Technical Information — Maintaining a Film Processor

Linotype-Hell

As imagesetter output of tints, graphics, and scanned images becomes commonplace, the role of the film processor has become very important. Every shop with a film processor needs to pay special attention to the issues involved in its maintenance, because consistent output can only be achieved through careful monitoring.

Anatomy of a piece of film

To understand how a processor works, it is important to know the make-up of a piece of film. A typical graphic arts film is made up of many layers. (See Figure 1.) The *emulsion* is a light sensitive substance made up of silver halide suspended in gelatin material. It is spread over the *base* material which nowadays is usually polyester or acetate, but in early photographic methods was glass. The emulsion has an *overcoat* to protect it during handling. Below the emulsion is an *interlayer* that helps the emulsion adhere to the base material. Beneath the base is an *undercoat* which helps to keep the film from curling. The *anti-halation backing* prevents light from reflecting back up and re-exposing the emulsion.

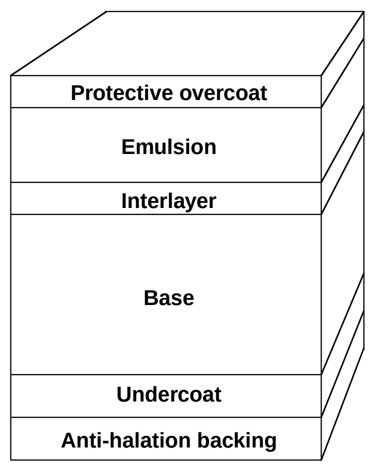

Figure 1 - Cross section of a typical graphic arts film.

Film and light

The emulsion in scanner and imagesetter films contains silver halide. When the silver halide in the film is exposed to enough light, for example by the laser beam of an imagesetter, a chemical reaction takes place. This forms a latent image, i.e., an image that will not be visible until the film is processed. During processing, these exposed areas turn black.[1] Unexposed silver halide is washed off of the film. This is why there is silver content in film processing waste products (For more information on silver recovery, please refer to the Linotype-Hell technical information piece entitled Film Processor Chemicals.)

[1]There is a lot of silver halide spread through the emulsion of a piece of film. As exposure increases, more of the silver halide within the film is affected by the light. Generally speaking, increasing the exposure also increases the density of that area on film after processing.

Film resolution

The ability of a film to hold detail is called its resolution, and is dependent on the size of the silver grains and their distribution in the film emulsion. Silver grains vary in size, but are generally smaller than a micron and are distributed evenly throughout the emulsion. For comparison, human hair ranges in diameter from 30 to 100 microns in diameter, dry toner for xerography may be 5 to 20 microns in diameter, imagesetter addressability at 3386 dots per inch is 7.5 microns, tobacco smoke ranges from .01-1 microns in diameter, and finally, silver grains vary in size from .005 to 2 microns in diameter.

The small size of silver grains gives film the ability to hold a great amount of detail. In fact, the ability of film to hold detail is actually greater than the ability of most laser recording devices to produce it. But no matter what level of detail is recorded on the film, none of it is visible until the film is processed.

Film processing

Film processing can be divided into four steps that will be familiar to anyone who has done any photographic darkroom work: developer, stop bath, fixer, and wash. The *developer* is what makes the exposed silver halide turn black. The *stop bath* stops the activity of the developer. The *fixer* makes the exposed silver grains stay black permanently. The *wash* removes any chemicals that remain on the film after the fixer. (If these chemicals remained on the film they could cause yellowing or fading of the image.)

Graphic arts film

There are three basic types of film in use in the graphic arts: lith, rapid access, and hybrids. Lith film (actually lithographic) was the most common graphic arts film for many years. It is capable of producing excellent high density films, however controlling a lith film processor is a difficult task requiring constant monitoring. Rapid access films cannot achieve the high maximum density (dmax) of lith films, but the process is much easier to control. Recently a new type of hybrid film has been developed. Hybrids can achieve higher densities than rapid access films, but their process is easier to control than lith. So far, their use is not widespread because of the cost of their chemicals and the fact that rapid access and hybrid films cannot be run through the same processor. Today, rapid access films are the most commonly used among imagesetters, primarily because of their ease of use.

Rapid access film processing

Automated film processors are very similar in operation. For the purpose of this piece we will look at a typical rapid access film processor.

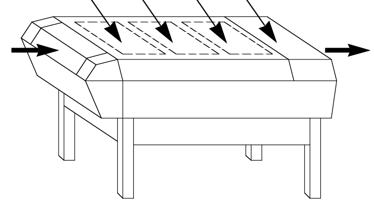

Figure 2 - Graphic arts film processor

The film in a rapid access processor is conveyed mechanically through four basic components: developer tank, a fixer tank, a wash tank, and a heated air dryer. (See Figure 2.) You will notice that this sequence doesn't exactly match the four standard steps described above. First, there is no stop bath; the fixer performs the role of both stopping and fixing. In addition, there is a dryer which dries the film as it leaves the processor.

Agitation, time, & temperature

Three factors play an important role in film processing: agitation, time and temperature. Agitation is important because the flow of the chemicals near the surface of the film determines the speed at which a chemical reaction takes place. Unless there is some agitation in each bath, those chemicals near the surface of the film become exhausted and are not replaced. This slows the rate at which the chemical reaction takes place. Agitation must occur consistently because otherwise it becomes difficult to estimate the amount of time it will take for a reaction (like development) to take place. Film processors achieve agitation in a couple of ways. First, chemicals may be circulated within the tank as chemicals are pumped in and out. Also, the movement of the film through the baths in the processor helps circulation.

By setting the speed with which the film goes through the processor you determine the amount of time that the film spends in each bath. Clearly, the longer you leave the film in a bath, the greater the chance that a chemical reaction will take place.

Temperature of the chemicals in the baths also plays a role. Generally, chemical activity increases as temperature increases. For rapid access processors, the temperature of the developer is particularly important. You will notice that the maximum density you achieve on film will vary greatly if the temperature of the developer is allowed to vary. If your processor has no temperature gauge, you can attach an inexpensive digital thermometer to any baths that you want to monitor.

Setting up a processor

When you set temperature and speed for the first time, your best bet is to follow manufacturer's recommendations. It is impossible to make general speed and temperature recommendations for the wide range of equipment on the market. (Though one processor might use a developer temperature of 93° and a speed setting of 30 seconds, this is useful only if you are working with the same processor under identical conditions.) Generally, it isn't wise to raise bath temperatures too high. While it will speed the rate of chemical reaction, it also causes the chemicals to degrade more quickly.[2]

The easiest way to keep your system working at its best is to set the time and temperature, keep them constant, and maintain your maximum density through adjustment of the imagesetter laser intensity (often referred to as the density setting). Monitoring maximum density is a requisite. Similarly, control strips[3], if available for the film material that you use, can make it easier to judge the state of the chemicals in the processor.

Here are a couple of tips for consistent film processor operation:

- It is important to be sure that developer temperature stays at a constant level. To achieve this, many people leave their processors on all the time, rather than turning them off at night. Leaving the processor on eliminates the problem of waiting for the temperature to come up at the beginning of a shift. However, oxidation is more likely to occur when the processor is on (because of the higher temperature and circulation). This will accelerate the exhaustion of chemicals. Therefore leaving the processor on is more appropriate for companies that run extra shifts.
- Don't set up different temperatures for different film materials. This leads to inconsistency since the temperature in a bath does not change instantaneously. Similarly, if you set different times for different materials, it is very easy for a worker to send the film through at the wrong time setting. It is best to leave these factors constant and change the exposure (laser intensity setting) to get the results you want.
- Film storage conditions are important. Store film in a cool and dry place. Let the film come back to room temperature before using.

[2]Oxidation (which occurs when oxygen is accepted into a solution) accelerates the degradation of the developer. High temperature as well as agitation can speed oxidation. In general it is best to keep all temperatures as low as possible to get the results that you want. This also holds true for dryer temperature.

[3]A control strip is a piece of pre-exposed film that is sent through a processor. By measuring the resulting densities you can tell if the processor is working properly.

Monitoring other factors

Developer temperature and maximum density are the two primary factors to monitor. However there are other tests that allow you to determine the state of the developer and fixer. For example, pH (the acidity or alkalinity of a solution) can be measured with specially-treated paper strips, and specific gravity can be measured with a hydrometer. You might use these types of devices to tell if you have mixed the proper proportions of chemicals and water.

Troubleshooting

Film processing is a combination three processes: mechanical, electrical, and chemical. The process is mechanical because of the path that the film takes through the processor; electrical because of the process of heating and drying; and chemical because of the reactions taking place. When troubleshooting, the problem itself may give you a clue to its source. For example, a physical problem like a scratch, can often be traced to a sharp edge on a cassette, guide or roller. The chart on the following page shows potential film problems and their likely causes.

Cleaning a film processor

Cleaning a film processor is one of the least popular jobs in the graphic arts, but it must be performed regularly. How often depends on your production volumes, but even lightly-used processors benefit from weekly cleanings. You want to strike a balance between changing chemicals frequently enough that the process remains consistent, and yet not so frequently that you are producing too much chemical waste. The handling and disposal of these waste chemicals has been discussed in a Linotype-Hell technical information piece entitled Film Processor Chemicals.

Troubleshooting Common Film Processor Problems

Problem	Characteristics	Causes
Streaking	Uneven development	Uneven rollers, residue on rollers, too high dryer temperatures, exhausted or contaminated chemicals[4], contaminants in wash
Scratching	Noticeable as a physical scratch in clear areas, often also as a clear line in solid areas. Usually runs parallel to length of film.	Physical impediment in film or take-up cassettes, on rollers or elsewhere in processor. May indicate soft emulsion. Emulsion may be softened by exhausted chemicals or excessive dryer temp.
Light leaks	Areas exposed by room light	Ineffective seals in cassettes, poor film loading
Jams & roller wraps	Film catches on rollers	Sticky emulsion (see Scratching),aging rollers
Low dmax	Reduced developer activity	Weak or contaminated chemicals, low developer temperature, unexpectedly increased speed
Fogging of clear film	Overactive development	Too long in developer, unexpected developer temperature increase, ineffective safe light
Pin holes	Small clear specks in solid black	Poor film batch, dust, encrusted rollers
Algae/Bacteria	Gunk in the wash water	Lack of filtration. May be solved with filtration, more frequent wash changes, or by swapping fixer and wash racks after cleaning.
Static	Lightning-like marks on film	Often a result of low humidity. May be resolved with increased humidity or anti-static spray.

[4]Fixer can contaminate the developer if the fix rack is removed carelessly or if jammed film is pulled through the processor.

Processor selection

Finally, here are some questions to ask when selecting a processor:

- *Is the processor appropriate for the types of volumes that will be run through it?* A processor's durability is a key selection issue. You should prepare an estimate of the number of pages (or preferably feet of material) that will be sent through the processor on any given day.
- *What factors are important for consistent operation?* Keep in mind that tank size and replenishment rates play a role in consistency. (For more information on replenishment, please refer to the Linotype-Hell technical piece entitled Film Processor Chemicals.)
- *What will be needed to install the processor?* The physical size of the processor, its electrical and ventilation requirements, as well as access to water should be considered. Be aware that the temperature and humidity of the processor room (as well as film storage areas) can play a role in both film dimensional stability and static problems.
- *Do I require an on-line processor?* (With an on-line processor film goes directly into the processor instead of into a take-up cassette.) An on-line processor limits loss in time and materials due to cutting, advancing, and processing film off-line.

Comments

Please direct any questions or comments to:

Jim Hamilton, Marketing Department
Linotype-Hell Company
425 Oser Avenue
Hauppauge, NY 11788

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