FAQ's:

1. Define white radiation.

Ans. When a high energy electron beam is incident upon a sample, its interaction with the sample leads to the production of broad wavelength band of radiation called white radiation. It is due to the loss of certain amount of energy by the electron beam as it enters the electron cloud of the sample atom.

2. What is photo-electric effect?

Ans. If a high energy electron strikes the bound atomic electron and the energy of the impinging electron is greater than the energy of bound atomic electron, it is possible that the bound atomic electron will be ejected from its atomic position . this process is called photo electric effect.

3. Describe any detector used in X-rays.

Ans. An important type of detector used in X-rays is Gieger-Muller counter. A Geiger counter (Geiger-Muller tube) is a device used for the detection and measurement of all types of radiation: alpha, beta and gamma radiation. Basically, it consists of a pair of electrodes surrounded by a gas. The electrodes have a high voltage across them. The gas used is usually Helium or Argon. When radiation enters the tube it can ionize the gas. The ions (and electrons) are attracted to the electrodes and an electric current is produced which is counted. After the pulse is counted, the charged ions become neutralized, and the Geiger counter is ready to record another pulse.

4. What are the advantages of X-ray fluorescence.

Ans. Several advantages of X-ray fluorescence are mentioned below:

a)Non-destructive technique: The analysed samples are not destroyed or changed by exposure to X-rays. They can thus be saved for future reference or used for other types of testing that may be destructive.

b)Minimal sample preparation required: Many samples can be examined with little or no pre-treatment.

c)Fast: X-ray spectrometry enables chemical compositions to be determined in seconds.

d)Easy to use: Modern instruments run under computer control, with effective software to handle measurement set-up and results calculation. No skilled handling is required.

e)Cost-effective: The technique involves a significantly lowered cost is per sample.

5. What is the application of X-rays in packaging industry.

Ans. X-ray inspection has traditionally been implemented to the greatest extent in the food packaging industry. Products that are packaged in bottles or cans are ideally suited for high speed X-ray inspection. Such units routinely process and inspect more than 20 samples per second. The inspection using X-rays is highly suitable for such products as there is the possibility of contamination of the product by metals, plastics, glass, bone fragments, etc. in the processing plant environment. An advantage of X-ray analysis over the metal detector equipment is their ability to detect all kinds of contaminants.

6. What is the application of X-rays in fruit and vegetable industry.

Ans. X-ray imaging of apples has been used for the detection of codling

moth damage, watercore disease and core rot in apples. Detection of codling moth larvae in apples has been investigated using CT (computer tomography), film, as well as linescan X-ray systems. High quality images can be obtained using film and CT, but the techniques cannot be used for the bulk inspection. Watercore disease is a physiological disorder wherein fluid accumulates around the vascular bundles of the fruit, leading initially to sweetening but eventually to core rot. Efforts to detect watercore have also been reported using CT, film and systems. Recognition of the disease is based on darkening of the affected areas in X-ray images, presumably because of fluid filling. Results are sketchy, with severe cases easily identifiable.

More limited research has been reported on a wide variety of food products. CT imaging has been used to determine maturity in tomatoes, monitor internal fruit changes in peaches during ripening, detection of core breakdown in pears and Woolly breakdown in nectarines. Linescan imaging has proven effective for detecting voids and rot in onions with more than 90% accuracy, as well as insect infestation in guava fruit. Other detection studies conducted using X-rays include inspection of seed weevil in mango, translucency in pineapple, hollow heart in potato, insect infestation in peaches and measure the micro-structure of meat emulsions.

7. What are X-ray monochromators?

Ans. X-ray monochromators are devices used to produce a monochromatic beam of radiation. These consist of a pair of collimators, one serving as slit and other as a dispersing agent. These collimators consist of a series of closely packed metal plates that absorb all the radiations except the parellel beams. Modern X-ray monochromators also employ a microprocessor controlled motors that help in automatic and independant driving of crystal and the detector devices, eliminating the use of gear based systems.

8. What are the different ways in which the X-rays are produced?

Ans. X-rays are generated by following methods:

a)Bombarding metal target with a beam of high energy electrons.

b)Exposing a substance to a primary beam of X-rays to generate a secondary beam of X-rays of lower energy, whenever required.

c)Using a radioactive source emitting X-rays during its decay process.

d)From a synchrotron radiation source.

9. List the qualities of an ideal detector in X-ray instrumentation.

Ans.An ideal detector should possess three important qualities:

a)Sensitivity: It should be sensitive to the appropriate photon energies so that all the given range of wavelengths or energies is detected.

b)Proportionality: The voltage pulse produced in the detector as a result of the interaction with the X-ray photon should be proportional to the energy of photon entering the detector.

c)Linearity: It is a property in which the output pulses are produced at this same rate by a detector at which the X-ray photons enters the same.

10. What properties of X-rays make these radiations suitable for wide range of applications?

Ans. The properties like the non-charged behaviour, travelling in straight lines with the speed of light and a tendency to induce fluorescence in the materials like calcium tungstate and zinc sulphide are important properties of X-rays. In addition, the specific properties of X-rays with respect to their application include their high penetration power which gives them an ability to penetrate the solid materials of considerable thickness and the property that these can expose photographic films.

11. Briefly describe the phenomenon of X-ray production.

Ans. X-ray photons are a form of electromagnetic radiation produced following the ejection of an inner orbital electron and subsequent transition of atomic orbital electrons from states of high to low energy. When a monochromatic beam of X-ray photons falls onto a given specimen three basic phenomena may result, namely absorption, scatter or fluorescence. The coherently scattered photons may undergo subsequent interference leading in turn to the generation of diffraction maxima. These three basic phenomena form the bases of three important X-ray methods: the absorption technique, which is the basis of radiographic analysis; the scattering effect, which is the basis of X-ray diffraction; and the fluorescence effect, which is the basis of XRF spectrometry.

12. Why do manufacturers need X□ray inspection systems?

Ans. Manufacturers need X□ray inspection systems in order to protect their brands, as a poor quality product will damage their reputation with consumers and their future business. The quality of products needs to be controlled and verified on the production line and incorporating X□ray inspection into a business, whether in the food, beverage or pharmaceutical industry, is one of the most effective ways to safeguard against potential issues. Reducing the risk of poor quality products will also help manufacturers to increase their profitability as they avoid unnecessary and costly product recalls.

13. What are the latest and advanced features of X□ray inspection systems?

Ans. The latest X□ray inspection systems provide enhanced graphical interfaces for ease□of□use and, combined with the versatility of new software solutions, also provide on□screen self diagnostics, full multi□ lane and multi□view capability, enabling operators to monitor the systems on one screen. Combining the information saves valuable time for the

operator as it allows more products to be inspected more quickly.

14. What is the most effective X-ray technique that can be employed for fat analysis?

Ans. Fat analysis is the process of determining the fat content in a given product, which is crucial for food manufacturers to meet the requirements of increasingly health conscious consumers. Dual Energy X□ray Absorptiometry (DEXA) technology is the most accurate and repeatable method of fat analysis. This technology measures the amount of X□rays that are absorbed by the fat content and lean meat through the use of two specific X□ray energies. By evaluating the ratio of energy absorbed at high energy to the level of energy absorbed at lower energy, the technology infers the average atomic numbers of the product scanned to provide the chemical lean value.

15. What does the future look like for X□ray inspection systems in the food industry?

Ans. We believe the food industry will continue to invest in food X□ray inspection systems that incorporate dual energy for purposes like fat analysis as they will provide manufacturers a strong return on investment (ROI) very quickly. This is due to the overall low cost of ownership, from a simple low□cost maintenance and replacement structure.