

Measurement of the velocity of fluid flow can be performed by scattering a laser beam from a liquid or gas. The laser beam interacts with small particles carried along by the flowing fluid. The particles scattered light is slightly shifted by the Doppler Effect. The magnitude of the frequency shift is proportional to the velocity of the fluid. Measurement of the frequency shift directly gives the flow velocity.

Construction:

The measurement techniques basically consist of a focusing laser light at a point within the flowing fluid. Light scattered from the fluid or from particles entrained within the fluid flow is collected and focused on an optical detector. Signal processing of the detector output yields the magnitude of the Doppler frequency shift and hence the velocity of flow.

Working:

The approach towards measurement is called Dual beam approach. Light from a continuous laser is split into two equal parts by a beam splitter. Light from a continuous laser is split into two equal parts by a beam splitter. The lens focuses the beam to the same position in the fluid. The place where the two beams crosses in the fluid, they interfere to form fringes consisting of alternating regions of high and low intensity.

when the particle transverse the fringe pattern, it will scatter light when it passes through regions of high intensity.

The scattering will be reduced when a particle is passing through regions of low intensity. Light scattered by a particles in the fluid and arriving at the detector will produce a varying output, the frequency of which is proportional to the rate at which particle transverses the interferences fringes. The distance S between fringes is given by

θ – Angle between two converging beams λ- wavelength

If a particle passes through the fringes with a component of velocity V_T in the direction perpendicular to the fringes the output signal from the detector will be modulated at a frequency 'f' which is given by

A factor 'n' is introduced in the above equation,

This factor is introduced because the wavelength λ is the wavelength in the fluid which differs from the vacuum wavelength λ0, by a factor equal to 'n'.

Advantages

- No critical contacts with a fluid. Flow is not disturbed.
- Hot or corrosive fluids can be measured without problems.
- The nano spectral width of the laser light makes accurate measurement possible.

It is possible to measure the flow velocity ranging from cm/s to 100s of m/s.

- Speed of response is high.
- Makes it possible to perform measurements related to transient conditions and to investigate turbulent flow characteristics

Disadvantages

These require the necessity of having scattering entrained in the fluid. Impossible to measure flow rate of very cleaned fluid.

Additional cost is encountered because of the introduction of scattering centers in case very clean fluids.

It is possible to seed the flow with scattering particles. But the constraint is that particles seeded into the flow must be very small so as to follow the flow faithfully.