CO_2 Laser

Characteristics of CO_2 Laser:

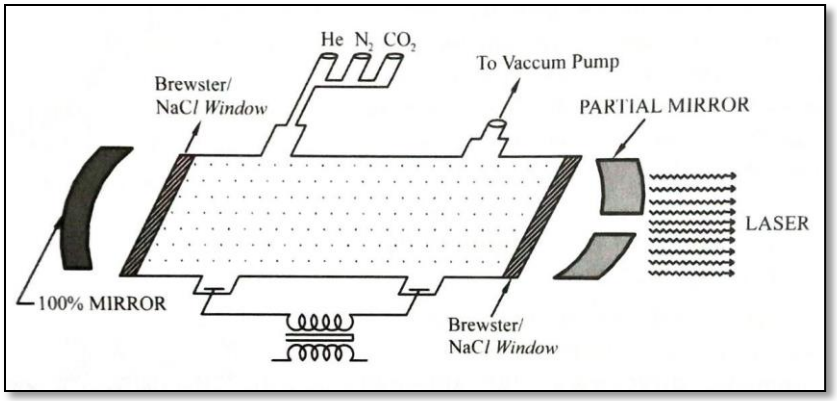
Type	Molecular Gas Laser
Active Medium	Gas mixture (CO_2 , N_2 & He)
Active Centre	CO_2
Pumping Method	Electric discharge method, Inelastic atom-atom collision
Optical Resonator	Metallic mirrors of Gold
Power Output	10 KW
Nature of output	Continuous or Pulsed
Wavelength output	9.6 μm & 10.6 μm

Principle:

- N_2atoms raised to the excited state through electron collision.
- Through resonant energy transfer the excited N_2atoms raises the CO_2 molecule to its excited state.
- Laser transition takes place between the vibrational energy levels of CO_2 and the high intensity laser beam is emitted from the partial reflector.

Construction:

- CO_2, N_2& Helium are taken in 1:4:5 ratio inside the discharge tube.
- Provision is given for filling the different gases inside the discharge tube and the discharge tube is connected to the Vacuum pump.
- NaCl window is placed at the ends of the discharge tube.
- The tube is connected to the power supply to produce electric discharge.
- 100% reflector and the partial reflector are placed outside the discharge tube as shown infig.



Working:

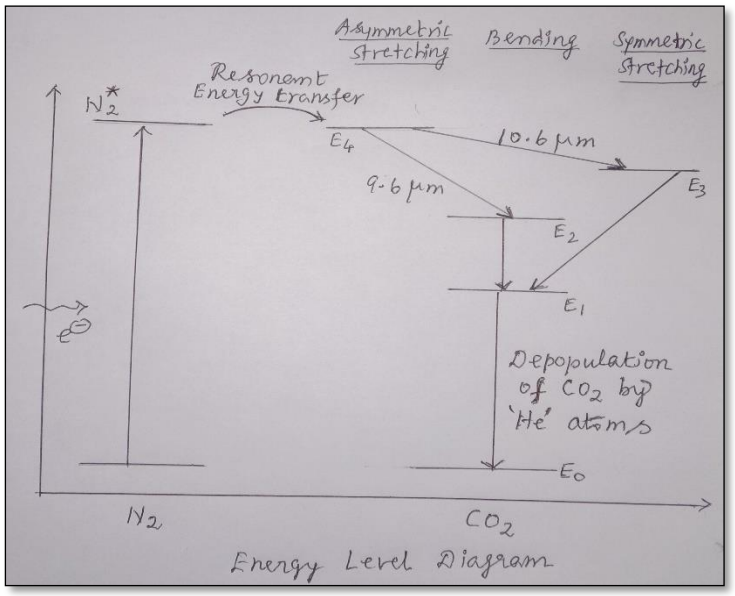
- Voltage is applied to the gas mixture and the gas is discharged.
- The electrons from the discharge interacts with the N_2 atoms and raised to excited state.

$$e^- + N_2 \rightarrow N_2^*$$

- The excited N_2 atoms interacts with ground state CO_2 molecule to the E_4 by resonant energy transfer.

$$N_2^* + CO_2 \rightarrow CO_2^* + N_2$$

- Now population inversion takes place between the E_4 & E_2 and E_4& E_3.
- Initially photons are emitted by spontaneous transition.
- These photons stimulates the CO_2 molecule to produce coherent photons.



- The laser transition from **E_4 toE_2**emits the light with the wavelength **9.6 μm.**
- The laser transition from **E_4 toE_3**emits the light with the wavelength **10.6 μm.**
- **NaCl window transmits only parallel polarized photons and reflects other photons.**
- No. of coherent photons are increased through multiple reflections between perfect and partial reflector.
- Finally the high intensity laser beam is emitted through the partial reflector.
- Now the CO_2molecules jumps from E_3& $E_2$to E_1.
- **"He" depopulates** the **CO_2 molecules** from E_1 to E_0(ground state).

Advantages:

- The construction of CO_2 laser is simple.
- It has high efficiency.
- It has very high output power.
- The output power can be increased by increasing the length of the discharge tube.

Disadvantages:

- Corrosion may occur at the surface of the discharge tube.
- Due to its very high power accidental exposure may damage our eyes since it is invisible.

Applications:

- It is widely used in material processing.
- It is suitable for open air communication.
- It is used in remote sensing.
- It is used in the treatment of Liver and Lung diseases.
- It is mostly used in Neurosurgery and general surgery.
- It is used to perform Microsurgery and bloodless operations.