CHAPTER III

UV RADIATION DOSE MEASUREMENT

A. Detection and Estimation of UV Energy

The measurement of ultraviolet radiations differs from that of visible radiation as the eye cannot be used directly as a detecting instrument. Some other means of detection must be used. There are three available classes of detecting instruments, i) Physical detectors : Radiometric detectors, phototube, Photo-voltaic cell and Fluorescence ii) Chemical detectors : Acetone, Photographic plate, Photographic paper, Zinc Sulphide etc., and iii) Biological detectors : Human skin, Erythema, Pigmentation, killing of Bacteria etc.

B. UV - dosimetry using Thermoluminescence Dosimeters (TLDs) :

Dosimetry is the fundamental discipline which concerns with the measurement of radiation dose given or absorbed and as such, meets the exigencies arising out of the needs for safe handling and effective use of radiation. For this purpose simple appropriate, portable, inexpensive, sensitive and accurate techniques have been developed. Just as it is required to measure the X - or gamma ray dose accurately for taking the radiation protection measures, it has become important to measure the dose from UV light also because of extensive use of UV lamps in industries and hospitals. Thermoluminescence dosimeters (TLDs) offer the easiest yet sensitive means of measuring UV exposure on a routine basis which is considered a sophisticated measurement to make. UV measurements can be made by either of the two methods i) Intrinsic response of the TL phosphor or ii) UV - induced transfer TL from pre gamma - irradiated and partially erased phosphor. With TLD phosphors such as $CaSO_4$-Dy phosphor both the methods have been found to complement each other. However, along-with this, several TL-phosphors have been developed to have desirable features for the dosimetry of UV radiation, like LiF:Mg:Ti, $CaSO_4$:Tm, natural CaF_2, CaF_2:Dy TLD-200, MgO, Al_2O_3:Si:Ti etc. Recent work on NaCl:Tl indicate that the material exhibits qualities suitable for UV - dosimetry.[20]

C. Application of Thermoluminescence Dosimetry :

On account of several favourable characteristics such as high sensitivity, small size, ability to cover wide range of exposure/dose, reusability, insensitive to environmental conditions, thermoluminescent dosimeters find applications in several areas.[21]

Predominent applications of thermoluminescent dosimeters have been in the field of radiation dosimetry and radiation protection. The dosimeters have been widely used for in-phantom and in-vivo dosimetry, in medical applications. Another area, where thermoluminescent dosimeters have found use is personnel monitoring of radiation workers. The advantages of TLD system over the commonly used film method have since been recognised and the film dosimeters have been or are being replaced by TLD system in several laboratories.

On account of their ability to integrate over long periods of time and measure very low exposures, they have been widely employed for environmental monitoring of doses of the order of a few micro Gray. The TLDs have been employed in protection monitoring for measurements such as leakage radiation levels on and around source containers, air scalter measurements around open top installations, area monitoring around radiation installations etc. Rapid fading of certain phosphors such as $CaSO_4$:Dy has been employed for the estimation of time of exposure after irradiation.

TL dosimeters have also been used for thermal and fast neutron dosimetry. Since TL phosphors insensitive to thermal neutrons are also available, combination of dosimeters can be employed for estimation of gamma and thermal neutron dose in mixed field.

Other applications of TL dosimetry include archaeological dating i.e. dating of ancient potteries and ceramics, space dosimetry, dosimetry of non-ionizing radiations such as UV and microwave dosimetry. If UV dosimeter has sensitivity close to the erythermal response of the human skin, it would provide a measure of the erythermally effective value of the UV energy.

D. Radiation Units :

Certain quantities and units are used particularly in the area of ionizing radiations. The units such as Curie, Roentgen, Rad and Rem which are adopted previously are not coherent with the SI units, but their temporary use with the SI has been approved while the transition to SI units takes place. The International Commission on Radiation Units (ICRU) and International Commission on Radiological Protection (ICRP) have adopted the special names, Becqueral (Bq) Gray (Gy) and Sievert (SV) for the SI derived units of activation energy, absorbed dose and dose equivalent.

i) Activity units : The Becqueral (Bq) is the SI unit of activity (radioactive disintegration rate). The Curie (Ci), the special unit of activity is equal to 3.7×10^{10} Bq.

ii) Exposure Unit : The unit of exposure is Roentgen (R). It is defined as that quantity of X-or gamma radiation which produces 1 esu of charge in 1 ml of dry air at NTP. The energy absorbed in 1g of air due to 1 R of exposure is 87.5 ergs.

iii) Absorbed Dose : The energy absorbed per unit mass of the material is measured in RAD (Radiation Absorbed Dose). 100 ergs of energy absorbed in 1 g of material is defined as 1 RAD. The Gray (Gy), the SI unit of absorbed, dose, is the absorbed dose when the energy per unit mass imparted to matter by ionizing radiation is 1 Joule/kg.

The relation between RAD and Gy is,

$$1 \text{ RAD} = 10^{-2} \text{ Gy}$$

The unit kerma is related to absorbed dose. The term kerma is acronym for kinetic energy released per unit mass.

iv) Dose Equivalent Units : The same dose of different types of radiations produces different effects in a material. Therefore, if a person is exposed to radiation, another unit for measuring quantity of dose equivalent must be used. This is obtained by multiplying the absorbed dose with a factor which depends on the biological effectiveness of radiation. This unit is called Rem (Roentgen Equivalent Man) and defined as absorbed dose of any radiation which produces the same biological effect as that of 1 RAD of X - or gamma rays. The population dose therefore is measured in Rem.

The Sievert (Sv), the SI unit of dose equivalent is the dose equivalent when the absorbed dose of ionizing radiation multiplied by the stipulated dimensionless factor is 1 J/kg

and, 1 Rem = 10^{-2} Sv.