



الجزء الثاني

X-ray Film Processor

Purpose

The automatic film processor is a machine that is used for developing and fixing X-ray films after their exposure to X-rays without user contact between insertion of the exposed film and receipt of the developed film into the wash tank for collection at the end of the process. The processing of radiographs involves a number of chemical reactions and changes, which take place in the machine under carefully controlled conditions to produce a satisfactory radiograph.

Principle A radiographic film consists of a transparent, blue-tinted base coated on both sides with an emulsion. The emulsion consists of gelatine containing microscopic, radiation sensitive silver halide crystals, such as silver bromide and silver chloride. When X-rays strike the crystals or grains, some of the Br^- ions are liberated and captured by the Ag^+ ions. In this condition, the radiograph is said to contain a latent (hidden) image because the change in the grains is virtually undetectable, but the exposed grains are now more sensitive to reaction with the developer. One of the critical operations in the field of radiography is the processing procedure that makes visible the latent image created by X-rays. This procedure involves the use of photographic chemistry. The term processing comprises of several procedures that collectively produce the visible, permanent image and consists of developing, rinsing, fixing, washing, and drying procedures. The functions of each of these steps are the following:

- 1-** Development: Converts latent image to black metallic silver.
- 2-** Wash: Removes excess developer.
- 3-** Fixing and hardening: Dissolves out unexposed silver halide crystals.
- 4-** Washing: Removes products of processing.
- 5-** Dry: Removes water.

All these steps were earlier carried out manually, but as the number of radiographs produced each day in a facility has increased, a method of processing these films more rapidly became a necessity. As a result, the automatic film processor has evolved from manual processing and is now in use in most hospitals. Automatic processing provides a means of processing quality films on a much more timely and efficient basis. The equipment is very compact and the process is much cleaner. Processing time varies from machine to machine, ranging from 90 seconds to 9 minutes. By comparison, manual processing takes approximately 1-1.5 hours for a completely dried film. Several companies manufacture automatic film processors and they all operate on the same basic principle. Automatic processing uses the same principles as manual processing with changes in solution and temperature to allow a faster processing time. The automatic processor is made up of the basic system - the transport system, the circulation and filtration system, the replenishment system, the tempering system, and the dryer system. The processor controls the processing time cycle, temperature, and automatic replenishment of chemicals. The time cycle is measured from when the film enters the processor until it drops out and is ready for viewing. Most medical X-ray film processors are designed for cycle time of 90 seconds. This time is divided into four phases comprising (i) development immersion time, where the most important factor in developing an image. In most processors, it is 23-32 seconds (ii) fixing, (iii) washing, and (iv) drying. The automatic film processing device is designed to transport X-ray or radiographic film from one solution to the next in the

developing process without any manual labour except the insertion of the film. The X-ray film or radiographic film is manually removed from a cassette and loaded into the processor in a darkroom setting. It has typically six main subsystems: transport, temperature, circulation, replenishment, drying, and electrical control.

The machine receives undeveloped film in a light-tight enclosed area, visible through its protective red Perspex flap, where a motor-driven mechanism carries it between two continuous belts through a tank containing developer. The film is then passed out into a second tank, containing fixer. Chemical temperature is maintained at 27°C (81 °F), by two rod heaters, heating each chemical tank through a metal sleeve. The film finally passes into a water wash tank after processing. It is retrieved by removing the film from the collector tank. Figure 1 is the schematic diagram of an automatic film processor. The processor consists of three separate tanks. These contain in turn the developer, fixer, and wash water. The developer and fixer solutions are kept heated to a precise temperature to suit the film and chemistry used. A series of rollers and crossover plates transport the film through these three sections, then finally through a heated air dryer before ejecting the processed film

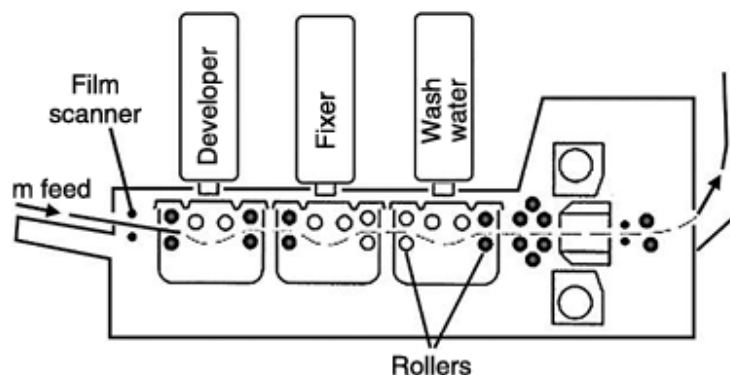


Figure 1 Schematic diagram of an automatic X-ray film processor.

As the film passes through the chemical solutions, the developer and fixer become less concentrated and require automatic top-up or 'replenishment' to retain the correct concentration. This is done by precision metering pumps. The time these pumps operate depends on the size of the film entering the processor. The wash water is continuously replenished, to insure minimum residual fixer content.

Developer Section The developer supply is a pre-mixed solution of developer concentrate and water. When a film is inserted, sensors at the insertion point determine the film width. As the film travels into the processor, the length is determined. The electronics then calculates the developer supply pump operation time. The developer solution is kept under circulation by another pump. This operates continuously when the processor is ready to accept films. Developer solution passes from the circulation pump back into the tank via a temperature controlled heater or heat exchanger. The developer temperature is normally set between 34 and 36 °C depending on developer and film combination. As fresh developer is pumped into the tank, excess used developer will flow from the top of the tank to a holding tank for used developer. For service to the processor, a drain valve or tap is provided to empty the developer tank. Micro sensors detect and measure film length and automatically replenish just the correct amount of chemistry for a perfect result. When the processor is awaiting another film, it will automatically go into the standby mode. That means minimal usage of chemicals and reduced electrical consumption, but remaining ready to instant action. To prevent the formation of crystals and the subsequent build-up of sediment on the rollers, the rollers turn automatically at 20 minute intervals. To ensure chemicals remain active, a small quantity is automatically replenished every hour to maintain optimum performance.

Fixer Section

The fixer supply is premixed fixer concentrate and water. The fixer supply pump is also controlled by the measurement of the film as it enters the processor. The rate of fixer replenishment to developer is about two to one. To obtain this the fixer pump will operate for twice the time as the developer pump. In some systems, two fixer pumps operate in parallel for a similar time as the developer pump. Other systems may instead have a larger capacity pump for the fixer. The fixer solution is passed through the heater and temperature control tank by the fixer circulation pump. The heater tank in this case is a dual chamber system. The main chamber of the tank is devoted to heating and controlling the developer solution. A smaller chamber of the tank allows the fixer solution to be heated, but at a slower rate than the developer. In some larger systems, separate heating tanks are provided for fixer and developer. As fresh fixer is pumped into the tank, depleted fixer is passed into a storage tank or else a silver recovery unit. Fixer contains components that are harmful to the environment, and health regulations forbid allowing this chemical to be dumped into the drainage system. For service to the processor, a fixer drain valve or tap is supplied to empty the fixer tank.

Wash Section

The water flow control valve or tap regulates the replacement rate of the wash water. A water filter is highly recommended to prevent sediment entering the processor. When a film is inserted, the solenoid operated 'water on' control valve operates to allow the wash water to be refreshed. A timer extends the time that water flows for several minutes and then closes to save excessive water consumption. Water enters the wash tank from the top via an air gap. This is a safety requirement and prevents possible transfer of the wash water back into the

water reticulation system. As the film passes through the transport rollers into the wash tank, the rollers remove almost all of the fixer from the film. As the concentration of fixer in the wash water is very small, the wash water is permitted to exit to the sewage drain.

Film Dryer

The transport rollers pass the film from the wash tank through the dryer section and into the film receiver. The dryer has a temperature-controlled heater. Air is blown past this heater by a blower and onto the film, removing the residual moisture. The actual temperature setting may be adjusted to suit local conditions. For example, areas of high humidity generally require increased drying temperature. As a safety precaution, the heating element has an 'overheat' sensing switch, as a backup to the temperature control for the heater. There must be a good exhaust system to remove the warm, moist air so that only hot, dry air is directed over the films as they move through the roller-transport system. There are holes at the ends and slits along the sides of the air tubes to direct the air onto the films. Processing film is a strict science governed by rigid rules of chemical concentration, temperature, time, and physical movement. Whether processing is done by hand or automatically by machine, excellent radiographs require a high degree of consistency and quality control.

Specifications

- 1-** Film format: Sheet films
- 2-** Film size: Minimum 100 x100 mm (4×4), maximum 358 x432 mm (14×17)
- 3-** Processing time: 90-167 seconds
- 4-** Processing capacity: 100 films/h
- 5-** Developer temperature: 28-37 °C

6- Fixer temperature: 28-37°C

7- Drier temperature: 50-70°C

Applications

The automatic film processors have today become an integral requirement of the radiology department. The machines are recommended, in particular, for accident and emergency departments, for surgical and orthopaedic clinics, and for other specialized departments and practices with large average daily film consumption.