Environment

INFORMATION FROM KODAK

J-200(ENG)

KODAK Chemical Recovery Cartridges

KODAK Chemical Recovery Cartridges provide an inexpensive and efficient means of recovering silver from photographic solutions. This publication describes the application, installation, and operation of the cartridges. It is intended to be the basic guide for using KODAK Chemical Recovery Cartridges to recover silver from photographic processing solutions.

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 optimize silver recovery. It describes the application, installation, and operation of the KODAK Chemical Recovery Cartridges.

Kodak Environmental Services

Information regarding the equipment, operation of the cartridge, installation, and silver yield is given on the following pages.

INTRODUCTION

The recovery of silver represents a potential source of revenue for the photographic processing facility. In addition, the enactment of environmental laws by local, state, and federal governmental agencies has resulted in discharge limits for silver and other parameters. Silver is also one of the world's limited resources and should be reclaimed to assure a continuing supply.

Silver has qualities which make it suitable for recovery and reuse. Its recovery and reuse achieve all of the benefits mentioned: a potential source of revenue, compliance with environmental regulations, and conservation of a valuable resource.

The KODAK Chemical Recovery Cartridge (CRC[1]), which employs the metallic replacement principle, is designed to recover silver efficiently from used photographic fixers, bleach-fixes, certain stabilizers, and low flow washes. In addition, you can use metallic recovery cartridges to recover silver from photographic wash water.

The KODAK Chemical Recovery Cartridge can be used with automatically replenished processors for batch- and hand-processing operations.

1. Cartridges used in metallic replacement process for recovering silver have been described as chemical recovery cartridges (CRCs), metallic recovery cartridges (MRCs), and silver recovery cartridges (SRCs). The photographic industry has avoided the term SRC to prevent theft of the cartridge during shipment. The term CRC is closely associated with the original Kodak product that was protected by a U.S. patent.

BASIC OPERATION OF THE CHEMICAL RECOVERY CARTRIDGE

The metallic replacement method for silver recovery from spent solutions is based on the principle that the more active metal in the electromotive series of elements will replace a less active metal in solution. Metal ions such as those of zinc, iron, and aluminum have the ability to replace silver ions from a solution. The KODAK Chemical Recovery Cartridge employs iron in the form of steel wool to replace the silver ion of a silver thiosulfate chemical complex, which is formed in the fixing reaction of a photographic processing operation.

The following chemical formula is a simplified expression of the chemical reactions that take place inside the chemical recovery cartridge when the silver-bearing solution comes in contact with the wound steel wool filler.

$$2Ag(S_2O_3)_2^{-3} + Fe \longrightarrow 2Ag + Fe^{+2\,+} + 4(S_2O_3)^{-2}$$

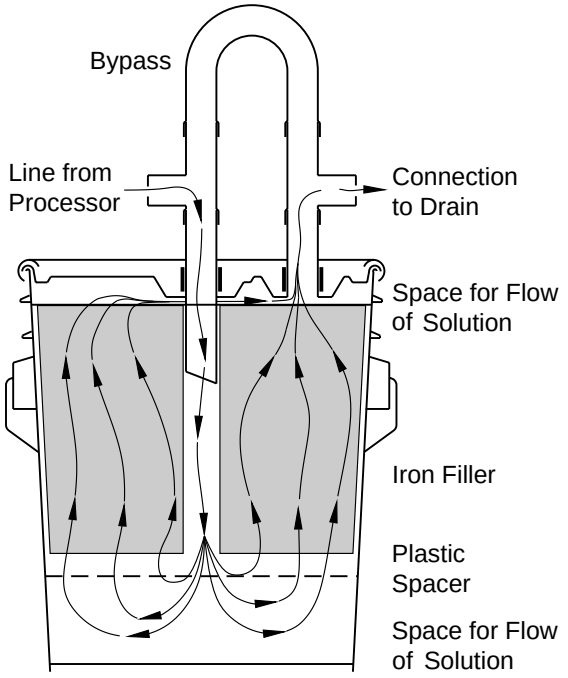
Very simply stated, silver (Ag) is separated from its complex, and iron (Fe) takes the place of silver, which collects in the cartridge as a metallic sludge. Because cartridge performance and silver yield are directly affected by the successful completion of this chemical reaction, it is helpful to have an understanding of the concept involved. For more information on this concept, refer to KODAK Publication No. J-212, *The Technology of Silver Recovery for Photographic Processing Facilities.*

If the unit fails to collect silver, or the silver yield does not meet expectations, the condition may have several causes, which are discussed later in this publication in the section titled, Factors that Affect CRC Performance on page 14.

DESCRIPTION OF THE EQUIPMENT

The Kodak silver-recovery method employs two equipment components: the KODAK Chemical Recovery Cartridge and the KODAK Circulating Unit, Model II. These components have no moving parts or electrical connections. Except for a hose-connection adapter at the appropriate processing tank overflow, no special plumbing is required.

You can adapt this equipment for use with practically all processing machines and processing methods. All you need to do is control the flow of the silver-bearing solution to the inlet of the recovery cartridge and locate a suitable drain to which the desilvered effluent can be discharged. The cross section drawing illustrates the flow of solution through the cartridge.



Cross section of a KODAK Chemical Recovery Cartridge.

KODAK CHEMICAL RECOVERY CARTRIDGE, MODEL II

This cartridge consists of a rigid plastic container with a factory-sealed cover. The cover has two threaded openings to which the KODAK Circulating Unit, Model II is attached.

The cartridge is packed with wound steel wool, a material that reacts with certain metal ions in solution. When the silver-bearing solution passes through the steel wool, metallic silver is precipitated and iron from the steel wool replaces it in the solution.

Two sizes of cartridges are available; a 5 U.S. gallon and a 3½ gallon size. These cartridges are used for the following conditions:

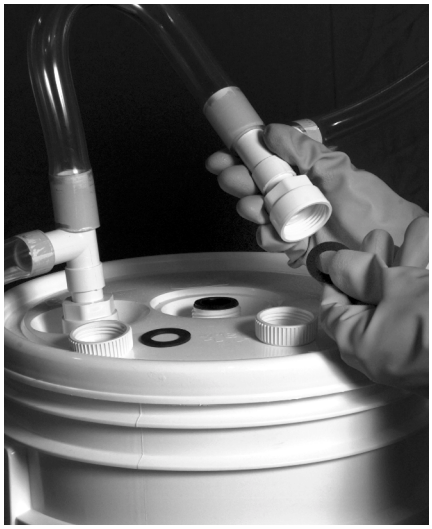
- KODAK Chemical Recovery Cartridge, Model II has a coarse steel wool filler (No. 2 grade) and is used for desilvering most black-and-white fixers, all color fixers, bleach-fix solutions, certain stabilizers, and low flow washes.
- KODAK Chemical Recovery Cartridge, Junior Model II. This cartridge is similar to the Model II and is used for desilvering the same solutions. Its smaller capacity and lower profile make it suitable for low-volume processors or for machines in which the fix tank overflow is lower than the inlet of the Model II.

KODAK CIRCULATING UNIT

This unit consists of two plastic fittings connected by a length of tubing. It is used to direct the flow of solution from the processor or holding tank to the recovery cartridge and from the cartridge to the drain.

A bypass loop in the circulating unit allows the solution to drain if an obstruction forms within the cartridge. A small opening in the bypass loop provides a siphon break to prevent solution from being accidentally drained from the processor tank, or an air lock forming in the cartridge.

The flow rate through the cartridge should not exceed the rate given in the table of Recommended Operating Conditions on page 16. Most automatic processors are not replenished at a rate exceeding those recommended rates. However, if a holding tank is used to collect silver-bearing solution or if recovery from wash water is attempted, the flow rate must be controlled by a restricting orifice in the inlet tubing to the cartridge.



The circulating unit directs the flow of solution into and out of the cartridge, and provides a bypass in case of blockage in the cartridge.

SMALL-VOLUME INSTALLATION

If you desilver less than 3½ gallons per day, such as in a dental office with a manual or rollerless processor, there is an easy way to recover silver from your depleted fixer. All you need is the KODAK Chemical Recovery Cartridge, Junior Model II, the KODAK Circulating Unit, Model II, and a few simple hardware items. When used properly, the concentration of silver in the discharged solution may be reduced to less than 5 milligrams per litre. Setup is easy. Just follow the five-step process below.

Hardware (Not Included)

- 2-quart funnel with tapered end no larger than ¾-inch (1.9 cm)
- Two ⅞-inch (2.2 cm) corks or stoppers
- ¾-inch (1.9 cm) ID plastic tubing

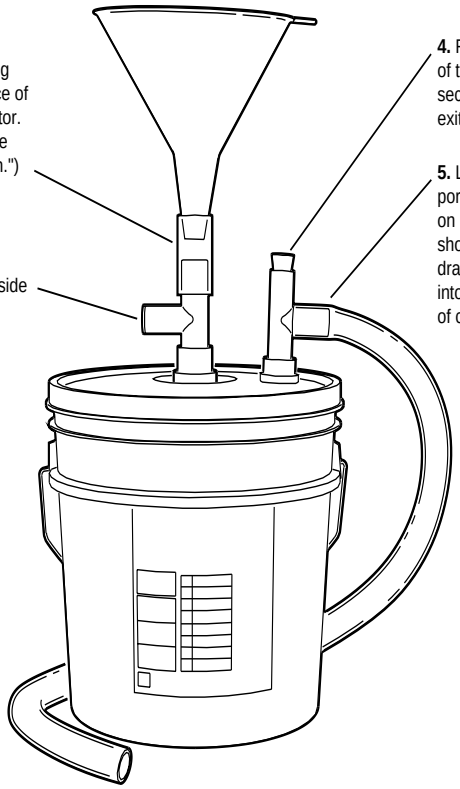
Operation

- Before initial use, fill the unit with water. Then slowly pour the depleted fixer into the funnel.
- The desilvered solution will flow through the outlet and down the drain as the unit fills with fixer.

Monitoring

To test the recovery process, use Silver Estimating Test Papers. See Monitoring the Chemical Recovery Cartridge with Silver Estimating Test Papers on page 12. Insert a single test paper strip in the outlet solution flow as directed. Refer to the color step chart to determine the approximate silver content of the solution. Ordering information for Silver Estimating Test Papers is located on page 19.

Simple Five-Step Setup



1. Cut one side of the recirculating unit so that a three inch long piece of 3/4" tubing is attached to connector. Screw into the inlet opening at the center of the unit. (It is labeled "in.")

2. Place funnel securely into the tubing so that a seal is formed.

3. Place a cork securely into the side nozzle of the central inlet of the connector.

4. Remove tubing from the other half of the circulating unit and place cork securely in the top nozzle of the exit connector.

5. Lubricate nozzle on the side outlet port with soap and place 3/4" tubing on nozzle. The length of the tubing should be sufficient to reach the drain. Screw entire exit connector into opening marked "Outlet" on top of cartridge.

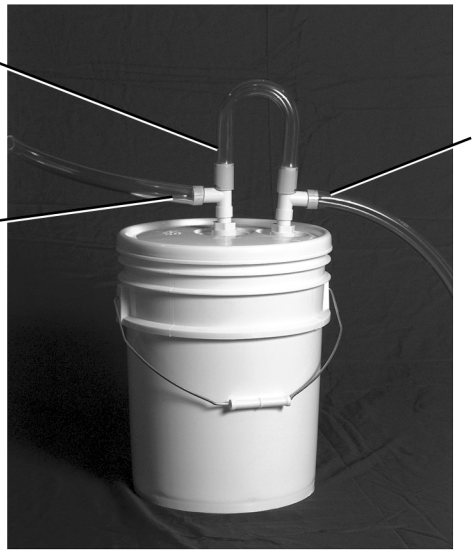
Changing the Cartridge

As the cartridge is used, particularly with steel wool, channels or bypasses may start to form. These grow with time and eventually the steel wool may begin to collapse internally and silver breakthrough can occur well before the iron is consumed. Iron consumption in a CRC is related to the volume of solution passing through the cartridge, the solution's silver content and pH.

To prevent undesireable silver losses and discharges from an exhausted cartridge, test the output from the cartridge on a regular basis for silver breakthrough using silver estimating papers. When the CRC is exhausted, remove it and replace with a fresh cartridge.

Change cartridges when any of the following four conditions exist:

- Silver is present in the effluent
- Every 3 months or, at the very least, 6 months
- Expected throughput capacity of the unit is close (refer to table on page 16)
- Plugging occurs



LARGE-VOLUME INSTALLATION

ADAPTER KITS

Certain fittings, which are supplied by Kodak as adapter kits, are needed for some processors to connect the circulating unit to the supply of silver-bearing solution (see page 19 for those that apply). This supply may be from the fixer tank of an automatic processor, a holding tank, a flexible container, or another suitable receptacle.

Make the connection to an automatic processor at the point at which the fixer overflows the tank. The adapter kits listed in the various Kodak product catalogs contain such items as hose adapters, hose clamps, special lightproof tubing, grommets, and caps. Because of the variety of processor tank configurations and overflow designs, it is important that you use the appropriate adapter kit for your particular processor.

If the connection is to be made to a holding tank, the adapter kit consists of a bulkhead fitting, a spigot, and a restricting orifice to control the flow rate of solution.

The materials from which the adapter kits are made are inert to photographic solutions. The holding tank should also be made of such materials.

The adapter kit and instructions on how to order it is given on page 19 of this publication.

INSTALLING THE CARTRIDGE

Installing the cartridge is a very simple procedure and usually can be done in a few minutes. You may need to install an adapter kit first on some processing machines before you install the cartridge. See the adapter kit or the processor manual for installation instructions for the adapter kit. Once you have installed the adapter kit, the KODAK Chemical Recovery Cartridge is installed in the same manner for all machines.

Single Cartridge Applications

1. Remove the KODAK Circulating Unit and the KODAK Chemical Recovery Cartridge from their cartons.
2. The package containing the circulating unit also contains two washers. Place the washers inside the two basket nuts of the circulating unit.
3. Attach the unit to the inlet and outlet ports of the cartridge and tighten the basket nuts finger tight.
4. With an appropriate length of ¾-inch (1.9 cm) ID plastic tubing, attach the overflow outlet of the fixer or bleach-fix tank to the inlet of the circulating unit (the portion connected to the cartridge port labeled “in”).
5. For a single-cartridge installation, connect another length of ¾-inch (1.9 cm) ID plastic tubing to the outlet side of the circulating unit (the portion connected to the cartridge port labeled “out”). Run the unconnected end of the tube to a drain.

Application for Batch Solution Recovery

When the processing solutions are discarded in part, or as an entire tank or tray changes, install the recovery system as illustrated below. Use a receiver tank for the processor solutions. The tank size depends on the amount of solution handled each day, but we do not recommend a tank capacity of less than 5 gallons. You must also use a device to restrict the flow to control the rate of solution flow from the tank to the circulating unit; for example, a pinch clamp. This device must have a hole no larger than 1/16-inch (0.16 cm) in diameter, and it must be held in position in the line with two hose clamps.

A KODAK Chemical Recovery Cartridge being fed from a raised holding tank. Place the tank outlet slightly higher than the inlet of the circulating unit as shown.

Installation for Multiple-Cartridge Applications

Because the chemical recovery cartridge relies on gravity to move solution through the cartridge, a small platform about 4 inches high is needed to raise the first of the two cartridges in the series as shown. Be sure that the first cartridge is not placed higher than either the overflow of the processing tank or the outlet from a holding tank, if one is used.

These two cartridges are connected in series. The cartridge on the right is in the No. 1 position and is connected to the processor. The cartridge on the left is connected to the drain. The right-hand cartridge is raised to maintain gravity flow.

Another circulating unit is required for the second cartridge. The inlet side of this unit is connected directly to the outlet T-fitting of the first circulating unit. Then, the outlet from the second unit is connected to a suitable drain.

MULTIPLE-CARTRIDGE APPLICATIONS

The single-cartridge applications suggested in the table of Recommended Operating Conditions will typically remove 90 – 95% of the silver passing through the cartridge under normal conditions. The current price of silver makes it economically advantageous to use two cartridges in series where a single cartridge is considered adequate. While the yield-per-cartridge may be lower, the total amount of silver recovered by both cartridges exceeds that of a single-cartridge installation. Note that where the table recommends two cartridges in series, this type of installation is not an option but a necessity for efficient silver recovery.

The following are other specific processing situations where multiple-cartridge installations are beneficial.

Excessive Flow Rate

If the flow rate of the solution passing through the cartridge exceeds that given in the table of Recommended Operating Conditions on page 16, the solution will not remain in contact with the steel wool long enough for the desilvering reaction to take place. As a result, silver will be lost down the drain. By installing a second cartridge in series with the first one, the solution has effectively twice the time to react with the steel wool, and desilvering will be more complete.

In this application, when the first cartridge in the series is exhausted, remove it and transfer the second cartridge to the No. 1 position. Then, place a fresh cartridge in the No. 2 position. The silver estimating test paper is a more useful guide to cartridge condition than relying on the capacities given in the table of Recommended Operating Conditions on page 16. This is because a quantity of desilvered solution from the first cartridge has passed through the second one. It is difficult to estimate how much steel wool has been consumed in this way. The desilvering capacity of the second cartridge operating in the No. 1 position may be lower or the efficiency may be somewhat reduced than that of a fresh cartridge.

Two-Cartridge Setup

When installations are serviced by dealers, service personnel may not be on hand at exactly the right time to change the cartridge and prevent silver-bearing solution from being lost down the drain. In a case such as this, two cartridges in series provide backup capacity if the first cartridge is not changed in time.

Many times, testing is not done in the two-cartridge setup. The replacement cycle is often governed by the service schedule or by the amount of solution that has been treated. However, you should establish a routine for changing the second cartridge. Change the second cartridge when three or four cartridges in the No. 1 position have been exhausted. Experience will indicate when you should change the cartridge. This second cartridge may not contain as much silver as the first cartridge, but using it ensures that little or none has been lost. Each of the cartridges used in the No. 1 position can be expected to yield the amount of silver that is normal for the particular installation.

Two-Cartridge Setup for Reducing Silver Content of Effluent

In a reasonably well-managed, two-cartridge installation, the concentration of silver in the effluent from the second cartridge may be less than 5 milligrams per litre. As the exhaustion point for the first cartridge is reached, remove and replace it with the second cartridge. Then place a fresh cartridge in the No. 2 position. Because the purpose of this application is to achieve a very low level of silver in the effluent, you should make periodic tests of the effluent from the second cartridge by laboratory analysis.

Lower concentrations have been achieved, but only under the most favorable conditions. Using this setup, sewer code requirements are more easily met, especially when the cartridge effluents are combined with other silver-free effluents.

Removal of Silver from Wash Water and Mixed Bleach-Fix and Wash Water

The metallic replacement principle is suitable for recovery of silver from wash water or mixed bleach-fix and wash-water effluent when these solutions are pumped through suitable steel-wool cartridges. We do not recommend Model II cartridges for this purpose because the plastic container is not designed to withstand the pressure resulting from the pumping system. Consult with your Kodak Representative or call Kodak Environmental Services (585-477-3194) for recommendations on suppliers of suitable equipment.

The success of this application depends on the amount of silver in the wash water and on proper control of the flow rate. By treating wash water in this manner, it is possible to reduce the silver concentration in the effluent to less than 5 mg/L.

Chemical Recovery Cartridge Tailing an Electrolytic Recovery Unit

In processing installations where an electrolytic silver-recovery unit is used, it may be economically feasible to install a chemical recovery cartridge as a tailing or secondary device to recover most of the silver that escapes the electrolytic process. The electrolytic unit functions in a similar manner to the first cartridge in a multiple-cartridge installation. This is true whether the electrolytic unit is operating in the terminal or the recirculation mode.

To determine the economic impact of this application, evaluate the silver content of the effluent treated by the electrolytic recovery unit. Variations in the processor workload throughout the operating day may result in silver input rates that exceed the capacity of the electrolytic unit. There may be lengthy periods, therefore, when the tailing cartridge will recover a considerable amount of silver.

Aside from economy, the tailing cartridge has possibilities as an aid in effluent management. If your goal is residual silver removal from an effluent at relatively low cost, including a chemical recovery cartridge as a tailing unit may be justified.

Washing Instructions for Chemical Recovery Cartridges

Your silver refiner may request that you wash the contents of the cartridge prior to shipment.

Contact Kodak Environmental Services at 585-477-3194 for an updated list of silver refiners and buyers who recycle the cartridges, or locate the list on our Kodak Environmental Services Web site at www.kodak.com/go/kes.

CHANGING THE CHEMICAL RECOVERY CARTRIDGE

When tests indicate that a cartridge is exhausted, install a new one by following this procedure:

1. Choose a time when the processor will not be in operation, because if the processor is operating when the cartridge is disconnected, spillage will result from the replenishment of the processor tank.

2. Open the carton containing the new cartridge carefully as it will be used to ship the exhausted cartridge to a refinery for processing. Remove the cartridge from the carton, unscrew the shipping caps from the cover and remove the washers from the caps. Place these parts on the cover for later use.

Remove the plastic caps from the new cartridge.

Remove the washers from the caps of the new cartridge.

3. Lift the supply hose to drain any solution it contains into the cartridge. Disconnect the supply side of the circulating unit. Then, cap the inlet side of the used cartridge, using the *old* washer from under the basket nut of the circulating unit fitting and one of the *new* caps from the fresh cartridge.

   Pump the solution remaining in the circulation unit into the drain hose, by pressing firmly but slowly on the cover of the used cartridge. Be sure that solution does not back up through the bypass loop and spill onto the floor.

Press down firmly to pump out the solution in the circulating unit.

4. To absorb any spillage, place a waste cloth or paper on the floor. Disconnect the circulating unit from the outlet side of the cartridge. Again, use the *old* washer from the outlet side of the circulating unit and the other *new* cap to close the outlet of the used cartridge.

Disconnect the circulating unit from the outlet side of the cartridge.

5. Place the exhausted cartridge into the carton. Set this aside for shipping preparation.

6. Before connecting the new cartridge, examine the T-fittings in the circulating unit for dried chemicals or other obstructions. These can be removed simply with a bottle brush or a similar tool.

Clean the T-fittings of the circulating unit.

7. Locate the new cartridge under the circulating unit. Use the *new* washers to reconnect the circulating unit. Make sure that the center hole in the cartridge cover is connected to the inlet side of the circulating unit. Also make sure that the washers are correctly placed in the basket nuts; otherwise, there may be leakage.

You should only need to finger tighten the basket nuts on the circulating unit. Tightening with a wrench may split the nut; if this happens, the entire T-fitting on the circulating unit has to be replaced. Any leakage at these fittings is due to improper placement of the washer.

Tighten the basket nuts only finger tight.

MONITORING THE CHEMICAL RECOVERY CARTRIDGE WITH SILVER ESTIMATING TEST PAPERS

These paper strips are impregnated with a chemical substance that changes color according to the amount of silver present in the solution. The test papers are supplied with a color step chart for estimating (by color comparison) the approximate silver content of a solution.

To test the effluent from the cartridge, cut a small slit in the top of the plastic drain line near the outlet fitting of the circulating unit. Insert a single test paper strip in the solution flow for a few seconds.

In this illustration, the desilvered solution is being tested with a silver estimating test paper.

Withdraw the strip and shake off any excess liquid. After about 15 seconds, compare the moist strip with the color step chart. If the test indicates a concentration of silver greater than 1 gram per litre, you should replace the cartridge.

On a routine basis, test the effluent from each cartridge to be sure that the cartridge is functioning properly and that excessive amounts of silver are not being lost down the drain. Based on the volume of solution processed by the cartridge, as indicated by the table Recommended Operating Conditions on page 16, you may need to take the test daily or perhaps more frequently as the cartridge nears the exhaustion point. After some experience with a particular installation and its operating conditions, you will be able to tell how often you need to run tests.

To avoid the possibility of a misleading test result, always take the test after the processor has been processing sensitized material for a reasonable period, say 1 hour. This precaution ensures that the solution being tested has not been standing in the cartridge for a number of hours. Such solution would not be representative of that leaving the cartridge under operating conditions, and therefore the test would be invalid.

With this method, silver estimating test papers are only sensitive for measuring silver concentrations greater than 1 gram per litre.

USEFUL LIFE OF THE CARTRIDGE

Eventually, as steel wool is consumed, the cartridge no longer removes silver from the solution leaving you to assume that all of the steel wool is used up. However, extensive experience and laboratory testing have shown that when approximately 85% of the filler material has been consumed, the cartridge no longer operates efficiently, and a significant amount of silver may pass to the drain. The cartridge, therefore, is considered exhausted before the steel wool is completely used up. It is preferable to waste some steel wool rather than to allow partially desilvered solution to be lost.

The practical exhaustion point is reached when the effluent from the cartridge contains about 1 gram per litre of silver as determined by the use of silver estimating test papers.

Intermittent or infrequent use of a chemical recovery cartridge has been shown to cause the steel-wool filler to oxidize, or rust, just by standing in a solution such as a fixer. Rust is not a suitable material for the chemical reaction necessary to precipitate silver. Its presence results in less iron available for the reaction. The silver yield from the cartridge, therefore, will be less than would normally be expected. Also, you will find that you have to remove the cartridges from service before the typical volume of solution is processed due to the rust formation. For more information, see Recommended Operating Conditions on page 16.

Because operating conditions vary greatly, no specific time can be given for the useful life of a cartridge used intermittently. To be sure that the unit is operating properly, check it at appropriate intervals with silver estimating test papers, as described in the previous section.

If a cartridge is used over a long period of time, a layer of rust can form about 3 inches (7.6 cm) from the bottom of the cartridge. This can exert sufficient pressure on the side of the cartridge to cause it to split. This may occur anytime from 3 - 6 months after installation for most applications, depending upon use. If a ridge or bulge appears on the side of the cartridge, replace the recovery cartridge. This condition is not dangerous but will create a clean-up problem should the split occur.

DETERMINING THE POTENTIAL YIELD

A simple method for determining the amount of silver that a recovery system should yield is based on multiplying the silver concentration of the solution entering the recovery cartridge by the volume of solution being treated. For example, if the average concentration of silver in the solution is ½ troy ounce per gallon and 200 gallons of solution are treated, the potential recovery is 100 troy ounces of silver.

Under controlled laboratory conditions, more than 95% of this potential has been recovered; however, under ordinary processing conditions, a more realistic figure would be about 90 – 95% with good maintenance. With poor maintenance, the amount will, of course, be less.

The recovery rate of the KODAK Chemical Recovery Cartridge is limited by the flow rate of solution through the cartridge. Most recommended maximum flow rates do not exceed 300 mL per minute, a figure which is within the range of replenishment rates for practically all processors with automatic replenishment systems. For recommended flow rates, see the table Recommended Operating Conditions on page 16.

The silver yield that you can expect from a chemical recovery cartridge depends on three factors:

- The concentration of silver in the solution being desilvered
- The volume of solution treated, and
- The efficiency of the recovery installation.

If the expected yield is not realized, one or more of the conditions discussed in the section Factors that Affect CRC Performance on page 14 are probably responsible for the deficiency.

FACTORS THAT AFFECT CRC PERFORMANCE

Type of Film Being Processed. The silver content of photographic emulsions varies with the type of film. For example, the thin-emulsion films used in the graphic arts industry contain less silver than double-coated x-ray films and therefore will yield less recoverable silver. In processing color films, all of the silver is removed by the fixer leaving only the colored dye image, so nearly all of the silver is available for recovery.

Exposure Level. In processing black-and-white materials, the ratio of exposed and developed silver to soluble silver halide has a considerable influence on the amount of recoverable silver in the fixing bath. This ratio depends largely on subject matter. For example, if negatives of a line drawing on white paper are processed, the emulsion contains a large portion of exposed and developed silver and a small proportion of soluble silver halide. On the other hand, if positives of the same drawing are processed, the emulsion contains a small proportion of exposed and developed silver and a high proportion of soluble silver halide. The positive-line image, therefore, yields much more recoverable silver from the fixer than the negative image because less silver is retained in the film.

Processing Workload. The quantity of material processed in a solution is, of course, a major factor affecting the amount of silver available for recovery. Processing work loads vary considerably in many operations, and the work load often peaks at certain periods during the working day. If the flow rate at these periods is greater than the recovery unit can handle, silver will be lost down the drain.

Replenishment Rate. In processing systems that require replenishment, always observe the recommended replenishment rates. Over-replenishment dilutes the silver-bearing solution going to the recovery cartridge, which results in a lower silver yield than expected. Steel wool is consumed by the passage of solution with a low silver content. Silver is not lost by over-replenishment, but the cartridge requires more frequent replacement, and replenisher solution is wasted as well.

Solution Carryout. Silver-bearing solution is carried out of the fixer tank on the surfaces of the photographic material and into the wash or stabilizer tank. This solution is not available for silver recovery by the cartridge. Factors that affect solution carryout include machine speed and film area, and drive belts as well as the incorrect adjustment or condition of squeegees. Under normal circumstances, the volume of solution that may be carried out varies between 3 and 15% of the replenishment rate. Use of squeegees is an effective means of minimizing solution carryout.

Obstruction of Solution Flow. If the solution going to the cartridge contains an abnormal amount of solid precipitates or gelatinous material, the steel-wool filler acts as a filter and eventually obstructs the passage of solution. The solution is then diverted through the bypass loop of the circulating unit and is discharged down the drain untreated.

Channeling and/or Plugging. The normal flow of solution through a cartridge is to enter the center opening of the cover and exit by the off-center opening. The design of the cartridge directs the flow of solution to the bottom of the unit, filling it gradually as processor replenishment occurs. In low-volume or intermittent usage applications, a blockage due to rust formation during idle machine times may restrict the flow of solution into the cartridge. In this situation, we suggest that you reverse the direction of flow—that is, have it enter the off-center port and exit through the center.

Note: If you reverse the direction of flow, you must prefill the cartridge with water to prevent a channel forming under the inlet port. Channeling occurs as a result of fixer solution dripping onto one place in the steel wool and "eroding" a vertical channel to the bottom of the cartridge. Solution will follow the channel as the path of least resistance and pass through the cartridge largely untreated.

Flow Rate. If silver-bearing solution flows through the cartridge too quickly, it does not remain in contact with the steel wool long enough for the desilvering reaction to occur. Lower flow rates are more efficient for removing silver. How much silver is recovered and how much is lost, therefore, depends on the flow rate. For more information, see Multiple-Cartridge Applications on page 8.

Incorrect Installation. If tests indicate that silver is not being recovered by a fresh cartridge, check to make sure that all hose connections to the recovery unit have been made properly and that the appropriate processor tank is connected to the inlet side of the circulating unit.

pH of the Fixer. For the most efficient operation of the metallic exchange method of silver recovery, the solution passing through the cartridge should be acidic—specifically, within the range of 4 to 6.5 pH. The acidity of most photographic fixers is within this range. Acidity of the silver-bearing solution is necessary for the continuous etching of the steel-wool surfaces so that fresh metal is presented to the solution continuously. If the solution is too acidic—below pH 4—the etching reaction is too rapid, and the steel wool will be depleted prematurely. If the solution becomes neutral or alkaline—that is, if the pH rises above 7.0—the necessary etching of the steel-wool surfaces slows down, and the silver / iron exchange reaction is reduced accordingly. Then, the solution will be only partially desilvered and the residual silver will be lost down the drain.

An exception to the pH range is bleach-fix solutions which have a pH between 7.2 and 7.8. The solution will be desilvered properly at this pH because of the presence of other components not normally found in conventional fixers.

RECOMMENDED OPERATING CONDITIONS

Silver Recovery from Used Fixer, Bleach-Fix, and Stop Bath Solutions, Using the KODAK Chemical Recovery Cartridge

Type of KODAK Solution from Which Recovery Is Made	Recommended Capacity for 5-gal Size Cartridge*		Maximum Recommended Flow Rate (mL/min)
	Gallons	Litres	
Ammonium Thiosulfate Fixer (pH 5.5)	375	420	300
Ammonium Thiosulfate Fixer (pH 6.5)	220	830	300
CINEFLURE Fixer and Replenisher	160	610	300
Fixer and Replenisher, Process E-6	150	570	500
EA-5 Fixer and Replenisher	Not Recommended		
EKTACHROME R-3 Bleach-Fix II and Replenisher	120	455	300
EKTACHROME R-3000 Bleach-Fix	120	455	300
EKTACOLOR RA Bleach-Fix and Replenisher	150	570	300
EKTACOLOR RA Bleach-Fix and Replenisher plus EKTACOLOR RA Stabilizer (Plumbingless Mini-Lab)	100	400	300
EKTACOLOR RA Bleach-Fix and Replenisher NR	Not Recommended		
EKTACOLOR RA Bleach-Fix and Replenisher NR plus Low-Flow Wash Water†			
EKTAFLO Fixer	220	830	300
EKTAMATIC Stabilizers‡	160	610	500
Fixer	220	830	300
FLEXICOLOR Electrosilver Fixer and Replenisher**			
FLEXICOLOR Fixer and Replenisher	220	830	300
FLEXICOLOR Fixer and Replenisher plus FLEXICOLOR ML Stabilizer abd Replenisher (Plumbingless Mini-Lab)	100	400	300
GBX Fixer and Replenisher	160	610	300
PROFESSIONAL INDUSTREX LO Fixer and Replenisher	160	610	300
PROFESSIONAL INDUSTREX Instant Stabilizer‡	160	610	300
KODAFIX Solution	220	830	300
Microfilm Fixer and Replenisher	220	830	300
PROSTAR Plus Fixer‡	200††	760	300
Rapid Fixer	220	830	500
ROYALPRINT Fixer	200††	760	300
RP X-OMAT LO Fixer and Replenisher	220	830	300
RA 3000 Fixer and Replenisher	220	830	300
RA 3001 Fixer	160	610	300
VERSAMAT Fixer and Replenisher, Type A	160	610	300
VERSAMAT 641 Fixer and Replenisher	160	610	300
VERSAMAT 885 Fixer and Replenisher	160	610	300
VNF-1/RVNP Liquid Fixer and Replenisher	375	420	300
Liquid X-ray Fixer and Replenisher	220	830	300

* You can use the Junior Model II cartridge for any application where a Model II cartridge is recommended. The cartridge capacity and flow rates are half those given for the Model II cartridge.

† Gravity feed not recommended. Pump not to exceed 4 gpm, 3 psi. Monitor to determine exhaustion.

‡ Adjust pH range to 4.0 to 6.5. Low silver levels in stabilizer. Silver should be recovered from fixer after stabilization.

** Chemical Recovery Cartridges should be used in processor tank overflow as secondary recovery. Capacity of Chemical Recovery Cartridges relates to the silver concentration of silver maintained by the recirculating electrolytic unit used for primary recovery. Suggested capacity will be in the 350 - 500 gallon range.

†† If batch replenishment is being used, thirty 5-gallon batches may be treated.

Note: KODAK Chemical Recovery Cartridges are not intended for use with bleach or reducer solutions or for use with black-and-white reversal film processing. Do not attempt to recover silver from any diffusion-transfer products, such as KODAK PMT® Materials, since no silver is released for recovery from these processes.

TROUBLESHOOTING CHART

PROBLEM	CONDITION	CAUSE	REMEDY
Leak at connection of circulating unit and chemical recovery cartridge	Split or cracked basket nut	Basket nut overtightened probably by using a wrench	Replace T-fitting
	Cross-threading	Circulation unit T-fitting not properly aligned	Loosen T-fitting, align circulating unit correctly, and finger-tighten nut
	Damaged or improperly seated washer	New washer from fresh cartridge not used at time of cartridge change	Replace washer carefully with new washer
		Washer not centered on flat surface of threaded nipple in cartridge cover	Replace washer carefully with new washer
Solution flowing over bypass tube	Internal blockage so that solution cannot flow through the cartridge	Blocked T-fitting on circulating unit	Remove circulating unit, examine T-fittings for foreign matter or crystallization
		Precipitate in solution has plugged steel wool	Correct chemical condition in processor. Replace plugged cartridge with new one.
	Damaged core of steel steel-wool roll (Core is the entry path for solution).	Cartridge was dropped or jarred heavily during use	Sometimes by using a wood dowel the path can be reopened. If unsuccessful, replace cartridge.
Flooding	Solution overflowing processor tank	Solution not getting to cartridge	Check tubing and fittings between fixer tank and cartridge for kinks or foreign matter
		Cartridge inlet above processor tank outlet	Cartridge operates on gravity flow. Locate cartridge inlet below level of processor tank outlet. It may be necessary to install a pump between processor and cartridge.
	Solution overflowing from vent hole in circulating unit	Solution not flowing to drain	Check tubing and fittings between cartridge and drain for kinks or foreign matter
		Cartridge outlet below drain inlet	Cartridge operates on gravity flow. Locate cartridge outlet above drain inlet.
	Solution backing up from drain	Drainpipe stopped up	See next section on “Stopped-up Drain”

PROBLEM	CONDITION	CAUSE	REMEDY
Stopped-up drain	Reddish black or brownish black material caking in pipe	Biological growth in drainpipe	Use algicide control on processor effluent
		Iron hydroxide forms as steel wool dissolves in the acid fixer and precipitates in an alkaline medium. This may occur if effluent is mixed with developer or other alkaline solutions (such as floor-cleaning chemicals) after entering the drain.	Use *acid-type* drain cleaner once a week
		Condition may be aggravated by drainpipe diameter, angle of slope, low volume, or flow of other waste.	Use a different drain or holding tank for fixer effluent
Unpleasant odors	Cartridge effluent encounters other chemicals in the drain which may release gas	Processor effluent contains sulfur compounds which may break down chemically and produce odors such as that of hydrogen sulfide.	Insert drain hose from cartridge further down drainpipe. Install drainpipe trap. Ventilate area adequately.
Cartridge leaks around cover	Solution seeps out under lip of cartridge and runs down side of container	Faulty cartridge	Replace cartridge and contact dealer or Kodak representative for replacement instructions
Bulge in sidewall of cartridge	Defect forms around circumference of cartridge about 3 inches from bottom	Accumulation of iron oxide layer due to peculiar local usage condition	Replace cartridge
Split in sidewall of cartridge	Same as above	Same as above	Replace cartridge and contact dealer or Kodak representative for replacement instructions

ADAPTER KIT

Kits are available for adapting processors and equipment such as the following:

Processor or Equipment	Part No.
KODAK *RP* X-OMAT Processor, Model M6B	240696

SPARE PARTS

For KODAK Chemical Recovery Cartridges, Model II and Junior Model II:

Part	Part No.
Plastic shipping cap	764773
T-fitting for circulating unit (Order CAT No. 175 0868)	
Plastic tubing, ¾-inch ID*	760477
Tubing clamp (Corbin type) suitable for ¾-inch ID, 1-inch OD plastic tubing	246803
Tubing adapter, ½-inch x ¾-inch	555561
½-inch ID tubing	760476

* Specify number of feet when ordering

These items may be ordered through your dealer. If you have a Kodak Customer Identification Number, you may order directly from:

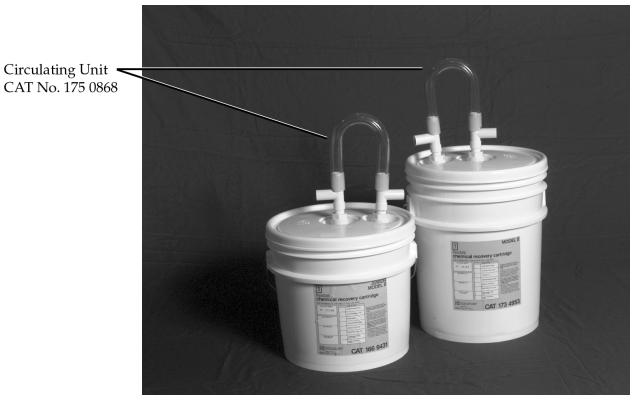
Eastman Kodak Company
Services Parts Management
800 Lee Road
Rochester, New York 14650
Telephone orders: 585-724-7278

SILVER ESTIMATING TEST PAPERS

This list has been compiled from various sources. Inclusion in this list does not imply endorsement or recommendation by Eastman Kodak Company.

X-Rite, Inc. 3100 44th Street SW Grandville, MI 49418 Phone: 1-888-826-3044 Web address: www.x-rite.com Part No. 10-00-01	Academy Corporation 6905 Washington NE Albuquerque, NM 87109 Phone: 1-800-545-6685 Web address: www.academy-corp.com Part No. 04322
CPAC, Inc. 2364 Leicester Rd. Leiceister, NY 14481 Phone: 1-800-477-1417 Web address: www.cpacequipment.com	USI PO Box 835 825 Schoenhaar Dr West Bend, WI 53095 Phone:1-262-334-3000 Web address: www.usi-usi.com/STF50/stf50.html

KODAK CHEMICAL RECOVERY CARTRIDGE



Junior Model II	Model II
3½-gallon size	5-gallon size
Overall height—19" (with bypass loop)	Overall height—23" (with bypass loop)
Height to inlet—12¼"	Height to inlet—16¼"
Dry weight: 3.22 kg (7.1 lbs)	Dry weight: 5.06 kg (11.16 lbs)
Overall width—12"	Overall width—12"
CAT No. 166 9431	CAT No. 173 4953

To order, contact your Kodak distributor or call Kodak Health Imaging at 1-800-677-9933.

Kodak
Environmental
Services

MORE INFORMATION

If you have environmental or safety questions about Kodak products or services, contact Kodak Environmental Services at 1-585-477-3194, between 8 a.m. and 5 p.m. (Eastern time) or visit KES online at www.kodak.com/go/kes.

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 1-585-722-5151.

For questions concerning the safe transportation of Kodak products, call Kodak Transportation Services at 1-585-722-2400.

Additional information is available on the Kodak Web site.

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 can be found at www.kodak.com/go/kes.

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*
J-217	*Using the Code of Management Practice to Manage Silver in Photographic Processing Facilities*
J-316	*Emergency Preparedness for Photographic Processing Facilities*

For more information about Kodak Environmental Services, visit Kodak online at:
www.kodak.com/go/kes

If you have questions about Kodak products, call Kodak.
In the U.S.A.:
1-800-242-2424, Ext. 19, Monday–Friday
9 a.m.–7 p.m. (Eastern time)
In Canada:
1-800-465-6325, Monday–Friday
8 a.m.–5 p.m. (Eastern time)

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