MEASUREMENT OF NO_2 CONCENTRATION IN THE ATMOSPHERE USING ABSORPTION TYPE TWO-WAVELENGTH DYE LASER RADAR

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ABSTRACT

The absorption type laser radar that can automatically and remotely measure the NO_2 concentration in the atmosphere has been developed. The NO_2 absorption spectrum has a train of definite peaks and valleys between about 4000Å and 5000Å. A two-wavelength laser beam corresponding to a peak and a valley of NO_2 absorption spectrum is transmitted and the intensity of scattered light from the target is measured. The concentration is obtained using the relation (1).

$$\bar{n}L=\frac{1}{\sigma_1-\sigma_2}\ln\frac{I_{01}\,I_2}{I_1\,I_{02}} \qquad (1)$$

where $\bar{n}$: mean value of NO_2 concentration, σ_1,σ_2: cross sections of absorption at λ_1 and λ_2 respectively, L: light path length, I_1,I_2: intensities of detected laser power scattered from the target at wavelengths λ_1 and λ_2, I_{01},I_{02}: intensities of monitoring laser power at wavelengths λ_1 and λ_2.

The transmitter consists of a pulsed DAHC organic dye laser and simple optics. The dye laser is pumped by a pulsed N_2 laser and generates two wavelengths (4630Å) and (4658Å) alternately (peak power 5kW, pulse width 5ns, spectrum width 3Å, repetition rate 75pps).

The detecting system consists of a reflection-type 50cm-diameter telescope, optical filters for intercepting background-noise, a photo-multiplier and a photodiode (laser power monitor). Elimination of the monochromator allows less attenuation of received light and results in larger s/n ratios. Signals are digitalized, calculated by a TOSBAC-40C mini-computer and the values of NO_2 concentration are type out. The above measurement is automatically performed by the signal from a clock.

This apparatus has been set up on the sixth floor of Toshiba R & D Center. Automatic measurement at one minute interval was carried out for

30 hours, detecting the scattered light from the wall of a building about 1 km apart from the observing point. The result was consistent with the result obtained by the Saltzman method. Concentration transition of 3 ppb was reliably detected when 1000 data are averaged. This corresponds to a relative intensity measurement with a precision of 0.2%.