



Environment

I N F O R M A T I O N F R O M K O D A K

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Sources of Silver in Photographic Processing Facilities



Silver is found in a number of different materials in facilities that process photographic materials. The biggest sources of silver are photographic films and papers. Once processed, silver is retained in the film and paper or transferred to the photographic processing solutions. You can collect the silver in photographic processing solutions using silver-recovery equipment or send the solutions off-site for recovery.

You can also have a refiner recover silver from some unprocessed, as well as processed, photographic films and papers. The amount of silver recovered depends on the type of film or paper, the exposure, and the type of processing used. Understanding the amount of silver available from photographic films and papers can help you determine if it is worthwhile for your facility to

recover that silver. Knowing this will assist you in selecting the proper silver-recovery equipment and ensure that you maximize the return from your refiner.

SILVER IN PHOTOGRAPHIC FILMS AND PAPERS

Silver is found in photographic films and papers—it is the element responsible for producing the photographic image. You can recover silver from unprocessed films and papers, as well as from processed black-and-white films and papers. Black-and-white films and papers include graphic arts films; medical, dental, and industrial x-ray films; and micrographic films. Processed *color* photographic films and papers (negatives, transparencies, and prints) do not contain appreciable amounts of silver.

Kodak's health, safety, and environmental publications are available to help you manage your photographic processing operations in a safe, environmentally sound and cost-effective manner. This publication is a part of a series of publications on silver management designed to help you estimate the silver available from your photographic processing operations.



VARIATIONS IN THE SILVER CONTENT OF PHOTOGRAPHIC FILMS AND PAPERS

Silver content in photographic films and papers may vary from emulsion to emulsion. These manufacturing variations are designed to ensure consistent product quality in contrast and speed. Therefore, the amount of silver available for recovery in photographic films and papers may slightly increase or decrease. Similar products made by different manufacturers may vary in the amount of silver they contain.

For information on the amount of silver you can potentially recover from Kodak's photographic films and papers, contact Kodak Environmental Services (KES) at (716) 477-3194.

SILVER FROM PHOTOGRAPHIC FILM SPLICING TAPE

In processing color photographic films, two potential sources of silver are often overlooked. Some color films are pre-spliced to allow for long processing lengths. A piece of film is cut off (*referred to as tongues*) and an additional piece of film is located underneath the splicing tape. Both pieces of film contain silver.

You can recover the silver from the splices on-site by soaking the film scraps in a fixer bath (you can use spent fixer) and then desilvering the fixer using your silver-recovery equipment. You can also send the splices directly to a refiner for recovery.

RECOVERING SILVER FROM PHOTOGRAPHIC FILMS AND PAPERS

Refiners recover silver from photographic films in two ways:

1. Some photographic films may initially be washed to remove the silver-bearing emulsion from the film base, allowing the base material to be recycled. The removed silver-bearing emulsion is heated to remove water and any organic compounds, and is then introduced into a smelting process.
2. When film base recycling is not performed, photographic films are directly heated to remove water and any organic compounds (including the film base), then introduced into a smelting process.

Photographic papers are generally not separated for recovery of the paper base. These materials are also heated to remove water and any organic compounds (including the paper base), then introduced into a smelting process.

WASTE CHARACTERIZATION

Representative samples of processed and unprocessed Kodak photographic films and papers were tested using the Toxicity Characteristic Leaching Procedure (TCLP) test. The samples did not leach silver at greater than or equal to 5 ppm. Therefore, these materials are not regulated as a hazardous waste (for silver) under the United States Environmental Protection Agency's (USEPA) Resource Conservation and Recovery Act (RCRA) regulations.

Some states may choose to regulate silver-bearing wastes under their own hazardous waste program more stringently than the USEPA. Check with your state authorities for any additional hazardous waste requirements. Outside the United States, check with your local authorities to determine waste classification and management requirements.

DETERMINING THE AMOUNT OF SILVER YOU CAN POTENTIALLY RECOVER

The process to estimate the amount of silver available from your photographic films and papers involves several steps:

1. **Determine the total area of the photographic films and papers.**

To determine this amount, you will need to estimate how much film and paper that you process at your photographic processing facility over a known period of time. If you are calculating the available silver to compare to the amount reported to you by your refiner, you will want to use an amount that represents your average processing over a specific period of time. Typically, a quarterly or annual estimate is used.

If you are calculating the available silver to determine the size of silver-recovery equipment that you will need, make sure that you use a peak processing amount to ensure that the equipment will always meet your needs. Typically, an hourly peak processing rate is used. See page 7 for conversion charts that will help you calculate area for common film and paper configurations.

2. **Determine the amount of silver in the photographic films and papers that you process.**

To determine this amount, you will first need to know the amount of silver that is present in the photographic films and papers.

Information on the amount of silver that is present in Kodak photographic films and papers is available from Kodak Environmental Services at (716) 477-3194. This information is typically reported in troy ounces per 1000 square feet.

3. **Determine the amount of silver available from the photographic films and papers that you process.**

For color films and papers, use the total amount of silver present to estimate the amount that is potentially recoverable. For black-and-white films and papers, you will need to estimate the percentage of exposure. The higher the level of exposure (dark images), the lower the amount of silver that is removed from the film or paper.

4. **Determine the total amount of silver available over a specific period of time.**

Once you have estimated the area of the films and papers that you process and the amount of silver that is available, you can calculate the total amount of silver. Make sure that you include operating parameters, such as days per week, when making the total calculation.

The examples on pages 4, 5, and 6 are provided to illustrate calculations for various photographic processing facilities. Please note that these examples may not be representative of the exact processing conditions at your facility.

MINILAB EXAMPLE

A minilab processes an average of 50 rolls of 35 mm film per day using KODAK EKTACOLOR ROYAL III Paper. How much silver is available for recovery each day?

Assume:

- Average film mix is
 - 25% KODAK GOLD 100
 - 30% KODAK GOLD 200
 - 25% KODAK GOLD 400
 - 5% KODAK ROYAL GOLD 100
 - 10% KODAK ROYAL GOLD 200
 - 5% KODAK ROYAL GOLD 400
- Average film is 24 exposure (0.44 square feet)
- Average of 5 square feet of paper processed per roll of film
- 6 day / week operation

The average amount of silver available per roll of film is—

KODAK GOLD 100	16 tr. oz. / 1000 sq. ft. x 25%	=	4.0 tr. oz. / 1000 sq. ft.
KODAK GOLD 200	16 tr. oz. / 1000 sq. ft. x 30%	=	4.8 tr. oz. / 1000 sq. ft.
KODAK GOLD 400	24 tr. oz. / 1000 sq. ft. x 25%	=	6.0 tr. oz. / 1000 sq. ft.
KODAK ROYAL GOLD 100	17 tr. oz. / 1000 sq. ft. x 5%	=	0.8 tr. oz. / 1000 sq. ft.
KODAK ROYAL GOLD 200	18 tr. oz. / 1000 sq. ft. x 10%	=	1.8 tr. oz. / 1000 sq. ft.
KODAK ROYAL GOLD 400	22 tr. oz. / 1000 sq. ft. x 5%	=	1.1 tr. oz. / 1000 sq. ft.
			18.5 tr.oz. / 1000 sq. ft.

$$18.5 \text{ tr. oz. / 1000 sq. ft.} \times 0.44 \text{ sq. ft. / roll} = 0.008 \text{ tr. oz. / roll}$$

The average amount of silver available from paper is—

$$\text{KODAK EKTACOLOR ROYAL III} \quad 2 \text{ tr. oz. / 1000 sq. ft.} \times 5 \text{ sq. ft. paper} = 0.01 \text{ tr. oz. / roll processed}$$

The annual available silver is—

$$(0.008 \text{ tr. oz.} + 0.01 \text{ tr. oz.}) / \text{roll} \times 50 \text{ rolls/day} \times 6 \text{ days/week} \times 52 \text{ weeks/year} =$$

$$\mathbf{280.8 \text{ tr. oz. of silver/year}}$$

GRAPHIC ARTS EXAMPLE

A medium sized color trade shop processes an average of 2 rolls of KODAK Scanner 2000 Films SAI and 10 sheets of KODAK Camera 2000 Film CGP per week.

How much silver is annually available for recovery?

Assume:

- Film area: Roll film = 297 sq. ft.
Sheet film (24 in. x 24 in.) = 3.3 sq. ft.
- Average film exposure of 70%
(Therefore, 30% of silver is removed during processing)
- 52 weeks / year operation

The average amount of silver available per roll of Scanner film is—

KODAK Scanner 2000 Film SAI = 9.6 tr. oz. / 1000 sq. ft.

(9.6 tr. oz. / 1000 sq. ft.) (297 sq. ft. / roll) = 2.85 tr. oz. / roll

(2.85 tr. oz. / roll) (0.30 [available]) = 0.86 tr. oz. available / roll Scanner film

The average amount of silver available per sheet of Camera film is—

KODAK Camera 2000 Film CGP = 9.6 tr. oz. / 1000 sq. ft.

(9.6 tr. oz. / 1000 sq. ft.) (3.3 sq. ft. sheet) = 0.03 tr. oz. / sheet

(0.03 tr. oz. / sheet) (0.30 [available]) = 0.01 tr. oz. available / sheet Camera film

The annual available silver is—

(0.87 tr. oz./roll)(2 rolls/week) + (0.01 tr. oz./sheet)(10 sheets/week)

(52 weeks/year) = 95.7 tr. oz. of silver/year

MEDICAL EXAMPLE

A hospital operates an M6B processor for general radiography. An average of 75 sheets of KODAK T-MAT RA Film (35 x 43 cm) is processed per day.

How much silver is available for recovery each day?

Assume:

- Film area: $(35 \times 43 \text{ cm.}) / (2.54 \text{ cm./in.}) (2.54 \text{ cm./in.}) = 233.3 \text{ sq.in./sheet}$
- Average film exposure of 50%
(Therefore, 50% of silver is removed during processing)

The average amount of silver available per sheet of film is—

KODAK T-MAT RA Film = 14.5 tr. oz. / 1000 sq. ft.

$(14.5 \text{ tr. oz. / 1000 sq. ft.}) (233.3 \text{ sq. in./sheet}) / (144 \text{ sq. in./sq. ft.}) = 0.023 \text{ tr. oz./sheet}$

$(0.023 \text{ tr. oz./sheet}) (0.50 \text{ [available]}) = 0.012 \text{ tr. oz. available / sheet of film}$

The annual available silver is—

$(0.012 \text{ tr. oz./sheet} \times 75 \text{ sheets/day} = 0.9 \text{ tr. oz. of silver/day}$

AREA OF COMMON FILM AND PAPERS

Disc and Roll Films

Film Size	Square Feet per 1000 Units	Square Metres per 1000 Units
Disc	26.4	2.45
110-12	78.0	7.30
110-20	113	10.6
110-24	131	12.2
126-12	177	16.5
126-20	272	25.3
126-24	319	29.6
127	305	28.0
135-12	268*	24.9*
135-20	382*	35.5*
135-24	440*	40.9*
135-36	619*	57.5*
120	547†	50.8†
620	530†	49.2†
220	1090	102
828	163	15.1

* This area includes the tongue. If the tongue is cut away and therefore will not be considered, then these areas will be as follows.

† These sizes are for color films only. Black-and-white film areas given below reflect their slightly shorter lengths.

Film Size	Square Feet per 1000 Units	Square Metres per 1000 Units
135-12	249	23.1
135-20	363	33.7
135-24	420	39.0
135-36	592	55.0

Black-and-White Film Size	Square Feet per 1000 Units	Square Metres per 1000 Units
120	538	50.0
620	522	48.5

Sheet and Bulk Films and Papers

Sheets or Prints (inches)	Square Feet per 1000 Units	Square Metres per 1000 Units
2¼ x 3¼	50.8	4.70
2½ x 3½	60.8	5.70
3¼ x 4¼	95.9	8.90
3½ x 3½	85.0	7.90
3½ x 4½	109.4	10.2
3½ x 5	121.5	11.3
4 x 5	139	12.9
4½ x 10	313	29.0
4½ x 17	531	49.2
5 x 7	243	22.6
7 x 17	826	76.9
8 x 10	556	51.6
10 x 12	833	77.5
11 x 14	1070	99.0
14 x 17	1650	154
16 x 20	2220	206
18 x 24	3000	279
20 x 24	3330	310
30 x 40	8330	774
34 x 44	10,400	965

Unforated Rolls (mm)	Square Feet/Cartridges per 1000	Square Metres
8 mm x 50 ft cartridges	1310	122
8 mm	26.2	2.44
16 mm	52.5	4.88
35 mm	115	10.7
46 mm	151	14.0
70 mm	230	21.3
82.5 mm	271	25.1
105 mm	344	32.0

Rolls (inches)	Square Feet per 1000 Units	Square Metres per 1000 Units
3½	292	27.1
4	333	30.9
5	417	38.7
7	583	54.2
8	667	62.0
9½	792	73.6
10	833	77.4
11	917	85.2
16	1333	124
20	1667	155
24	2000	186
30	2500	232
36	3000	279
40	3330	310
42	3500	325
50	4170	387

Perforations—Percentage of Film Area

Perforations	Percentage of Surface
8 mm (regular)	7.64
8 mm (super)	3.10
16 mm film perforated on both edges with regular pitch	3.82
16 mm film perforated one edge (regular 16 mm)	1.91
35 mm film perforated both edges	6.66
46 mm film perforated one edge	2.54
70 mm film perforated both edges	3.33
70 mm film perforated one edge	1.67

Conversion Table

To Convert:	Multiply By:
troy ounces to grams	31.1035
troy ounces to pounds	0.0686
grams to pounds	2.205×10^{-3}
feet ² to metre ²	0.0929

Spliced Film

Film Size	Amount Cut Off Before Splicing (sq ft/1000 units)		Amount Covered by Splicing Tape
	Head	Tail	
110	13.12	4.37	$\frac{1}{2}$ inch
126	—	15.5	$\frac{3}{4}$ inch
135	21.27 (long tongue) 10.63 (short tongue) plus 9.57 (1 inch x 35 mm)	—	$\frac{3}{4}$ inch
Super 8 Cartridges	15.31	10.77	—

MORE INFORMATION

If you have environmental or safety questions about Kodak products or services, contact Kodak Environmental Services at 1-716-477-3194, between 8 am and 5 pm (Eastern time).

Kodak also maintains a 24-hour health hotline to answer questions about the safe handling of photographic chemicals. If you need health-related information about Kodak products, call 1-716-722-5151.

For questions concerning the safe transportation of Kodak products, call Kodak Transportation Services at 1-716-722-2400.

Additional information is available on the Kodak website and through the U.S.A. / Canada faxback system.

The products and services described in this publication may not be available in all countries. In countries other than the U.S., contact your local Kodak representative, or your usual supplier of Kodak products.

The following publications are available from Kodak Customer Service or from dealers who sell Kodak products.

- J-210 *Sources of Silver in Photographic Processing Facilities*
- J-211 *Measuring Silver in Photographic Processing Facilities*
- J-212 *The Technology of Silver Recovery for Photographic Processing Facilities*
- J-213 *Refining Silver Recovered from Photographic Processing Facilities*
- J-214 *The Regulation of Silver in Photographic Processing Facilities*
- J-215 *Recovering Silver from Photographic Processing Facilities*
- J-216 *The Fate and Effects of Silver in the Environment*



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