Processing Anscochrome Motion-Picture Films for Industrial and Scientific Applications

By JOHN L. FORREST

Anscochrome is a new 16mm reversal motion-picture film with an exposure index of 32. The film can be processed by the regular Ansco color process in the field or in the laboratories of the manufacturer. Higher speeds can be secured for scientific and industrial applications at a sacrifice of fineness of grain and color balance by modifying the process. The processing procedure is described.

REVERSAL-TYPE color films for motion-picture work have been on the market for many years. Such films in 16mm and 8mm widths are best known for their prominence in the amateur color field. In recent years, improvements in resolution and grain, combined with the lower cost of 8mm film, have channeled much of the amateur market to 8mm film and advanced 16mm film into the professional category where it is used extensively for commercial, educational and advertising purposes.

While the negative-positive system has been generally adopted for 35mm professional motion pictures, the advantages of the reversal process in grain and definition have enabled it to hold its own in the production of commercial 16mm positives. It also offers unique advantages for scientific and industrial work where the film is used primarily for investigational and information-gathering purposes. Here a single print is often sufficient and the reversal process yields this at minimum time and cost.

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Description of Anscochrome

To meet the need for a higher-speed reversible color film, Anscochrome was introduced in the spring of 1955. This film is an integral tripack reversal film in classical formation (Fig. 1).[1] The top layer is sensitive to blue and gives a yellow image. A yellow filter which disappears in processing is placed between the top and middle layers to prevent blue light from recording in the middle layer. The middle layer records green light and yields the magenta image. The bottom layer records red light and gives a cyan image. A thin colloidal silver layer under the emulsion layers provides halation protection.

The film can be processed by the regular Ansco color process[2] by the user, or in the Ansco processing laboratories.

Two types of Anscochrome are available: one balanced for use in average daylight conditions, and the other for tungsten (floodlight) illumination.

The processing of reversal film has always been rather critical because only within a narrow range of speed did all the layers respond the same to processing. Slight changes outside of these narrow limits caused the responses of the layers to diverge, resulting in a shift in color balance throughout the exposure scale.[3]

Anscochrome differs from previous reversal color films in that the three emulsion layers respond alike to changes in developing time over a wide range. This makes it possible to adjust processing conditions to the exposure, as in black-and-white work.

Characteristics

Daylight-type Anscochrome is balanced for use under average daylight conditions (about 6000 K). For daylight exposure, no filter is required. For exposure under tungsten illumination, a #10 conversion filter should be used. This combination reduces the speed to about E.I. 8 and is ordinarily not recommended because of speed loss.

The tungsten type is balanced for use with photoflood illumination (about 3400 K). For use in daylight, a #11 conversion filter is required. (This makes no significant change in the effective speed.)

The dyes produced in both types of film are similar (Fig. 2). They are more brilliant than those produced in Ansco color film, and the red and blue color reproduction has been improved.

Anscochrome is somewhat softer in

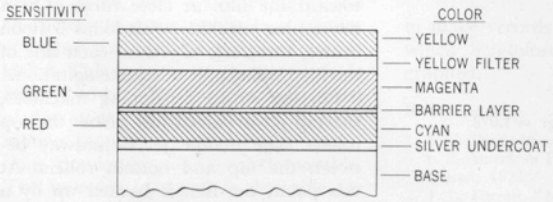


Fig. 1. Anscochrome layer arrangement.

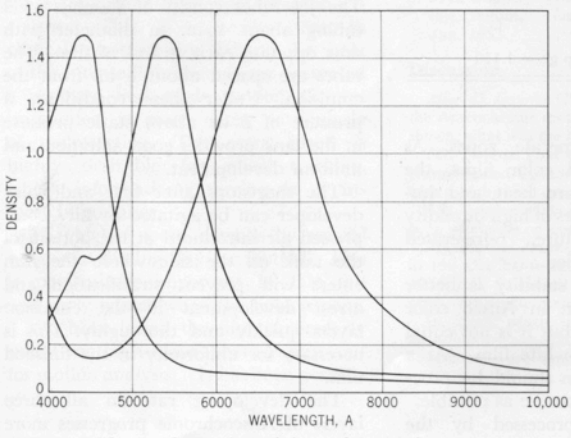


Fig. 2. Absorption of dyes of Anscochrome.

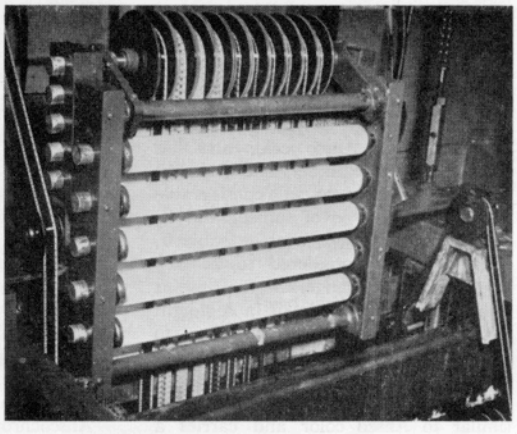


Fig. 3. Equipment for obtaining the second exposure.

Processing Formula for Anscochrome for 16mm Motion-Picture Film.

	First Developer — 502A-3		502A Replenisher	
	Metric	U.S. Liquid	Metric	U.S. Liquid
Water	800 ml	100 fl oz	800 ml	100 fl oz
Calgon	1 g	58 grains	1 g	58 grains
Metol	3 g	175 grains	3.5 g	204 grains
Sodium sulfite (dry)	50 g	6½ oz	52 g	6¾ oz
Hydroquinone	6 g	350 grains	8.5 g	1 oz, 58 grains
Sodium carbonate (mono)	40 g	5⅔ oz	45 g	6 oz
Sodium thiocyanate	2 g	117 grains	2.3 g	134 grains
Potassium bromide	2 g	117 grains	—	—
0.1% potassium iodide solution	6 ml	1 oz	—	—
Water to make	1 l	1 gal	1 l	1 gal
	Sp gr = 1.084			
	Shortstop — 859-B		858 Replenisher	
Water	800 ml	100 fl oz	800 ml	100 fl oz
Acetic acid (glacial)	3 ml	½ fl oz	10 ml	1¼ fl oz
Sodium acetate	30 g	4 oz	20 g	2⅔ oz
Water to make	1 l	1 gal	1 l	1 gal
	pH = 5.3 ± 0.2		pH = 5.0 ± 0.2	
	Hardener — 901			
Water	800 ml	100 fl oz	Replenish with same, then discard after one week.	
Potassium chrome alum	30 g	4 oz		
Water to make	1 l	1 gal		
	pH = 3.2 ± 0.1		Sp gr = 1.018	
	Color Developer — 607		607 Replenisher	
Water	800 ml	100 fl oz	800 ml	100 fl oz
Calgon	1 g	58 grains	1 g	58 grains
Sodium sulfite	5 g	292 grains	5.6 g	327 grains
S 5	5 g	292 grains	7.5 g	1 oz
Sodium carbonate	120 g	16 oz	135 g	18 oz
DA 3	2.8 g	162 grains	3.2 g	187 grains
Potassium bromide	1 g	58 grains	0.6 g	35 grains
Water to make	1 l	1 gal	1 l	1 gal
	Sp gr = 1.105			
	Bleach 716-1, with double ferro-ferri content for machine operation			
Water	800 ml	100 fl oz		
Potassium ferricyanide	100 g	13⅓ oz		
Potassium ferrocyanide $3H_2O$	10 g	2¼ oz		
Sodium bromide	15 g	2 oz		
Disodium phosphate	11 g	1½ oz		
Citric acid	8 g	1 oz		
Formalin (37%–40%)	15 ml	2 fl oz		
Water to make	1 l	1 gal		
	pH = 4.7 ± 0.2		Sp gr = 1.078	
	Fixer — 800-B			
Water	800 ml	100 fl oz		
Sodium thiosulfate	200 g	26⅔ oz		
Sodium sulfite	5 g	292 grains		
Boric acid	4 g	233 grains		
Borax	3 g	175 grains		
Water to make	1 l	1 gal		
	pH = 8.0 ± 0.1		Sp gr = 1.110	

gradation than Ansco color and has more exposure latitude. The exposure latitude depends to a considerable degree on the type of subject and its brightness range. For average subjects, the latitude is considered to be ±½ stop. Within this range, the film retains full scale with good detail in highlight and open shadows; this lends it to satisfactory duplication on Ansco duplicating film Type 238.

The stability of the emulsion is similar to Ansco color and carries a one-year dating for storage at room temperature in temperate zones. As is the case with all color films, the enemies of stability are heat and humidity, and for climates of high humidity and high temperature, refrigerated storage is recommended.

The latent image stability is better in Anscochrome than in Ansco color reversible color film, but it is not equal to that of black-and-white film. As a general rule, the film should be processed as soon after exposure as possible.

Anscochrome is processed by the regular Ansco color process as outlined in Table I. The process consists of 13 steps including washes. The developing times in the first and color developer are adjusted for the exposure index used to expose the material. Normally, the film is processed to correspond to E.I. 32.

When processing for higher speeds, the developing time both in first developer and color developer is increased as shown in Table I. This prolonged time may not be obtainable on some developing machines. Similar results can be obtained by increasing the temperature of the first developer (step 1) from 68 F to 75 F, and adjusting the first developing time as indicated. The temperature of the color developer and other solutions need not be increased but should remain at 68 F.

The second exposure (processing step 4) can be accomplished simultaneously with the wash after hardener. In combining wash and the exposure, the top bank of rollers is raised out of the tank to accomplish wash and second exposure simultaneously. The method of obtaining the second exposure is shown in Fig. 3, and either tungsten or white fluorescent lamps can be used. Fluorescent lamps are preferred because they provide even illumination with little heat.

Agitation in Processing

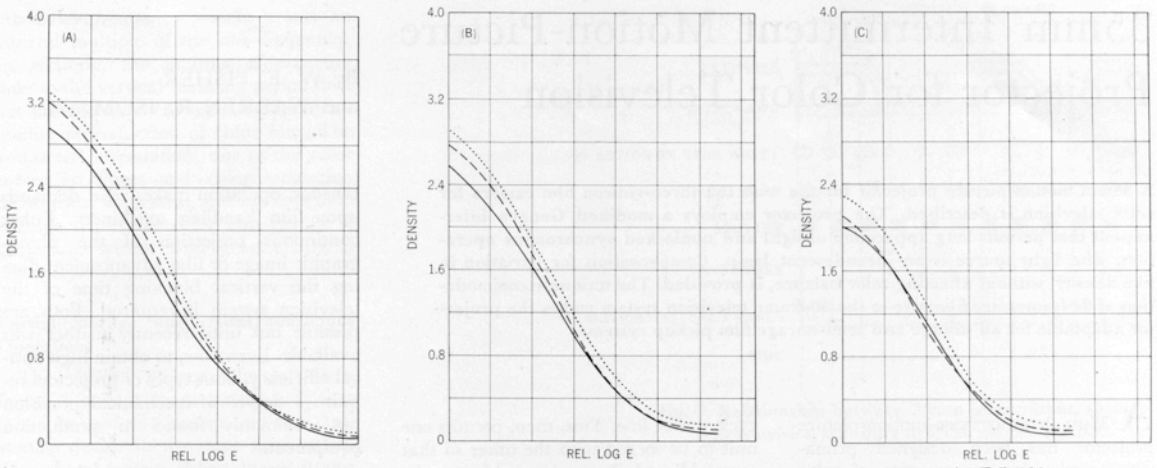
Agitation should be provided in the first developer (step 1), the short stop (step 2), color developer (step 5), and the shortstop after color developer (step 6).

In the developers, agitation can be supplied by submerged jets directed toward the film at close range. On a developing machine with loops 3 ft on center, three sets of jets on each side of the loop will supply adequate agitation.

On the Ansco developing machines, the top jet is placed just below the top rollers. The middle jet is midway between the top and bottom rollers. At this point, the film is backed up by a large rubber-covered roller. The third jet is placed near the bottom rollers. The jet tubes consist of stainless steel tubing about 1 in. in diameter with slots opposite each strand of film. The tubes are spaced about ½ in. from the emulsion. Under these conditions, a pressure of 6 oz above static pressure in the tank provides good agitation and uniform development.

The shortstops after first and color developer can be agitated by air. Compressed air introduced at the bottom of the tank on the side where the film enters will prevent stratification and arrest development in the emulsion layers quickly and thoroughly. This is necessary for uniformity in the finished film.

The developing rate in all three layers of Anscochrome progresses more uniformly than in Ansco color. This



(a) E.I. 32 (b) E.I. 64 (c) E.I. 128

Figs. 4(a)-(c). Characteristic curves: ——— red; – – – – – – green; ..... blue.

characteristic makes it possible to process the material with the speed range of E.I. 16 to 64 with little shift in characteristic curve.

Ansco laboratories process the material to correspond to an E.I. of 32. Up to an E.I. 64, the curve conformity shows little change. Above 64, the film becomes progressively unbalanced but holds together fairly well for one more stop in speed up to E.I. 128. The best quality from the standpoint of granularity occurs between E.I. 32 and 64 (Figs. 4A–4C).

At E.I. 64 and above, the increased speed is obtained at a sacrifice in fineness of grain, and a steepening of the characteristic curve results in a picture of higher contrast and increased granularity. This processing characteristic is referred to because the increase in speed of two stops makes it possible to make motion pictures in color under conditions previously considered impossible. The increase in speed is desirable for many scientific and industrial applications where information obtained is more important than photographic excellence. This is especially true in clinical photography, where the heat of the intense light has always presented a problem and made motion pictures impractical in many cases, particularly of microsection. The extra speed is highly desirable for missile-tracking, where information-gathering is of utmost importance.

The higher speed extends by several hours the filming day for football. This is particularly important in late fall and early winter when the light is poor.

We have found the film particularly useful for high-speed photography and for motion analysis. It has been possible to make records of fast-moving objects which heretofore could not be photographed.

Table I. Anscochrome Processing Procedure.

	E.I. 32	E.I. 64	E.I. 125
1. First developer —	15 min at 68 F ± ¼	19 min at 68 F ± ¼	30 min at 68 F ± ¼
2. Rinse 15 sec			or
Shortstop 3 min			19 min at 75 F ± ¼
3. Hardener 3 min			
4. Wash and 2nd exposure 3 min			
5. Color developer —	15 min at 68 F ± ¼	17 min at 68 F ± ¼	20 min at 68 F ± ¼
6. Rinse 15 sec			
Shortstop 3 min			
7. Hardener 3 min			
8. Wash 3 min			
9. Bleach 6 min			
10. Wash 3 min			
11. Fix 6 min			
12. Wash 6 min			
13. Dry			

References

1. E. J. Wall, *History of Three-Color Photography*, p. 2, American Photographic Publishing Co., Boston, 1925.
2. J. L. Forrest, "Machine processing of 16mm Ansco Color Film," *Jour. SMPE*, *45*: 313, Nov. 1945.
3. J. L. Tupper, "Practical aspects of reciprocity law failure," *Jour. SMPTE*, *60*: 20–29, Jan. 1953.

Discussion

Albert D. Emurian (Philco Corp.): In reference to the Anscochrome motion picture which was just shown, what was the last shot you showed us?

Mr. Forrest: That was a picture of a missile photographed against a referenced background with a high-speed camera.

Mr. Emurian: How is this film available? That is, in what sizes or lengths.

Mr. Forrest: Anscochrome 16mm is available in 100 and 200-ft daylight-loading rolls, and in 400-ft rolls on special order. It can also be supplied with single perforation.

In 35mm width, it is available in cartridges for miniature cameras and 100-ft rolls. 400 and 1000-ft rolls are available on special order for special applications.

Richard O. Painter (General Motors Proving Ground): What was the exposure index used in making the shots with the high speed camera?

Mr. Forrest: Those scenes were made at an exposure index of 125. The camera was operating at 3000 frams/sec.

Mr. Painter: I understood that the tungsten balanced film was not recommended for use at an exposure index of 125, only the daylight.

Mr. Forrest: Both Daylight and Tungsten Type Anscochrome film can be exposed at E.I. 125 and the process modified as I have just described in this paper to yield that high speed.

Mr. Painter: Have you any information of reciprocity-law failure of this material at much shorter exposure?

Mr. Forrest: The 3 emulsions used in Anscochrome respond similarly to exposures of various times over a wider range than color films which we have supplied in the past. This is the reason that the very short exposures of the high-speed camera yield acceptable color values.

Mr. Painter: I am thinking of exposures down in the range of 10^{-5} seconds. Would there be any trouble there?

Mr. Forrest: I could not say. That would have to be tried.

Henry Rogers (Rolab Laboratories): What kind of a camera was used for the first three shots?

Mr. Forrest: The first scenes on the demonstration reel were made with a Cine Kodak Special and the last high-speed scenes were made with an Eastman Type-III high-speed camera.