2. Gas Detection with a Laser

Every gas is composed of atoms or molecules. For instance, if the target gas was hydrogen fluoride, then 1 atom of hydrogen would have combined with 1 atom of fluoride to give 1 molecule of hydrogen fluoride. These molecules have various frequencies or wavelengths at which they resonate or vibrate. See Fig.1. These are known as the absorption wavelengths because when the molecules absorb a portion of the light energy, they vibrate at these wavelengths. Because molecules of other gases are different, these gases absorb light at different wavelengths from the target gas. Wavelengths for gas detection are chosen in regions that the absorption of the target gas does not interfere with the absorption wavelength of any other gases that may be present.

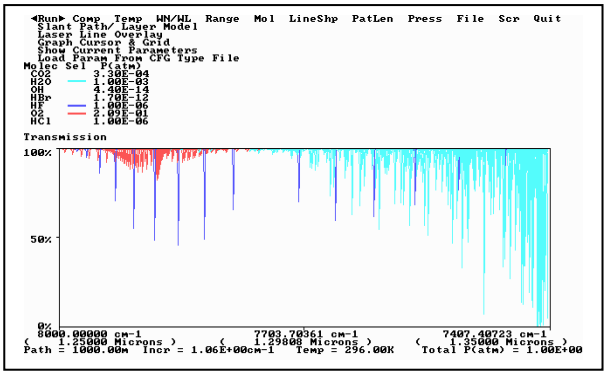

Fig.1.

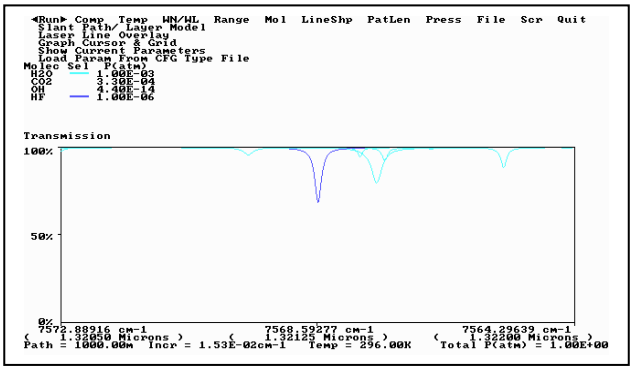

Fig.2.

A laser beam can be chosen which operates at a specific absorption wavelength for this target gas. See Fig.2. The laser operating wavelength is kept stable by housing it in a temperature-controlled box. A fluctuating (saw-tooth) current is used to drive the laser and this causes the wavelength to change slightly so that the laser scans across the absorption wavelength.
The laser beam has a signal superimposed on it at a different frequency. See Fig.3. When the gas molecule is struck by the laser beam, the molecule is induced to vibrate. These vibrations affect the laser beam by changing this superimposed frequency. This difference is detected by a receiver in the instrument, after the laser beam is reflected back.

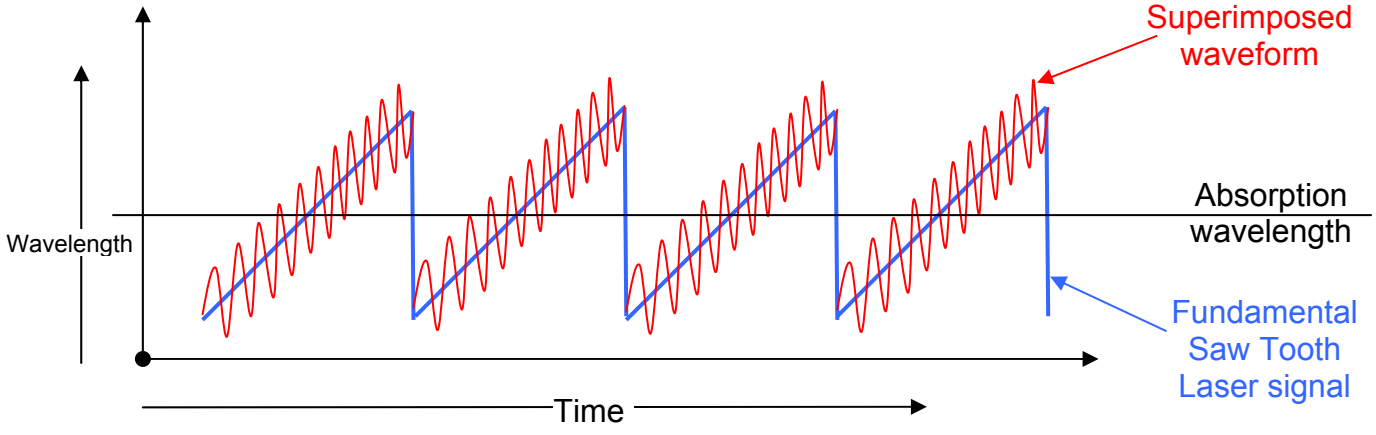

Fig.3.

2. Gas Detection with a Laser, (continued)

The difference in the superimposed signal, together with the intensity of the returning beam, is used by a computer to obtain a measurement of the target gas concentration. The laser operates in the Near Infra- Red spectrum (1300 to 1700 nano meters) and cannot be seen with the eye. It has a line width of about 0.3 nm and is concentrated and very intense. For the same power output, it is able to penetrate dust and steam better than a visible laser.

The laser beam is transmitted to a retro reflector made with a special type of corner cube arrangement. This causes the signal to be reflected directly back to the detector in the transmitter enclosure. With the appropriate number of reflectors, path lengths up to 1 km can be traversed.