X-RAY FILM

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Radiology Equipment Technician I (X-Ray)

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Outline

- Construction of Film
- Intensifying screens
- Cassettes
- Processing the latent image (manually, automatically)
- Filters types and HVL

Objectives

The student should be able to do the followings;

- Explain the Construction of Film
- Explain Intensifying screens
- Draw the Cassettes and its parts
- Differentiate between processing the latent image (manually, automatically)
- Explain the filters types and HVL

Construction of X-Ray Film

There are three general types of x-ray examinations:

radiography, **fluoroscopy**, and **computed tomography**. Radiography uses film or a solid-state image receptor and usually an x-ray tube mounted from the ceiling on a track that allows the tube to be moved in any direction.

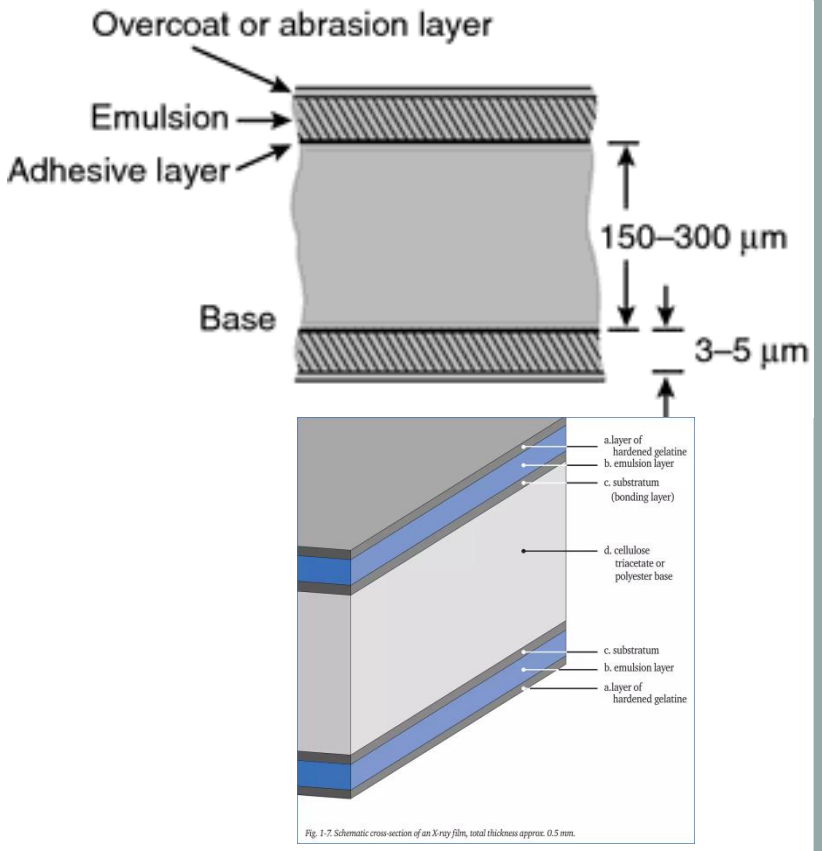
An X-ray film, total thickness approx. 0.5 mm, is made up of seven layers,

1- a transparent cellulose triacetate or polyester base (d).

On both sides of this base are applied:

2- a layer of hardened gelatine (a) to protect the emulsion
3- emulsion layer (b) which is suspended in gelatine, sensitive to radiation.

4- a very thin layer called the substratum (c) which bonds the emulsion layer to the base



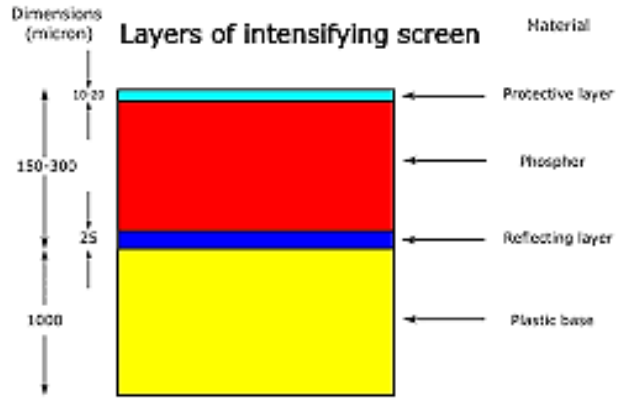
Intensifying Screens

An intensifying screen is a plastic sheet coated with fluorescent material called phosphors. Phosphors are materials which convert photon energy to light.

LUMINESCENCE is the emission of light from a substance bombarded by radiation. There are two types; fluorescence and phosphorescence.

Fluorescence means that luminescence is excited only during the period of irradiation and will terminate at completion of the x-ray exposure.

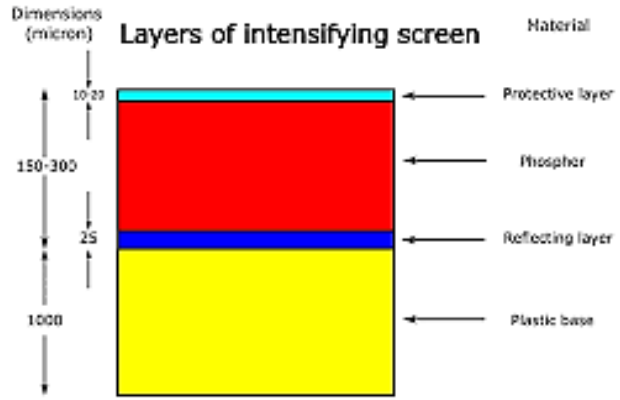
The phosphors : Phosphorescence is afterglow. The irradiated material continues to emit light for a time after cessation of exposure to radiation and will continue to produce an image which you do not want.



Intensifying Screens

Characteristics of Intensifying Screens

1) An intensifying screen consists of a base of polyester or cellulose triacetate similar to radiographic film.
2) This base must be radioparent
3) Chemically inert.
4) It must combine characteristics of toughness and flexibility
5) Should neither curl
6) not discolor with age.
7) The base is first coated with a reflective layer of titanium dioxide to bounce light back onto the film. Divergence of the light rays causes unsharpness of the image



latent image,

latent image: is an invisible image that created during the imaging process in medical radiology.

When an X-ray photon strikes a silver halide crystal (primarily silver bromide), it causes a chemical change that precipitates a tiny speck of silver. The degree of change corresponds to the intensity of the X-rays that hit that spot. After processing with chemicals, this latent image becomes a visible, black-and-white image, where areas with more X-ray exposure appear darker.

X-Ray Cassettes

X-ray cassettes are rigid holders used in conventional and computed radiography (CR) for the screen film system and imaging plate respectively.

Structure of a cassette

The back side of the cassette has rubber or felt for adequate contact with the screen film system or imaging plate. The front of the cassette is made of a low atomic number material (e.g. aluminium, plastic or carbon fiber) to enable ease in passage of x-rays and the back is made of a high atomic number material (e.g. lead) to reduce backscatter. This backscatter may re-irradiate the patient and/or screen.

In the case of conventional radiography, two screens are mounted, one on each side of the cassette, except in mammography, where a single screen is mounted on the back side. These cassettes have to be loaded with film in the darkroom unlike the cassettes used in CR which can be loaded with a imaging plate in the light.

The formats of the cassettes used in conventional radiology are multiple: 13 x 18 cm; 18 x 24 cm; 24 x 30 cm; 20 x 40 cm; 30 x 40 cm; 35 x 35 cm; 35 x 43 cm; 30 x 90 cm.

No cassettes are required in direct digital radiography.

Processing the Latent Image (manually)

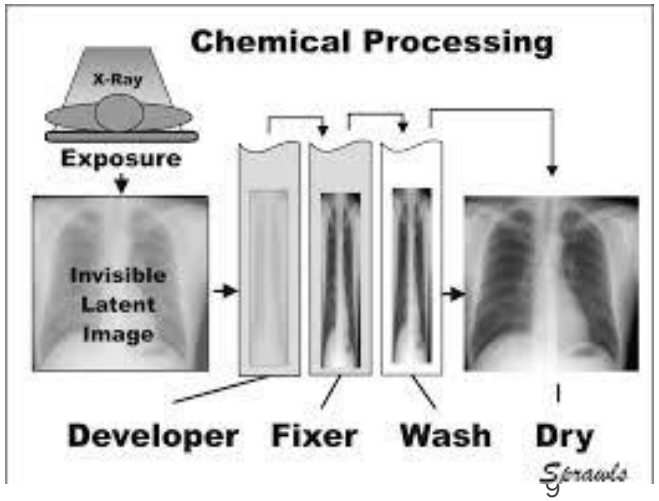
1- Development: - Developer solution (e.g. hydroquinone or phenidone) is used to reduce more silver ions into silver atoms while the developer solution itself is oxidised. Unexposed silver grains will also be developed much later. Fogging is the development of unexposed silver halide crystals.

2- **Fixing:** The purpose is to remove the remaining unreacted silver halide crystals. Silver halide crystals are only slightly soluble in water. Sodium thiosulfate or ammonium thiosulfate is used as fixing agent.

3- **Washing:** Washing is a process whereby the remaining fixed agent are removed. Incomplete washing will cause the film to turn brown after prolonged storage. This is because the remaining fixing agent will react with silver atoms to form silver sulfide which is brown in color.

4- Drying: This process is to remove excessive water from the film.

(https://www.youtube.com/watch?v=jlQuN7ZVB48)



Difference between processing the latent image (manually, automatically)

Manual Process	Automated Process
Manual processes take longer to complete	Automated processes are quicker and more efficient
May cause errors because crucial steps are skipped	Ensures all steps are followed according to the system
process performed in a darkroom with individual tanks	uses a machine to transport films through a series of chemical baths
more versatile and uses simpler equipment	uses higher temperatures and different chemical formulations to speed up the process

The Filtration and HVL

- **Filtration**: Metal filters, usually aluminum or copper, are inserted into the x-ray tube housing so that low-energy x-rays are absorbed before they reach the patient. These x-rays have little diagnostic value.

When filtration is added to the x-ray beam, patient dose is reduced because fewer low-energy x-rays are in the useful beam. Calculation of the reduction in exposure requires knowledge of half-value layer (HVL).

- **Attenuation** is the reduction in x-ray intensity that results from absorption and scattering.
- **The HVL** of an x-ray beam is the thickness of absorbing material necessary to reduce the x-ray intensity to half of its original value. A diagnostic x-ray beam usually has an HVL in the range of 3 to 5 mm Al or 3 to 6 cm of soft tissue.

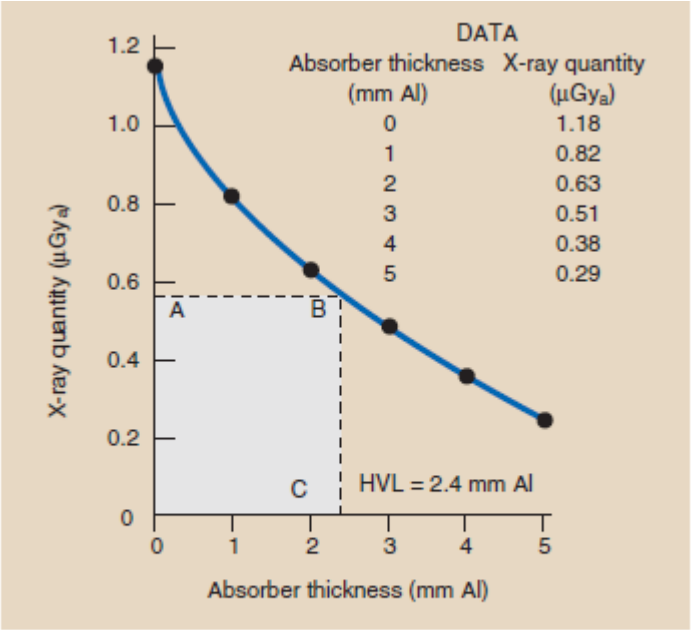
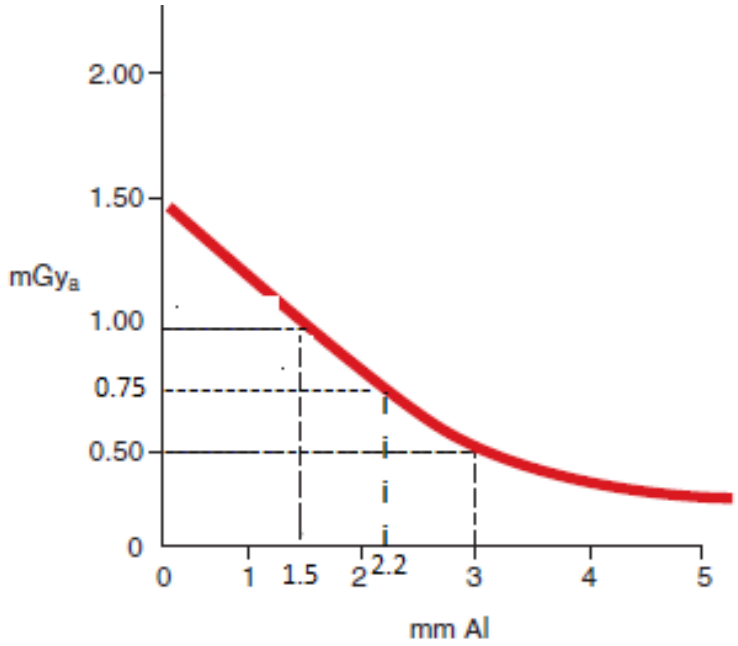


FIGURE 8-3 Data in the table are typical for half-value layer (HVL) determination. The plot of these data shows an HVL of 2.4 mm Al.

The Filtration and HVL

Question: The following boxed graph was plotted from measurements designed to estimate HVL. What does this graph suggest the HVL to be?



References

- Bushong S. C., . (2017). *Radiologic science for technologists*. St. Louis, Missouri: Elsevier.
- Guy C. and Ffytche D. (2005). *An Introduction to The Principles of Medical Imaging*. Imperial College Press
- Hendee W., and Ritenour E.,. (2002). *Medical Imaging Physics*. Willy-Liss,Inc