An Accelerated Process for Anscochrome Color Films

By WILLIAM L. WIKE

ANSCOCHROME-TYPE color films, which were initially released in 1955, consist of a number of multipurpose camera and duplicating-film products, all of which can be processed in the same solutions. The initial process, identified as the Anscochrome Process, was designed to operate at 68 F and required a processing time of 75 min, exclusive of drying.

In 1961, a new process, the AR-1, reduced the processing time to approximately 45 min. The reduction in time was realized through changes in chemistry and by increasing the temperature of the process to 80 F. After the release of the AR-1 Process, a number of new Anscochrome reversal camera films were introduced. These new films, namely, Anscochrome D-50, Anscochrome D-100, Ultra-Speed Anscochrome and Anscochrome T-100, were specifically designed for the AR-1 Process, thereby replacing the former 68 F processing conditions. An accelerated AR-2 Process has now been designed to supplement the AR-1 Process.

The principal objective in designing the AR-2 Process was to shorten the process time without altering the photographic characteristics of Anscochrome color films. Secondary objectives were to: (1) maintain the process temperature at 80 F; (2) minimize the number of formulation changes; and (3) retain processing compatibility with all the Anscochrome films. These objectives have been realized through the chemistry of the AR-2 Process. This process will develop Anscochrome-type color films in approximately 20 min at a temperature of 80 F instead of 45 min as hitherto required. Anscochrome films processed through the AR-2 Process are comparable in photographic quality with those processed in the AR-1 Process. Although formulation adjustments toward increased developing power often result in side effects such as increased granularity, steeper gradation and higher stain, none of these undesirable characteristics is observed with the AR-2 Process; nor is the physical quality of films affected. The AR-2 Process was purposely designed to operate at the same temperature (80 F) as the AR-1 Process to facilitate existing temperature control equipment in commercial laboratories. The difference in solution chemistry between the AR-1 and the AR-2 processes is solely in the developer formulations.

This accelerated process is also more adaptable to small developing machines. The AR-2 Process is recommended primarily for cine machines. It is of interest in converting processing machines of limited tank capacity to Anscochrome processing and in increasing the output of existing Anscochrome processors.

Table I. AR-1 Process Procedure.

Step	Time (min) at 80 F
First Developer #504A	8.5
Short-Stop Hardener #907	2.5
Wash and re-exposure	2.0
Color Developer #611A	10.0
Short-Stop Hardener #907	2.5
Wash	2.5
Bleach #718B	4.5
Wash	2.5
Fixer #806A	3.5
Wash	2.5
Conditioning bath (16mm film only)	.5
Wash	2.5
Anti-Spot Rinse #951D	.5
Total time (wet process)	44.5
Dry 80 90 F 30–40% RH	

The AR-2 Process

The AR-2 Process as outlined in Table I has the same number of steps as that used in the AR-1 Process. The first developer is a fast acting solution that is similar to but not interchangeable with the AR-1 first developer. A combination short-stop hardening bath follows. The re-exposure required to reverse the image is carried out during the initial washing step in the process. Subsequent color development forms positive silver and dye images simultaneously in each of the three emulsion layers, followed by a second short-stop hardening bath. All silver formed during both first and color development is then converted in a bleach solution. After a brief rinse to minimize carry-over of bleach, the converted silver salts, along with undeveloped silver halides, are fixed out, leaving a positive dye image. Postfixing steps include a wash, a conditioning bath which makes the film more pliable, a brief water rinse and finally an anti-spot dip rinse. Conventional cine drying equipment is used to dry the film.

As in most color reversal processes, the first developer represents the most critical step in the AR-2 Process. Since the immersion time for this step is, by design, quite short in duration, it is extremely important to maintain control of time, temperature and agitation. It is recognized that existing cine processing machines will probably require an immersion time slightly different from that outlined in Table II for best results. However, once the optimum immersion time has been established for a given machine, that time for first development should be maintained to within ±15s to insure uniform results. The temperature of the first developer solution should be controlled to within ±0.5 at 80 F. In addition, agitation or circulation rates should be constant and reproducible in this solution.

Table II. AR-2 Process Procedure.

Step	Time (min) at 80 F
First Developer #505	3.5
Short-Stop Hardener #907	1.5
Wash and re-exposure	2.0
Color Developer #625	4.0
Short-Stop Hardener #907	1.5
Wash	2.0
Bleach #718B	2.0
Rinse (Water)	.5
Fixer #806A	2.0
Wash	1.0
Conditioning bath (16mm film only)	.5
Wash	1.0
Final Rinse #951D	.5
Total time (wet process)	22.0
Dry 80–90 F 30–40% RH	

Overdevelopment in the first developer due to an increase in time or temperature will affect the photographic characteristics of Anscochrome films. Compared to films developed at the optimum time and temperature, films subjected to extended first development will be faster in speed and lower in maximum density. The gradation will be steeper, especially in the highlight areas. Conversely, films which do not receive sufficient first development will show a loss in speed, higher maximum density and softer highlight gradation (Fig. 1).

To obtain optimum photographic and physical results, strict time and temperature specifications must also be maintained for the secondary solutions.

Another aspect in the control of any photographic process is the maintenance of the chemical activity in all solutions. The most important chemical factors to be controlled are:

(1) accurate mixing of the starting solutions and their respective replenishers,

(2) maintaining the correct replenisher rates, and

(3) maintaining the pH of the solutions within their respective recommended ranges.

Chemistry of the AR-2 Process

In order to provide a reversal process which would be shorter in time, it was necessary to reduce the immersion times in both developer solutions since

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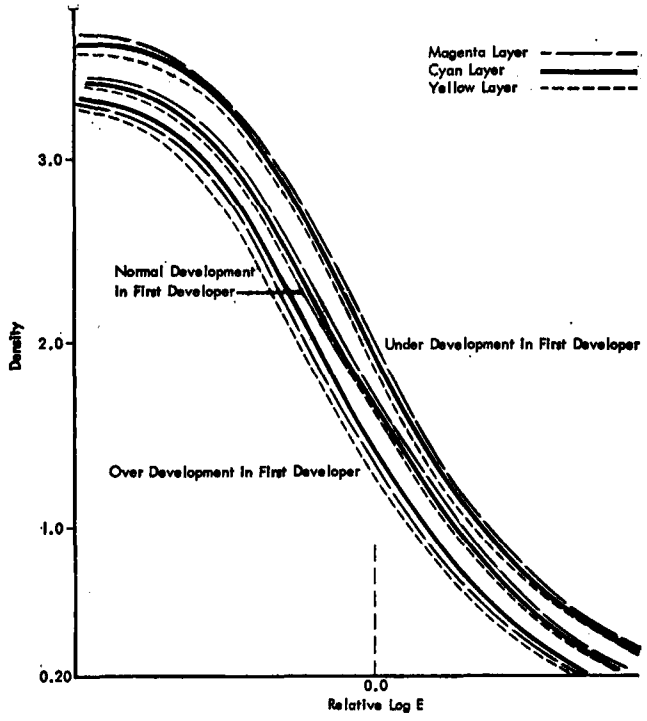

Figure 1

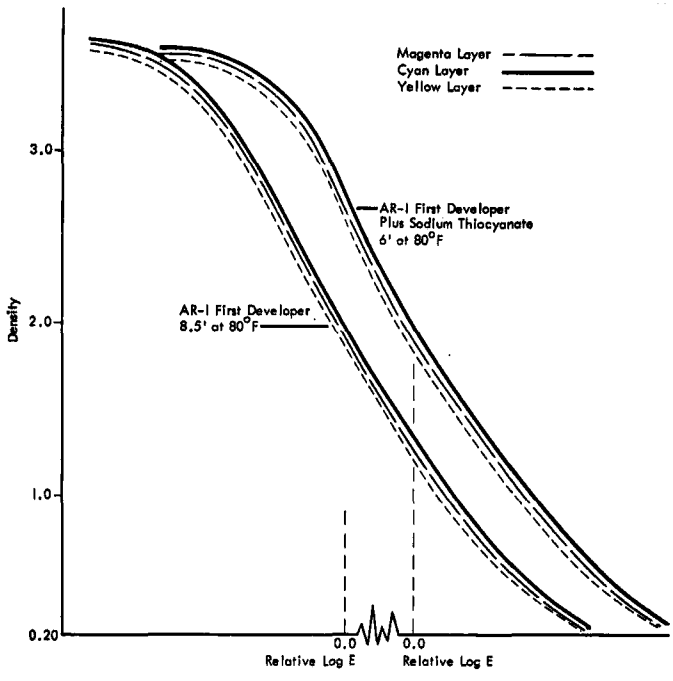

Figure 2

these two particular steps consumed the longest time in the AR-1 Process. During initial experiments on increasing the reaction rate of the first developer, it was observed that by increasing the concentration of sodium thiocyanate in the AR-1 First Developer, the reaction rate was increased by about 25%. Figure 2 shows the sensitometric results obtained by processing identically exposed films in

(a) AR-1 First Developer for 8.5 min @ 80 F, and

(b) AR-1 First Developer plus additional sodium thiocyanate for 6 min @80 F

Subsequent addition of phenidone to the AR-1 First Developer increased the reaction by an additional 25%. The combination of the increase in thiocyanate concentration and the addition of phenidone permitted the immersion time to be reduced from 8.5 min to approximately 3.5 min at 80 F. Although these two changes were sufficient to match the standard AR-1 First Developer in speed, it was necessary to make additional changes in concentrations of hydroquinone and borax to achieve satisfactory photographic results. These changes constitute the formula for the AR-2 First Developer. Figure 3 exhibits the sensitometric results obtained when identically exposed films were:

(a) developed for 3.5 min at 80 F in the AR-2 First Developer,

(b) developed for 3.5 min at 80 F in the AR-1 First Developer, and

(c) developed for 8.5 min at 80 F in the AR-1 First Developer.

The next objective was to increase the activity of the color developer solution through chemical additives. A primary chemical compound in the color developer for the AR-1 Process is Beta phenylethylamine. This is used to accelerate the activity of the developing agent in this step. Experimental tests showed that by increasing the concentration of Beta phenylethylamine (DA-3), the immersion time normally required to produce optimum color coupling could be reduced by approximately 60%. This increase in concentration of DA-3 is the major change instituted in the AR-2 Color Developer. Minor chemical and pH adjustments were necessary to optimize this developer. Sensitometric results show the faster reaction rate of the AR-2 Color Developer as compared to the AR-1 Color Developer, when identically exposed

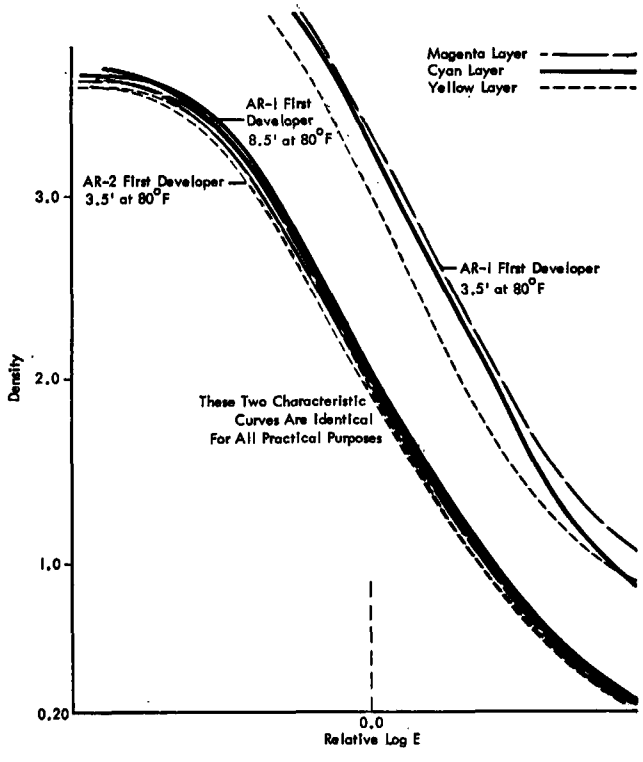

Figure 3

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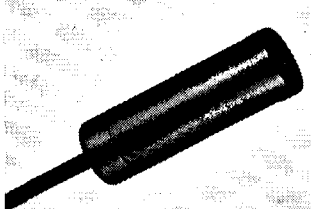

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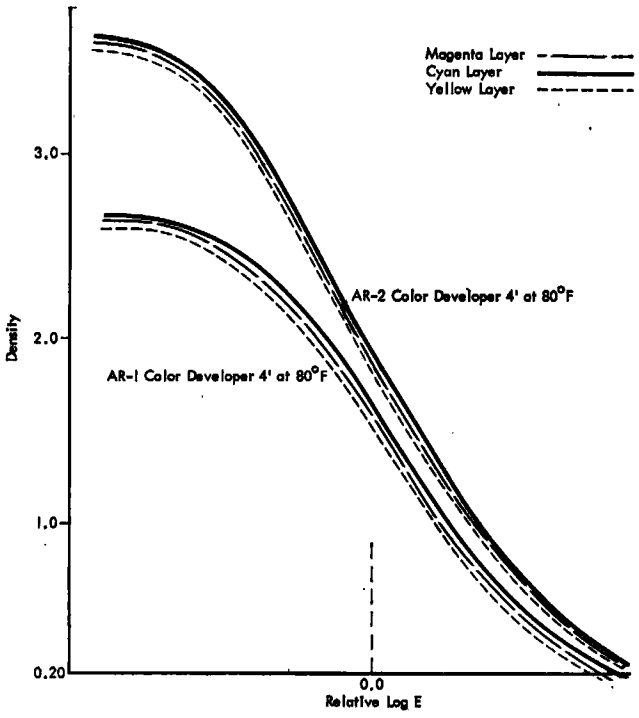

Figure 4

films were processed in each developer for 4 min at 80 F (Fig 4).

The chemistry of the AR-2 Process for the remaining or secondary solutions is identical to that of the AR-1 Processor.

Time and Temperature Tolerances

The AR-2 Process was designed to produce optimum results for Anscochrome type color films at 80 F. Lower temperatures with increased times in this chemistry will provide satisfactory results but this procedure obviously defeats the objective of reducing the process time. The developers should be maintained to within ±0.5 F, the secondary solution to within ±3 F and the washes between 75 and 80 F. The developers, bleach, fixer and conditioning bath should be circulated for temperature control and agitation. It may be necessary to circulate all solutions in order to maintain the recommended temperatures in a given installation depending upon the existing local conditions.

Agitation

The developers are agitated either by the use of turbulation tubes directed against the film or by distribution tubes located in the bottom of the tank. Air agitation is used in the short stop hardening baths to provide rapid, even action. Valves should be provided on the air lines for control of the amount of air used for agitation.

Replenishment Data

Since the AR-2 Process is intended primarily for motion-picture laboratories, it is economically feasible to replenish all of the solutions on a continuous basis. The replenishment data as outlined in Table III should serve as a satisfactory starting point for most machines. The use of replenishers provides considerable savings in chemical costs and enhances more uniform processing. With proper replenishment in cine processors, solutions may be maintained in close control indefinitely. This requires adjustment of replenishment rates to fit the specific machine and adequate chemical controls. Best results are obtained with regular photographic crosschecks of developers and their replenishers along with accurate chemical analysis.

Filtration

All of the chemical solutions used in the AR-2 Process should be filtered to remove dirt and sludge. This provision will ensure physically clean processed film.

Chemicals — Mixing Directions

The formulas for all of the chemical solutions used in the AR-2 Process are tabulated in Tables IV—X. The chemical constituents in each solution should be added in the order outlined. The developers and their replenishers are susceptible to oxidation and precaution should be taken to avoid stirring air into the solution during mixing.

All of the chemical constituents should be added slowly with mechanical mixing to prevent caking.

The factors of greatest influence when mixing photographic solutions are time, temperature and initial volume of water. In regard to time, any chemical constituent should not be added until the previous one has fully dissolved. The temperature for mixing a particular solution should follow the manufacturer's recommendation. The amount of water as prescribed prior to the addition of the initial chemical compound should be used to ensure solubility.

Process Control

The process control procedure recommended for the AR-2 Process is identical to that presently used to control the AR-1 Process. Anscochrome D-100 Type 2210 is used as the control material, and the same process tolerances are recommended for the AR-2 Process.

Generally, the solutions used in the AR-2 Process behave like the corresponding solutions in the former chemistry. However, due to the shorter immersion times and the increased reaction rates of the solutions, it is necessary to apply narrower tolerances.

(*A*) *First Developer:* As mentioned earlier, the first developer solution is the most critical step in the process. Rather large shifts in speed, color balance and gradation may be produced by variation in time and/or temperature. Improper replenishment rates will cause process variations. Over-replenishment, increased time or higher temperatures will cause an increase in speed and/or steeper gradation, and generally the color balance will become greener. Lower speed and a more magenta balance could be attributed to inadequate replenishment, insufficient immersion time or too low a temperature.

(*B*) *Color Developer:* The color developer solution used in the AR-2 Process, while not as sensitive to variations as the first developer also requires close control. Shifts in color balance and speed will be noted from time and temperature variations as well as with replenishment differences.

Contamination of color developer

Table III. AR-2 Process Replenishment Data.

Solution	Replenishment ml/1000 ft			Replen. Formula
	16mm	35 mm	70mm	
First Developer #505	1000	2200	4400	505R
Stop Hardener #907	400	800	1760	907R
Color Developer #625	900	1980	3960	625R
Stop Hardener #907	400	880	1760	907R
Bleach #718B	300	660	1320	718B-R
Fixer #806A	200	440	880	896A-R
Final Rinse #951D	14	30	60	951D-R
Conditioning bath	Per Analysis			

Table IV. AR-2 Process — First Developer and First Developer Replenisher.

	505	505R
EDTA	0.8 g	0.8 g
Phenidone B	1.0 g	1.5 g
Metol	3.0 g	3.5 g
Sodium sulfite, anhydrous	50.0 g	52.0 g
Hydroquinone	12.0 g	12.0 g
Sodium hydroxide, 76% flakes	12.0 g	14.0 g
Borax · $5H_2O$	30.0 g	32.0 g
Sodium bromide	2.0 g	1.0 g
Sodium thiocyanate	4.0 g	4.0 g
Potassium iodide	12.0 mg	10.0 mg
DA-7	1.0 g	0.5 g
Water to make	1.0 liter	1.0 liter
pH	10.35 ± 0.5	10.40 ± 0.5

Table V. AR-2 Process — Color Developer and Color Developer Replenisher.

	625	625R
EDTA	0.8 g	0.8 g
Sodium sulfite, anhydrous	2.0 g	2.5 g
Sodium hydroxide, 76% flakes	10.7 g	12.4 g
Borax · $5H_2O$	30.0 g	33.0 g
Sodium bromide	0.86 g	0.5 g
Sodium sulfate, anhydrous	100.0 g	120.0 g
DA-3	3.5 g	4.3 g
S-5	5.0 g	8.0 g
Water to make	1.0 liter	1.0 liter
pH	10.75 ± 0.5	10.75 ± 0.5

Table VI. AR-2 Process — Short-Stop Hardener and Replenisher.

	907	907R
Potassium alum sulfate · $12H_2O$	20.0 g	35.0 g
Sodium sulfate, anhydrous	20.0 g	30.0 g
Boric acid	4.0 g	1.0 g
Sodium acetate	25.0 g	20.0 g
Acetic acid, glacial	12.0 ml	22.0 ml
Water to make	1.0 liter	1.0 liter
pH	4.5 ± 0.10	4.0 ± 0.10

Table VII. AR-2 Process — Bleach and Bleach Replenisher.

	718B	718B-R
Potassium ferricyanide	80.0 g	100.0 g
Potassium ferrocyanide · 3 H_2O	5.0 g	—
Sodium bromide	15.0 g	30.0 g
Sodium nitrate	30.0 g	38.0 g
Sodium acetate	10.0 g	12.0 g
Acetic acid, glacial	1.5 ml	2.5 ml
Water to make	1.0 liter	1.0 liter
pH	5.2 ± 1.0	5.1 ± 1.0

Table VIII. AR-2 Process — Fixer and Fixer Replenisher.

	806A	806 A-R
Sodium thiosulfate, anhydrous	130.0 g	150.0 g
Sodium sulfite, anhydrous	4.0 g	6.0 g
Borax · 5 H_2O	6.0 g	8.0 g
EDTA	0.8 g	0.8 g
Sodium hydroxide, 76% flakes	0.8 g	0.7 g
Formalin, 40%	15.0 ml	20.0 ml
Water to make	1.0 liter	1.0 liter
pH	10.0 ± 0.10	10.1 ± 0.10

Table IX. AR-2 Process — Conditioning Bath and Replenisher.

	Starting soln.	Replenisher
Methyl cellosolve acetate	40.0 ml	40.0 ml
Diethyl carbitol	30.0 ml	30.0 ml
Water to make	30.0 ml	

Table X. AR-2 Process — Final Rinse and Replenisher.

	Starting soln.	Replenisher
Water at 75–85 F	750.0 ml	750.0 ml
Dow Corning Silicone Emulsion #36	2.0 ml	10.0 ml
Water to make	1.0 liter	1.0 liter
pH	7.5 ± 0.50	7.5 ± 0.50

by first developer will result in low maximum density and a blue or greenish balance. As little as 1% of first developer solution is required to produce objectionable results.

(*C*) *Short-Stop Hardener:* It is important to control the pH of this solution within the desired range (4.3–4.7). Higher or lower pH values will affect the hardening properties of this bath. Also too high a pH leads to insufficient short-stopping and scumming.

(*D*) *Bleach:* Low concentration of ferricyanide and sodium bromide due to inadequate replenishment or excessive dilution will cause insufficient bleaching. Since the immersion time in the bath is only 2 min, it is extremely important to maintain 70 grams per liter of ferricyanide and 15 grams per liter of bromide. Minor shifts in pH will not affect the bleaching or photographic results.

(*E*) *Fixer:* The pH of this solution should be maintained at the recommended range (10.0 ± 0.1) to ensure good hardening.

General processing information found in the AR-1 Anscochrome Motion Picture Process Manual (formerly the AR-80 Manual) with the exception of the developer formula and the process timing, also applies to the AR-2 Process described herein and should be followed.

Conclusion

Anscochrome color films and their respective processing procedures have been improved in the last ten years, culminating in present films and the AR-1 and AR-2 Processes designed to operate at 80 F. The AR-2 Process is identical to the previous AR-1 Process in regard to basic processing steps but different in both time and chemistry of the developer solutions. This process provides increased production capacity due to a shorter process cycle. The AR-2 Process is recommended primarily for cine processing machines because of the short immersion times required for Anscochrome film in this process. The AR-2 Process represents a further step in the continuing effort to shorten the process cycle for color reversal color films.

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