L.8: Development of repetitively pulsed Xenon Chloride Excimer Laser

Excimer lasers are gas discharge lasers that produce efficient intense short pulses in the UV spectral range. They find numerous applications in scientific, technological, medical and industrial fields. A repetitively xenon chloride excimer laser was designed and developed at chemical and excimer laser section of RRCAT. The photograph of the developed excimer laser system was depicted in fig. L.8.1. The laser system mainly consists of metal chamber, laser head, pre-ionizer, gas circulatory unit and excitation circuit. Excimer lasers use inert and HCl gas mixture at pressure of about 2-3 atm. Material for its construction was care fully chosen to suit a) highly reactive & corrosive gases b) high voltages c) high pressure operating conditions and d) UV environment. The system was made vacuum as well as pressure tight. The laser head consists of two nickel electrodes and inbuilt automatic UV sparks pre-ionizer. The discharge has an effective length of 50 cm and its inter-electrode distance and discharge width are 2.3 cm and 1 cm respectively. The gas circulatory system mainly consists of a magnetically coupled tangential blower and a set of water cooled finned tube heat exchangers.

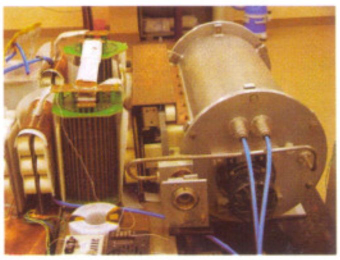

Fig.L.8.1 Photograph of the laser developed.

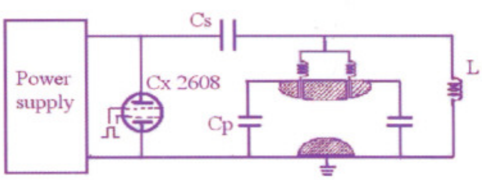

Fig.L.8.2. Schematic diagram of the set up and excitation circuit

The schematic of charge-transfer electric circuit adopted for this laser was directed in Fig.L.8.2. The excitation circuit primarily constitute a high voltage power supply, a thyratron, main energy storage capacitors and peaking capacitors. The storage capacitor Cs is charged from capacitor charging HV power supply up to 25 kV. Thyratron was used as discharge switch. Peaking capacitor Cp were placed very close to the laser head to reduce loop inductance. On switching the thyratron Cp gets pulsed charged and pump the active medium. The optical cavity is formed by a flat total reflecting mirror and a plane quartz window separated by 120 cm. The optimized gas mixture was found to be 5 mbar HCl, 80 mbar Xeon and Neon with total pressure of 2500 mbar. The laser could produce optical pulses of energy 150 mJ at 150 Hz with electrical to optical conversion efficiency of 1%. The peak current handled by the thyratron is 12 kA. The single fill gas life time was found to be 2x106 shots for 20% reduction of energy without any halogen injection.

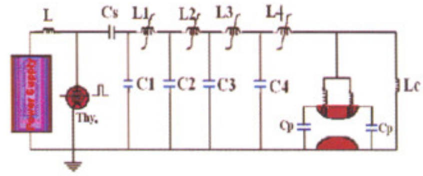

Fig.L.8.3a Excitation circuit with MPC

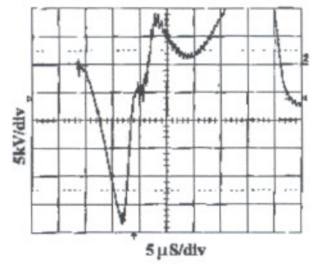

Fig. L8.3b Initial voltage

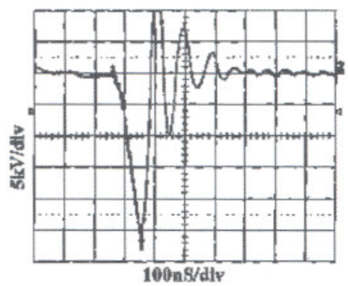

Fig. L.8.3c Discharge voltage

Thyratron is a strategic, imported and expensive component. It has limited life. With a view to reducing the stress on the thyratron and there by increasing life time of this discharge switch, a 4- stage MPC circuit (Fig.L.8.3a) was developed and incorporated in the excitation circuit. Voltage pulses of 8 µs rise time (Fig. L.8.3b) have been compressed to 100 ns (Fig. L.8.3c) in successive 4 stages of MPC with a compression factor of 80. The laser could produce pulses of energy 150 mJ at operating frequency of 150 Hz. Here, the peak pulse current through the thyratron is reduced from 12 kA to 0.2 kA. This reduction in stresses is expected to increase in life time of the thyratron.

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