Radiological Equipment Techniques (Lec 9)

Processing the latent image

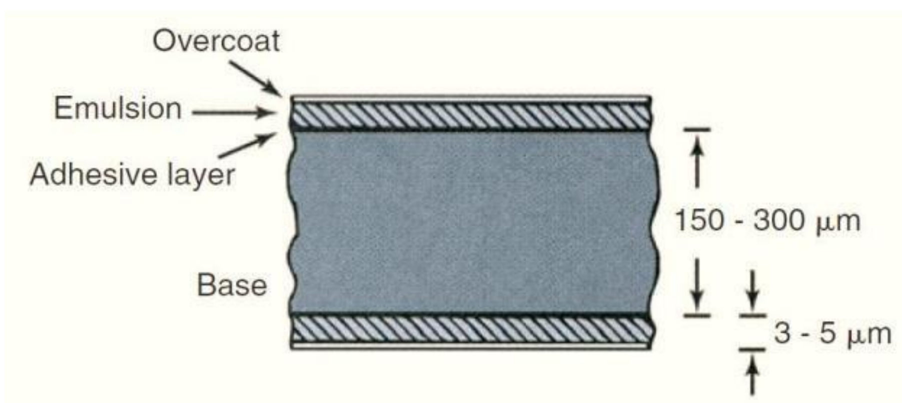
1. Film construction:

Radiographic film basically has two parts, 1-the base and 2-the emulsion, see figure below.

Between the emulsion and the base is a thin coating of material, called the adhesive layer, this adhesive layer allows the emulsion and base to maintain proper contact and integrity during use and processing.

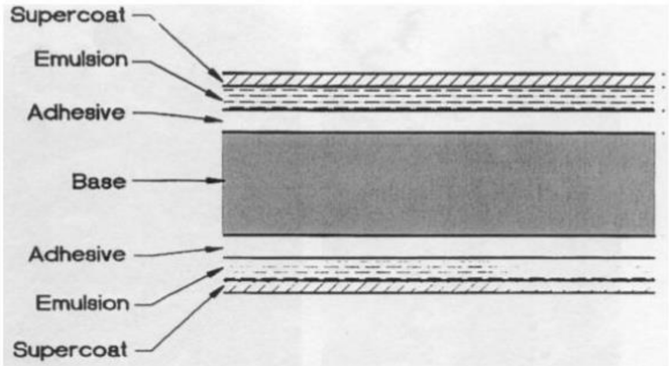
The emulsion is enclosed by a protective covering of gelatin, called the super coating. This super coating protects the emulsion from;

1-scratching, 2-pressure, and 3-contamination during use and processing. The thickness of a radiographic film ranges from 150 to 300 μm.



1.1.1 The base

The base is the foundation of radiographic film. Its primary purpose is to provide a rigid structure onto which the emulsion can be coated. The base is flexible and fracture resistant to allow easy handling but is rigid enough to be put into a view box. The base is usually made of polyester.



1.1.2 Emulsion

The emulsion is the heart of the x-ray film. It is the material in which X-rays interact and transfer information. Most x-ray film has the emulsion coated on both sides and therefore called double – emulsion film.

The emulsion consists of homogeneous mixture of gelatin and silver halide crystals. The gelatin is clear, so that it transmits light, and is sufficiently porous/absorbent for processing chemicals to penetrate the crystal of silver halide during processing.

The principle function of gelatin is to provide mechanical support for the silver halide crystals by holding them uniformly distributed/dispersed in place. The silver halide crystal is the active ingredient of the radiographic emulsion. In the typical emulsion, 98% of the silver halide is silver bromide; the remainder is usually silver iodide.

1.2 Formation of latent image

The X-ray that exiting the patient and incident on the radiographic film deposits energy in the emulsion primarily by photoelectric interaction with the atoms of the silver halide crystal. The x-ray energy is deposited in a pattern representative of the object or part of the anatomy being radiographed. Immediately after exposure, no image can be observed on the film. An invisible image is present that is called a latent image.

With proper chemical processing, the latent image becomes a visible image.

1.2.1 The sequence steps of processing the latent image

1-Wetting, 2- Development, 3- Fixing, 4-Washing and 5- Drying

The steps of development and fixation are the most important to the processing of radiographic film.

1- Wetting

The wetting loosens the emulsion to allow penetration of developing chemicals. The wetting agent is water, and it penetrates the gelatin of the emulsion, causing it to swell/expand. In automatic processing the wetting agent is in the developer.

2- Development

The stage in which the latent image is converted to a manifest/visible image.

The principal action of the developer is to change the silver ions of exposed crystals into metallic silver.

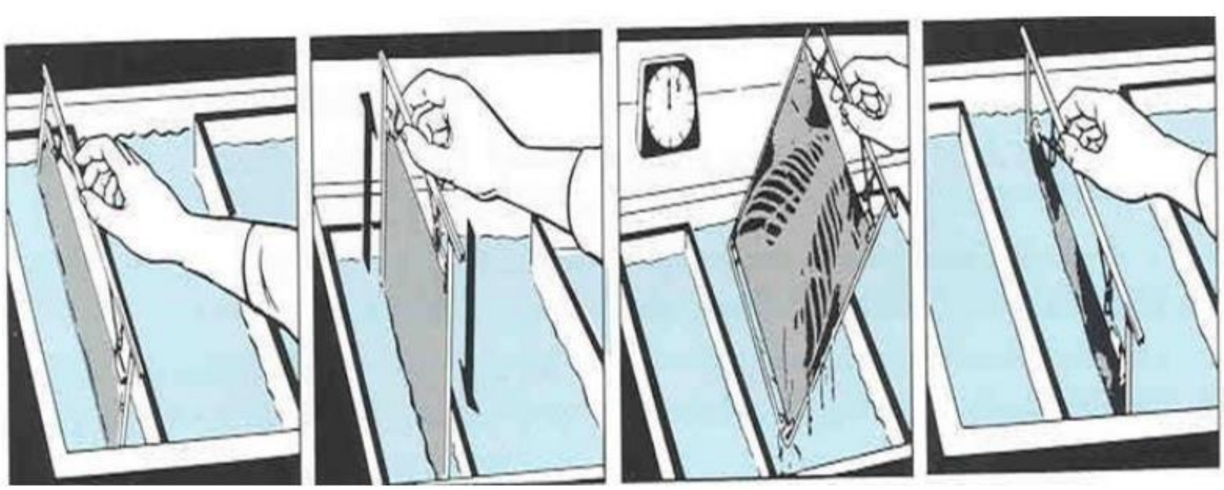
The developer provides electrons to the sensitivity center of the crystal to change the silver ions to silver.

The main development agent is hydroquinone.

• Rapidly produces shades of gray.

The other developing agent phenidone.

• Produces black tones slowly.



3- Fixing

When development is complete, the film must be treated so that the image will not fade.

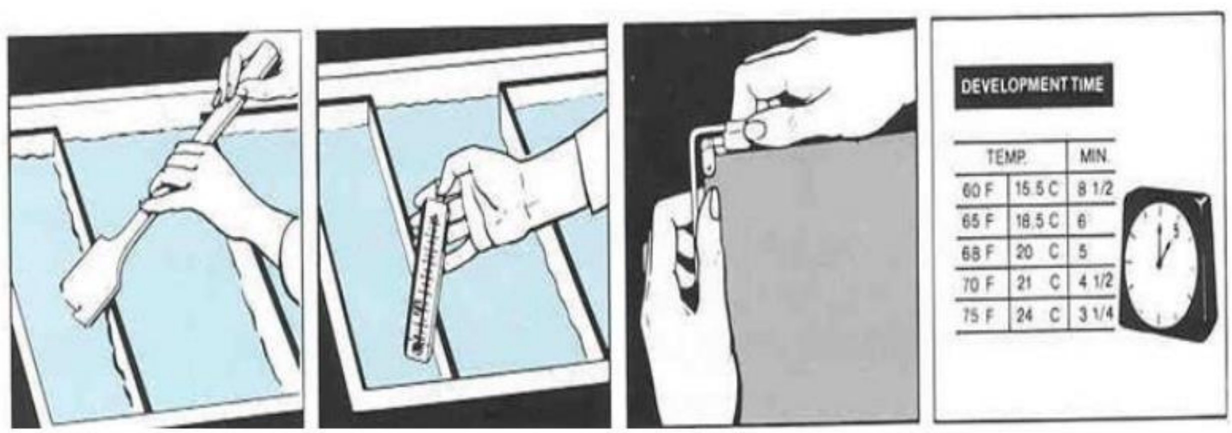
This stage of processing is fixing. The image is said to be fixed on the film, and this produces permanent film radiograph.

Where the image does not deteriorate with age but remains fixed.

Step stop Bath

- Where the film is rinsed in an acid solution to stop the development process and remove excess developer chemicals from the emulsion.
- During the automatic processing, step stop bath is removed.

During fixation, the silver halide that was not exposed to x-ray is dissolved and removed from the emulsion while the gelatin portion of the emulsion is hardened.



4- Washing

The next stage in processing is to wash away any residual chemicals remaining in the emulsion that clings/holds to the surface of the film.

The temperature of the wash water should be maintained at approximately 3 °C (5 °F) below the developer temperature.

Poor washing can result in hypo retention (Yellowish stain that appears on finished radiograph due to inadequate washing) or other chemical artifacts.

5- Drying

For the final step in processing, drying the radiograph, warm dry air is blown over both surfaces of the film as it is transported through the drying chamber.

2. Intensifying screens

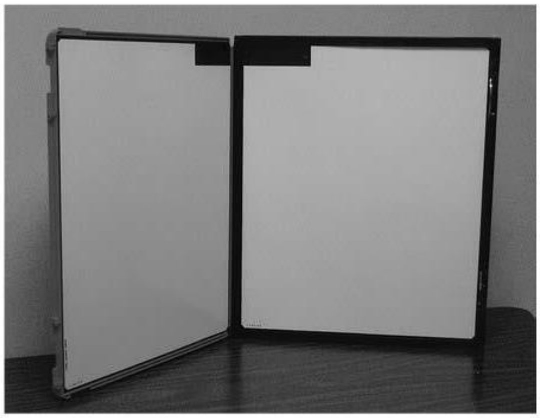
A radiographic intensifying screen is a device that converts the energy of the x-ray beam into visible light.

This visible light then interacts with the radiographic film then forms the latent image.

Film is much more sensitive to visible light than to x-rays. By converting each absorbed high energy x-ray photon into thousands of visible light photons, thus, intensifying screens will amplify film optical density.

The use of a radiographic intensifying screen lowers the patient radiation dose considerably, however, the image is slightly blurred.

• With modern screens such image blur is not serious.



Use of screens allows the following:

1. Reduce the Dose to the patient.

2. Reduce the Loading of tube and generator.

3. Allow the use of Short exposure time (motion blur).

4. Allow the use of Small focal spot (geometrical blur).

3. screen construction

Most screens have four distinct layers; these are shown in cross-section. As with radiographic film, the construction of screens can be described in layers.

The phosphor layer, or active layer, is the most important screen component because it contains the phosphor material that absorbs the transmitted x-rays and converts them to visible light. **1- Protective Coating**

The layer of the radiographic intensifying screen closest to the radiographic film is the protective coating. It is 10 to 20 µm thick and is applied to the face of the screen to make the screen resistant to the abrasion and damage caused by handling. The protective layer is transparent to light.

2- Phosphor

The active layer of the radiographic intensifying screen is the phosphor. The phosphor emits light during stimulation by x-rays. The phosphor converts the x-ray beam into light. Phosphor layers vary in thickness from 50 to 300 µm, depending on the type of screen.

The rare earth elements gadolinium, lanthanum, and yttrium are the phosphor material in newer, faster screens.

Many materials react in this way, Through the years, several materials have been used as phosphors because they exhibit these characteristics. rare earth screens are faster than those made of calcium tungstate, rendering/interpreting them more useful for most types of radiographic imaging. Use of rare earth screens instead of crystalline calcium tungstate results in:

1-a lower patient dose.

2-less thermal stress on the x-ray tube.

3- reduced shielding for x-ray rooms.

3- Reflective Layer

Between the phosphor and the base is a reflective layer, approximately 25 μm thick, that is made of a shiny substance such as magnesium oxide or titanium dioxide. When x-rays interact with the phosphor, light is emitted isotropically.

Isotropic emission refers to radiation emitted with equal intensity in all directions. Less than half of this light is emitted in the direction of the film. The reflective layer intercepts light headed in other directions and redirects it to the film.

The reflective layer enhances the efficiency of the radiographic intensifying screen, nearly doubling the number of light photons that reach the film.

4- Base

The farthest layer from the radiographic film is the base. The base is approximately 1 mm thick and serves principally as a mechanical support for the active phosphor layer. Polyester is the popular base material in radiographic intensifying screens, just as it is for radiographic film.