PROPERTIES OF RADIOACTIVE MATERIALS AND METHODS OF THEIR MEASUREMENT

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Regardless of what we do on a typical day, go to the university, work, or stay home, in each case we are being exposed to radiation. Whether we know it or not we are being exposed to radioactivity everyday of our life. Radiation and radioactive materials are part of our environment. They are everywhere and have been around since the universe was born. Radiation reaches us from outer space and is also emitted from radioactive materials in the ground, in the sea and in the air. Even our bodies are radioactive. Nowadays we are also exposed to radiation that we create, from X-rays used in medicine, from televisions and from certain types of measuring equipment in industry. That is why it is important to know the radiation level to which we are exposed.

There are three main types of radiation emitted from radioactive atoms. These are alpha, beta and gamma radiation. Alpha radiation consists of alpha particles. An alpha particle is identical to the nucleus of a helium atom, which comprises two protons and two neutrons. Beta radiation consists of high energy electrons emitted from the nucleus. These electrons have not come from the electron shells or energy levels around the nucleus. Instead, they form when a neutron splits into a proton and an electron. The electron then shoots out of the nucleus at high speed. Gamma radiation is very short wavelength - high frequency - electromagnetic radiation. This is similar to other types of electromagnetic radiation such as visible light and x-rays, which can travel long distances.

As is well known, radiation cannot be felt, smelled, seen, heard or tested. However with the use of instruments it can be detected and measured. For this purpose different technical devices are used such as:

- *Photographic film.*Photographic film goes darker when it absorbs radiation, just like it does when it absorbs visible light. The more radiation the film absorbs, the darker it is when it is developed. People who work with radiation wear film badges, which are checked regularly to monitor the levels of radiation absorbed.
- *The Golden Leaf Electroscope.* Dry air is normally a good insulator, so a charged electroscope will stay that way, as the charge cannot escape. When an electroscope is charged, the gold leaf sticks out, because the charges on the gold repel the charges on the metal stalk. When *a* ***radioactive source comes near***, the air is ionized, and starts to conduct electricity. This means that the charge can "leak" away, the electroscope discharges and ***the gold leaf falls***.
- *The Spark Counter.* It is an early form of detector that uses the ionizing effect of radioactivity, and for this reason it works best with alpha particles. A high voltage is applied between the gauze and the wire, and adjusted until it is just below the voltage required to produce sparks. When a ***radioactive source is brought near***,

the ***air*** between the gauze and the wire is ***ionized***, and ***sparks jump*** where particles pass.

• *The Cloud Chamber.* There are two types of cloud chamber: the "expansion" type and the "diffusion" type. In both types, alpha or beta particles leave trails in the vapor in the chamber, rather like high-altitude aircraft leave trails in the sky. The chamber contains a supersaturated vapor (e.g. methylated spirits), which condenses into droplets when disturbed and ionized by the passage of a particle (alpha particles are best for this). We can clearly see the direction and energy of the particles (low energy particles only leave short trails). Occasionally, a particle collides with an air molecule and changes direction. A cloud chamber shows the randomness of radioactive emissions clearly. Expansion cloud chambers use a vacuum pump to *briefly* produce the right conditions for trails to form, whilst the *diffusion type* uses solid carbon dioxide to cool the bottom of the chamber and produce a temperature gradient in which trails can be seen continuously.

• *Scintillation Detector.* It works by the radiation striking a suitable material (such as sodium iodide), and producing a tiny flash of light. This is amplified by a "photomultiplier tube" which results in a burst of electrons large enough to be detected. Scintillation detectors form the basis of the hand-held instruments used to monitor contamination in nuclear power stations. They can recognize the difference between alpha, beta and gamma radiation, and make different noises (such as bleeps or clicks) accordingly.

• *Solid-State Detector* is the most up-to-date instrument. It is used in particle-accelerator laboratories to show the results of high-energy collisions, with banks of it clustered around the collision site, feeding data into huge computers. The way it works is *way* beyond what we need for GCSEs, but basically they are similar to the CCD Silicon chips used in video cameras.

• *Geiger-Muller tube.*Most people use a "Geiger Counter" for measuring radioactivity. This is actually a Geiger-Müller tube (GM tube) with some form of counter attached, which usually tells us the number of particles detected per minute ("counts per minute").Each time it absorbs radiation, it transmits an electrical pulse to a counting machine. This makes a clicking sound or displays the count rate. The greater the frequency of clicks, or the higher the count rate, the more radiation the Geiger-Muller tube is absorbing.

On the whole, important considerations for choosing a particular type of detection device include the application, the type of radiation, the energy of the radiation, and the level of sensitivity needed.

Over a period of less than a century, radiation detectors have steadily extended human senses into entirely new realms. They have virtually provided man with a sixth sense. A great many reliable instruments for detecting and measuring ionizing radiation are now available, ranging from instruments that are widely used as routine tools in nuclear laboratories, to highly sophisticated complex instrument systems designed for very special applications. Detectors have not only investigated the nature of nuclear radiation and radiation emitters, but they have served the beneficial application of radiation in medicine, industry, and research, and also the control of any hazards that might arise from ionizing radiation. The rapid development of measuring instruments and their wide availability, however, has brought with it new problems: one can see highly sophisticated instruments being used in many places where a simpler instrument would be sufficient, for example multichannel analyzers might be used where a single-channel analyzer would serve.

All things considered, radiation measuring instruments have given man the ability to characterize his environment at levels of precision that even a few years ago would have been considered impossible. For many elements, sensitivity has reached the level of parts per billion - very much smaller concentrations than have ever before been accessible to any measurements.

REFERENCES

1. Al-Jarallah, M.I., Fazal-ur-Rehman, Musazay, M.S. and Aksoy, A., Radiation Measurements 40, pp. 625-629(2005).
2. http://en.wikipedia.org/wiki/Solid-state_nuclear_track_detector
3. http://en.wikipedia.org/wiki/Photographic_emulsion
4. http://www.suite101.com/content/nuclear-radiation-detectors-101-a31736
5. http://www.darvill.clara.net/nucrad/detect.html
6. http://www.bo.infn.it/opera/scanning/ESS/index.html
7. http://encyclopedia2.thefreedictionary.com/Nuclear+Radiation+Detectors

ABOUT ELECTRIC POWER SAFETY IN THE XXI

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The electric power industry is a leading industry in the world.It is important not only in the economy of any industrialized country, but even for the underdeveloped countries of the world.Advantages of electric power are the following:light transmission over long distances, conversion into other kinds of energy.Featureof electricity is in its generation and consumption.It is a universal, technically and economically effective form of energy.

Power plants are always a danger. The degree of danger depends on thepower installation, pressure and coolant temperature, spin speed, electrical parameters (voltage, current), coolants, etc.

According to the Federal Law dated 21.07.1997 № 116-FZ "On industrial safety" in the category of dangerous industrial facilities there is includedpower equipment installed in the computer rooms of thermal power plants (TPP). Ensuring the safety of hydroelectric power plants (HPP) is provided by the Federal Law dated 21.07.1997 № 117-FZ "Hydraulic structuressafety."

Changes of electric power in the Russian Federation are resulted in a delay of the technical re-equipment of electric power and in the increase in the share of power with