

9 BATCH PROCESSING

STEPS AND CONDITIONS

Table 9-1
Steps and Conditions—Sink-Line and Batch Processing

Step	Time* (Minutes:Seconds)			Temperature °C (°F)	Comments
	Lower Limit	Aim	Upper Limit		
Perform these steps in total darkness.					
First Developer*	5:00	6:00	7:00	36.7 to 39.4 (98 to 103)	Nitrogen. One 2-second burst every 10 seconds.†
First Wash‡	1:00	2:00	4:00	33.3 to 39.4 (92 to 103)	Manual agitation. One cycle every 30 seconds.
Reversal Bath	1:00	2:00	4:00	24 to 39.4 (75 to 103)	None. Tap to dislodge air bubbles.
Remaining steps can be done in room light.					
Color Developer	5:00	6:00	7:00	36.7 to 39.4 (98 to 103)	Nitrogen. One 2-second burst every 10 seconds.
Pre-Bleach II	2:00	2:00	4:00	24 to 39.4 (75 to 103)	None. Tap to dislodge air bubbles.
Bleach	6:00	6:00	8:00	33.3 to 39.4 (92 to 103)	Air. One 2-second burst every 10 seconds.
Fixer	4:00	4:00	6:00	33.3 to 39.4 (92 to 103)	Air. One 2-second burst every 10 seconds.
Final Wash‡	3:00	4:00	8:00	33.3 to 39.4 (92 to 103)	Manual agitation. One cycle every 30 seconds.
Final Rinse	0:30	1:00	4:00	Ambient	None. Tap to dislodge air bubbles.
Dry	As needed			Up to 63 (145)	

* All times include a 10-second drain time. Increase the first-developer time by 15 seconds when you process roll films on reels with manual agitation.

† For sheet films on hangers, first use manual agitation; then continue using gaseous-burst agitation as described on page 9-3. For roll films on reels, use **only** manual agitation.

‡ Flowing wash. See "Washes" on page 9-3 for more information.

TIME AND TEMPERATURE

You can control your process by adjusting the developer times and temperatures, and by monitoring changes with KODAK Control Strips, Process E-6. **Do not** exceed the times and temperatures given in Table 9-1. If you do not need to adjust the time and temperatures of the developers, use the midpoint of the ranges; 6 minutes at 38°C (100.4°F) for both developers. Once you have selected the times and temperatures for your process, keep them within these tolerances:

First Developer	Color Developer
Time: ±5 seconds	Time: ±5 seconds
Temperature: ±0.2°C (±0.3°F)	Temperature: ±0.3°C (±0.5°F)

First Developer Starting Temperature: To determine the starting temperature for your first developer, follow the procedure described below.

1. Adjust the developer temperature to 38°C (100.4°F). Use an unshielded thermometer with an expanded range that is calibrated in 0.1°C units, such as the ASTM No. 91C, or Fahrenheit equivalent. Place the thermometer in the developer for several minutes to register an equilibrium temperature. Record this temperature. Leave the thermometer in the developer.
2. Place a full rack of *processed* scrap film in the developer. The rack should be at room temperature, and the film load should be typical of your normal film load. Provide the same initial agitation that you normally do. At the end of the first 60 seconds (measured from the time you placed the film in the developer), record the solution temperature.
3. Determine the temperature difference between steps 1 and 2. This temperature change is valid only for the room temperature at which you made this measurement.
4. Your starting temperature is 38°C (100.4°F) *plus* the temperature change that you determined in step 3. You will not need to repeat this test as long as your processing conditions (i.e., room temperature and amount and type of film) remain the same.

The temperature change will be different for different film loads. Although the temperature difference may be small, you must consider it for critical processing, and for consistency between processes.

AGITATION

You can use manual or gaseous-burst agitation when you process sheet films. When you process roll films, use *only* manual agitation; gaseous-burst agitation will cause nonuniformity.

Use humidified nitrogen to provide gaseous-burst agitation in the developers; air will oxidize the developers. You must use air agitation to aerate the bleach and fixer to maintain the stability of the solutions. If you use manual agitation in the bleach, you will also need to use another method to aerate the bleach. In the other solutions and washes, use compressed air or nitrogen for gaseous-burst agitation.

Note: If you process sheet films of different sizes at the same time, such as 8 x 10-inch sheets and 4 x 5-inch sheets, separate adjacent hangers that contain different-size sheets with a hanger loaded with an 8 x 10-inch sheet of scrap film to avoid uneven development of the larger sheets. This unevenness is caused by turbulence around the central frame of the multiple-film hanger during agitation.

Manual Agitation: Use *only* manual agitation when you process roll films on reels. You can also use manual agitation when you process sheet films.

Initial Agitation—All Solutions and Washes, Except the Final Rinse—Immerse the rack into the solution. Rapidly tap it on the bottom of the tank to dislodge air bubbles; then agitate the films continuously by lifting the hangers or reels approximately three-quarters of the way out of the solution and then reimmersing them. Repeat to complete eight lift cycles (in approximately 15 seconds).

Initial Agitation—Final Rinse—Tap the loaded reels or hangers on the bottom of the tank to dislodge air bubbles. Use no other agitation; foaming will occur.

Subsequent Agitation—All Solutions and Washes, Except the Reversal Bath, Pre-Bleach, and Final Rinse—Every 20 seconds, lift the loaded hangers or reels out of the solution and then reimmerse them. Repeat to complete two lift cycles (in approximately 5 seconds).

Subsequent Agitation—Reversal Bath, Pre-Bleach, and Final Rinse—None; use no other agitation for these solutions.

Drain Time—All Solutions—Ten seconds before the end of the solution time, raise the rack, tilt it approximately 30 degrees toward one corner, and drain for 10 seconds. At the end of 10 seconds, immerse the rack into the next solution.

Gaseous-Burst Agitation: Use gaseous-burst agitation *only* when you process sheet films.

Initial Agitation—First and Color Developers, Bleach, Fixer, and Washes—Lower the loaded film hangers into the solution and tap them sharply against the tank to dislodge air bubbles. Then agitate the films continuously for 15 seconds by lifting the hangers approximately three-quarters of the way out of the solution and then reimmersing them (approximately eight lifts).

Initial Agitation—Reversal Bath, Pre-Bleach, and Final Rinse—Tap the rack sharply on the bottom of the tank to dislodge air bubbles. Use no other agitation; loss of solution activity or foaming will occur.

Subsequent Agitation—First and Color Developers—Provide humidified nitrogen with enough pressure to raise the solution level approximately 15 mm ($\frac{3}{8}$ inch) during a 2-second burst. Use one 2-second burst every 10 seconds.

Subsequent Agitation—Bleach, Fixer, and Washes—Provide oil-free air with enough pressure to raise the solution level approximately 15 mm ($\frac{3}{8}$ inch) during a 2-second burst. Use one 2-second burst every 10 seconds. Use air agitation in the bleach and fixer *only* during processing. **Do not** use nitrogen in place of air in the bleach and fixer. You can also use manual agitation for subsequent agitation in the washes by lifting the hangers approximately three quarters of the way out of the water, and then reimmersing them. Repeat to complete two lift cycles (in approximately 5 seconds).

Subsequent Agitation—Reversal Bath, Pre-Bleach, and Final Rinse—None; use no other agitation for these solutions.

BLEACH AERATION

In a seasoned process, the efficiency of the bleach depends on aeration of the bleach. The best way to aerate the bleach is to use air-burst agitation. To aerate the bleach, continue the air bursts during the complete process cycle. If you use nitrogen-burst or manual agitation, provide another method for aerating the bleach. You can use a separate compressed-air supply to bubble air into the bleach through a sparger at a valve pressure of about 2.5 lb/in². Bubble the air for approximately 5 minutes during each complete process cycle. If you cannot aerate the bleach by bubbling air into it, vigorously stir the bleach with a mixer so that air is drawn into the solution.

WASHES

Flowing Washes: Whenever possible, use flowing washes for the first and final washes. Use the conditions given in the following table.

Wash	Time (minutes)	Temperature °C (°F)	Flow Rate L/min (gal/min)	Agitation
First	2	33 to 39 (92 to 103)	7.5 (2)	Initial
Final	4	33 to 39 (92 to 103)	7.5 (2)	Initial
	6	25 to 39 (77 to 103)	7.5 (2)	Initial

Nonflowing Washes: You can use nonflowing washes for sink-line processing to conserve water and energy. Use these conditions:

First Wash—Use a 2-minute wash time with one tank filled with water at 36.7 to 39°C (98 to 103°F). Replace this wash after two processing runs. Drain the wash tank at the end of each day, and leave the tank empty overnight. **Do not** interchange the tanks that you use for the first and final washes.

Final Wash—Use a 6-minute wash time with three tanks filled with water at 20 to 39.4°C (68 to 103°F). Wash for 2 minutes in each tank. Replace the water in all three tanks after you have completed four processing runs. Drain the wash tanks at the end of each day, and leave them empty overnight.

REPLENISHMENT

You can extend the life of processing solutions by replenishing your solutions. Table 9-2 gives the amount of replenisher to add for each roll or sheet of film processed.

Calculate the volume of replenisher for a batch of film by adding the volumes of replenisher for each roll or sheet of film processed. For example, to determine the replenisher volume needed for thirteen 8 x 10-inch sheets, use the following calculation:

mL per 8 x 10-inch sheet x 13 sheets per batch = mL of replenisher

First and Color Developers

110 mL x 13 sheets = 1,430 mL

Bleach

11 mL x 13 sheets = 143 mL

Other Solutions

54.9 mL x 13 sheets = 714 mL

Replenish the solutions after each processing run unless the run is your last run of the day. After your last run, record the amount of replenisher that you need to add to each solution, and replenish the solutions before the first run of the next day that you process film.

Table 9-2
Replenishment Rates—Sink-Line and Batch Processing

Film Size	Area per Roll or Sheet (ft ²)	First and Color Developers 2,153 mL/m ² (200 mL/ft ²)	Bleach 215 mL/m ² (20 mL/ft ²)	Other Solutions 1,076 mL/m ² (100 mL/ft ²)
		mL of Replenisher per Roll or Sheet		
135-24	0.395	79.0	7.9	39.5
135-36	0.556	111.0	11.1	55.6
120	0.550	110.0	11.0	55.0
220	1.090	218.0	21.8	109.0
4 x 5-in. sheets	0.134	27.0	2.7	13.4
5 x 7-in. sheets	0.238	48.0	4.8	23.8
8 x 10-in. sheets	0.549	110.0	11.0	54.9
11 x 14-in. sheets	1.064	213.0	21.3	106.4

Note: Wash rates are 7.5 L/min (2 gal/min).

CAPACITY OF UNREPLENISHED SOLUTIONS

If you do not replenish your tank solutions, use the 1-gallon-size chemicals. The capacity of the first- and color-developer solutions without replenishment is about 1.7 square metres (18 square feet) of film per 3.8 litres (1 gallon). The capacity of the other solutions is 5 square metres (54 square feet) per 3.8 litres (1 gallon). Keep the number of processes low by processing as much film as possible in each batch. After you have processed 1.1 square metres (12 square feet) of film, increase the first developer time to 6½ minutes. If you process only one size of film in a particular batch, you can use Table 9-3 to determine the capacity of the solutions.

Table 9-3
Capacity of Unreplenished Solutions

Film Size	Rolls or Sheets per Gallon with First-Developer Time of 6 Minutes	Rolls or Sheets per Gallon with First-Developer Time of 6½ Minutes	Discard Both Developers After This Many Rolls or Sheets Processed
135-24	1 to 30	31 to 46	46
135-36	1 to 22	23 to 33	33
120	1 to 23	24 to 34	34
220	1 to 12	13 to 17	17
4 x 5-in. sheets	1 to 90	91 to 134	134
5 x 7-in. sheets	1 to 46	47 to 74	74
8 x 10-in. sheets	1 to 22	23 to 33	33

Be sure that the solution completely covers the film during processing. You may need to add tank solution to maintain the solution level of the first developer. Discard solutions that have been stored beyond the recommended storage time regardless of unused capacity (see page 2-6).

Note: For best results, replenish your tank solutions according to Table 9-2.

SILVER RECOVERY

You can recover silver from used fixer or fixer overflow by collecting the solution, and then passing it through a KODAK Chemical Recovery Cartridge, Junior Model II (3½-gallon size, CAT No. 166 9431), a KODAK Chemical Recovery Cartridge, Model II (5-gallon size, CAT No. 173 4953), or an equivalent cartridge.

