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Basic Concept of Radiation and Detail Study of Biological Effects of Radiation

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ABSTRACT

Here, we will know about the basic concept of radiation, all laws of radiation, black body concept and we will deal about a detail study of biological effect of radiation.

KEYWORDS: *Black body, Dose, Effect, Exposure, Radiation, Temperature, etc*

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INTRODUCTION

Radiation is that mode of heat transfer by which heat is transferred from one body to another. Like other process of heat transfer (conduction and convection) material medium is not necessary in radiation. Radiation can travel through vacuum too. The energy radiated by a hot body is called radiant energy or radiation energy. Heat radiation is electromagnetic in nature. The position of the heat radiation in the electromagnetic spectrum is beyond the red end of the spectrum. Some substances absorb heat radiation to a great or less degree and thereby get heated to a more or less extent. Glass, metal, wood etc. absorb heat radiation and become heated while sock salt, quartz, fluorspar etc. allow heat radiation to pass through themselves without getting much warmed. The heat radiation obeys all the laws of light like reflection, refraction, polarization, diffraction, interference, rectilinear propagation etc. A concept of perfectly black body is also related to the radiation.

STUDY

Laws of radiation

1. **Kirchhoff's law-** At a given temperature and a given wavelength the ratio of the emissive power to the absorptive power is the same for all bodies and is equal to the emissive power of a perfectly black body at that temperature.
2. **Stefan's law-** According to Stefan's law of radiation the rate of emission of radiant energy by unit area of a perfectly black body is directly proportional to the fourth power of it's absolute temperature.

   $E=\sigma T^4$

Where σ is called Stefan's constant, T is absolute temperature and E is the radiant energy.

Stefan- Boltzmann law- Boltzmann modified this law he states that the rate of emission of radiant energy by unit area of a perfectly black body is directly proportional to the difference between fourth power of it's absolute temperature and fourth power of surrounding.

$E= \sigma(T^4-t^4)$

Where t= temperature of surrounding.

3. **Wien's displacement law-** Wien has shown that the wavelength corresponding to maximum energy is inversely proportional to the absolute temperature.

The constant is called wien's displacement constant and has a value 2898microm-K.

In other words this law states that the curve of black body radiation for different temperatures will maximum at different wavelengths. The shift of that maximum is a direct consequence of Planck's law of radiation.

4. Rayleigh-Jeans law- This law was a useful but not successful at establishing the functional form of the spectra of thermal radiation.

According to Rayleigh-Jeans radiation the energy density

K= Boltzmann constant, T= absolute temperature.

This formula is an empirical measurement for low frequencies but fails increasingly for higher frequencies.

5. Planck's law of radiation- Max Karl Ernst Ludwig Planck thought of the wall of cavity to contain electrical generator of all frequency. He assumed that they emit radiations into cavity and additionally absorb radiations from it solely within the multiples of an exact minimum energy (E=hυ). Wherever, h= Planck's constant and υ= frequency.

Concept of black body

A perfectly black body is one which absorbs all the incoming light or radiation of any wavelength which fall on it and doesn't reflect any. When the black body is heated to a suitable high temperature, it emits full or total radiation. It is a perfect absorber as well as a perfect radiator.

In actual practice, a perfectly black body is not available till. Platinum black and Lamp black both are the nearest approach to a black body.

Biological effects of radiation

Whether the source of radiation is natural or man-made, whether it is a small dose of radiation or a high dose. There will be some biological effects. Radiation causes ionization of atoms which may affect molecules, cells, tissues, organs and the whole body.

The biological effects of radiation are typically classified into two parts. The first part consists of high doses of radiation over short periods of time producing accute or short term effects. The second part consists of exposure to low dose of radiation over an large periods of time producing chronic or long term effects.

High doses tend to kill cells while the low doses can harm living things by damaging their cells. The cells might stop functioning and change them.

High dose Effects	
Dose(radiation)	**Effect observed**
15-25	Blood count changes in a group of people
50	Blood count changes in an individual
100	Vomiting (threshold)
150	Death(threshold)
320-360	LD 50/60 with minimal care
480-540	LD 50/60 with supportive medical care
1100	LD 50/60 with intensive medical care(bone marrow transplant)

The other high doses effects are given below-

1. **Skin Burns-** Skin effects are more likely to occur with exposure to low energy gamma, x-ray or beta radiation. Large amount of energy of the radiation is deposited in the skin surface.
2. **Hair loss-** It is also called epilation and it is similar to skin effects and can occur after acute doses of about 500 radiations.
3. **Sterility-** It is temporary or permanent in males, depending upon the dose. It is permanent in females but it requires a higher dose. 400 radiationsis required to produce permanent sterility.
4. **Cataract-** Cataract's meaning a clouding of the lens of the eye. It appears to have a threshold of about 200 radiations. The main reason for producing cataracts is neutrons. Since eye has a high water content which is effective in stopping neutrons.

Summary of Biological response to high doses of radiation

<5 radiation- No immediate effects

~5 radiation to 50 radiation- slight blood changes

~50 rad to 150 rad- symptoms of fatigue, vomiting etc.

~ 150 rad to 100 rad- symptoms appear immediately. At about 300-500 rad, upto one half of the people exposed will die within 60 days without intensive medical attention. The reason of death is due to the destruction of the blood forming organs.

~1100rad to 2000 rad- The chances of mortality increases to 100% upto two weeks. After few days the things get critical very quickly since the gastrointestinal system is destroyed. Once the GI system ceases to function nothing can be done and Medical care is for comfort only.

>2000rad - Death is certain. At doses above 5000 radiation the brain and muscles can no longer control the body functions. Nothing can be done and Medical care is for comfort only.

Low dose effect-

There are three general effects resulting from exposure to low doses of radiation. These are-

1. **Genetic effect-** The effect is suffered by the offspring of the individual exposed. Radiation is an example of a physical magnetic agent. This effect involves the mutation of very specific cells namely the egg or sperm cells. Radiation increases the spontaneous mutation rate but does not produce any new mutations.
2. **Somatic effect-** This effect is primarily suffered by the individual exposed. Since cancer is the primary result, it is also called the Carcinogenic effect. Unlike genetic effects of radiation induced cancer is well documented. Many studies have been completed which directly link the induction of cancer and exposure to radiation. Some of the popular and their associated cancers are-

A. Lung cancer- uranium miners
B. Thyroid cancer- therapy patients
C. Bone cancer- radium dial painters
D. Skin cancer- radiologist
E. Breast cancer- therapy patients
F. Leukemia- radiologist, therapy patients, bomb survivor

3. **In-Utero effect-** The in-utero effect involves the production of malformations in developing embryos. Radiation is a physical teratogenic agent. There are many chemical agents (such as thalidomide) and many biological agents (such as the viruses which cause German measles) that can also produce malformations while the baby is still in the embryonic or fetal stage of development. The effects from in-utero exposure can be

considered a subset of the general category of somatic effects. The malformation produced does not indicate a genetic effect since it is the embryo that is exposed, not the reproductive cells of the parents. The actual effects of exposure in-utero that will be observed will depend upon the stage of fetal development at the time of the exposure: Weeks Post Conception 0 - 1 (preimplantation) 2 - 7 (organogenesis) 8 - 40 (fetal stage) Effect Intrauterine death Developmental abnormalities/growth retardation/cancer same as above with lower risk plus possible functional abnormalities.

CONCLUSION

Radiation can affect cells. High doses of radiation affect many cells, which can result in tissue/organ damage, which ultimately yields one of the Acute Radiation Syndromes. Even normally radio-resistant cells, such as those in the brain, cannot withstand the cell killing capability of very high radiation doses.

REFERENCES

[1] Lal B., Subrahmanyam N., Hemne P. S. (2014). Heat and Thermodynamics (297,300,301,305,308). S. Chand and Company PVT.LTD.

[2] Report NCRP (1989). Guidance on radiation received in space activities (98).

[3] Manual Reactor Concept. Biological effect of radiation (9-1, 9-2, 9-4, 9-11-9-19).USNRC Technical Training Centre.