SILVER RECOVERY

with the
KODAK CHEMICAL RECOVERY CARTRIDGE,
TYPE 3
Introduction

This chemical recovery cartridge is intended for use in large-scale photofinishing and other processing applications where a larger silver recovery capacity than that provided by the 5-gallon Type 1-P cartridge is needed. The Type 3 cartridge is not intended as a larger capacity replacement for the Type 2-P cartridge, which is used mainly in color negative and color reversal processes. For a complete listing of cartridge applications, refer to KODAK Publication No. J-9, Silver Recovery with the KODAK Chemical Recovery Cartridge, Type P. The principal applications for the KODAK Chemical Recovery Cartridge, Type 3, are given in the table of Recommended Operating Conditions.

The Type 3 cartridge works on the metallic replacement principle in which silver is removed from spent processing solutions and replaced by iron from the steel-wool filler in the cartridge. For a complete discussion of silver recovery by this method, refer to the Kodak publication mentioned above and KODAK Publication No. J-10, Recovering Silver from Photographic Materials.

Shown in the above illustration is the Kodak Chemical Recovery Cartridge, Type 3, and its components.
SILVER RECOVERY FROM FIXERS AND BLEACH-FIXES

For silver recovery from fixers and bleach-fixes a Kodak Circulating Unit, Type P, is attached to the inlet and outlet openings of the cartridge. The cartridge is then used to recover silver from the fixer overflow before it is discharged to the sewer, or in the case of the bleach-fix, before it is regenerated for reuse.

Description of the Equipment

Silver recovery using the Kodak Chemical Recovery Cartridge, Type 3, requires only the Kodak Circulating Unit, Type P, and, for some processors, an adapter kit for operation. There are no moving parts or electrical connections. All that is required is a controlled flow of silver-bearing solution and a suitable drain for the discharge of the desilvered effluent.

Kodak Chemical Recovery Cartridge, Type 3—This recovery unit consists of a 15-gallon (57-litre) stainless steel drum with a removable lid. The drum, which measures 18 1/2 inches in diameter and 31 inches high, contains 24 pounds (10.9 kilograms) of steel wool wound on a core. The weight of the unused cartridge is approximately 70 pounds (31.8 kilograms). The exhausted cartridge, full of solution and silver-bearing sludge, weighs approximately 220 pounds (100 kilograms). An important advantage of the Type 3 cartridge is that the steel-wool filler may be replaced by the user when it has become exhausted. See the section “Recharging the Cartridge.”

Kodak Circulating Unit, Type P—This unit consists of two plastic fittings connected by a length of tubing. It is used to direct the flow of the solution from the processor to the recovery cartridge and from the cartridge to the drain.

A bypass loop in the circulating unit allows the solution to flow directly to the drain rather than flooding the processor should an obstruction form 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.

Approximately 4 feet of 1/4-inch ID plastic tubing is supplied with the unit.

Adapter Kits—Fittings supplied as adapter kits are needed for some processors to connect the circulating unit to the supply of silver-bearing solution. This supply may be from the fixer tank of an automatic processor, a holding tank, a flexible container, or some other suitable receptacle.

A list of adapter kits and instructions on how to order is given in Kodak Publication No. J-9.

Installation Procedure

Installation of a cartridge involves simply a few plumbing connections. The only equipment required, in addition to the Kodak Circulating Unit, is two Kodak Circulating Unit Adapters, Type 3 (CAT No. 191 3425).

To install the Kodak Chemical Recovery Cartridge:

1. Unscrew the shipping plugs from the top lid of the cartridge and install a Kodak Circulating Unit Adapter, Type 3, in each of the threaded openings.

2. Remove the circulating unit from the carton. The carton will also contain two washers and a length of tubing. Place the washers inside the two basket nuts of the circulating unit.

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3. Attach the circulating unit to the cartridge by screwing it onto the circulating unit adapters. Tighten the basket nuts only finger tight to avoid breaking them.

4. With a length of \( \frac{3}{4} \)-inch 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 at the center of the cartridge cover).

5. For a single cartridge installation, connect another length of \( \frac{3}{4} \)-inch ID plastic tubing to the outlet side of the circulating unit (the portion connected to the cartridge port near the rim of the cover). Then run the unconnected end of the tube to a drain.

**Flow Rate of Solution Through the Cartridge**—The recommended flow rate of solution through the cartridge should not be exceeded, because too high a flow rate does not allow the solution sufficient time in the cartridge for the silver/iron replacement reaction to be completed and some silver may be lost. Maximum flow rates and cartridge capacities for different solutions are given in the table of “Recommended Operating Conditions.”

**Cartridge Exhaustion**

As silver is removed from the solution, the steel-wool filler in the cartridge becomes depleted. Before the recommended maximum throughput of solution has been reached, test the cartridge with Kodak Silver Estimating Test Papers as described in Kodak Publication No. J-9, *Silver Recovery with the Kodak Chemical Recovery Cartridge, Type P*. When the silver concentration in the effluent from the cartridge reaches 1 gram per litre or more, change the cartridge.

When Type 3 cartridges are used in a bleach-fix regeneration installation, the color of the effluent is also a reliable guide to cartridge exhaustion. The bleach-fix effluent from the cartridges should be pale green or colorless. A dark red effluent flow indicates that the cartridge is exhausted; in which case, change it immediately. Be careful not to judge exhaustion from bleach-fix which has been standing in the tube for a period of several hours since it will turn dark red from being exposed to air within the tubing.

To measure the lower silver concentrations found in wash waters, soak the test paper for 1 hour. A wash with 10 mg/L of silver will significantly darken the test paper, while a wash water with 0.5 mg/L will cause no more than a barely perceptible darkening.

These methods are discussed in greater detail in Kodak Publication No. Z-98, *Chemical Control Methods Handbook*.

**Two-cartridge Installations**

To avoid loss of silver by cartridge exhaustion or malfunction, connect two cartridges in series; thus, any silver that escapes recovery in the first of the two cartridges is recovered by the second one.

In bleach-fix regeneration, the two-cartridge installation is necessary. The second cartridge acts as a backup unit in case the first one fails to remove the silver, which, if not removed, reduces the efficiency of the bleach. Silver recovery with steel-wool filled cartridges in bleach-fix regeneration is described in detail in Kodak Publication No. Z-122A, *Regenerating Kodak EktaPrint 2 Bleach-Fix*.

**Rotating the Cartridges**—When the first of the two cartridges is exhausted as determined by the use of silver estimating test papers or, in bleach-fix regeneration, by observing the color of the effluent, remove the first cartridge and replace it with the second one. Then, place a fresh cartridge, or one containing a fresh refill, in the second position.
SILVER RECOVERY FROM WASH WATER AND MIXED BLEACH-FIX AND WASH WATER

The Kodak Chemical Recovery Cartridge, Type 3, can be used for desilvering wash water or mixed bleach-fix and wash water. A specific application for this cartridge is with the recovery of silver from the effluent when Kodak Ektaprint 2 Bleach-Fix and Replenisher NR is used. With this process, recovery of silver from both the bleach-fix and the succeeding wash is required for efficient desilvering of the processing effluent.

This application requires two cartridges equipped with Kodak %-inch Hose Adapter Elbows. These are attached to the inlet and outlet openings of the cartridges in place of the circulating unit used with the conventional installation. Additional equipment required includes a 5- to 25-gallon holding tank, a centrifugal pump with a delivery rate not exceeding 4 gal/min at a pressure less than 3 pounds per square inch, a liquid level control switch, a flow control valve, and a water meter. There are a variety of plumbing arrangements which can be used to suit the individual needs of the laboratory. One such basic setup is shown in the diagram below.

For the installation shown, this equipment is required:

**Kodak %-inch Hose Adapter Elbows**—These elbows with the plastic hose attached are used to direct the flow of solution into and out of the cartridge. They are supplied as a set of two elbows (CAT No. 183 2815).

**Collection Tank (5- to 25-gallon capacity)**—This tank is used to collect the bleach-fix and the wash so that it can later be pumped to the cartridges for desilvering. It may be simply a plastic holding tank with an outlet at the bottom and an overflow port at the top connected by tubing to the drain. As a rough guideline, the overflow port should be $\frac{3}{4}$-inch diameter for a maximum water flow rate of 3 gal/min, 1 inch for a 6-gal/min flow rate, and 1$\frac{1}{4}$ inches for a 10-gal/min flow rate.
Level Control Switch—Pump actuation is governed by this switch, turning it on when the level in the holding tank is high and off when the level recedes to a certain point. A switch such as the KODAK Level Control Assembly, Model 1, Part No. 528530, is acceptable for this application.

Centrifugal Pump—This pump is used to pump the solution from the holding tanks to the cartridges. It should be capable of delivering 2 to 4 gal/min. However, the solution should not be pumped through the cartridge at a rate greater than 4 gal/min. An immersible or non-immersible pump can be used. A spare bleach-fix recirculation pump, which may have been used for the Kodak Bleach-Fix Regeneration Unit can be used for this purpose.

Flow Control Valve—Installation of this valve makes sure that the proper rate of solution flow will go to the cartridge. For maximum silver-recovery efficiency, the pumping rate should be only slightly greater than the influent rate and should not exceed 4 gal/min through the recovery cartridge.

Pressure Gauge—Excessive pressure can result from a restricted flow line or plugging within the cartridge. Under normal conditions there should be no pressure buildup if the proper size pump is used. The pressure should not exceed 3 psi. A pressure gauge enables this pressure to be monitored. This gauge should either have a Type 316 stainless steel Bourdon tube or be protected by a gauge isolating device made of plastic or Type 316 stainless steel.

Water Meter—By using a water meter it is possible to approximate when the cartridge capacity has been reached. It should not, however, be considered a substitute for regular monitoring of the silver concentration.

   The meter should be made of plastic or Type 316 stainless steel. Brass is not a suitable material for this application.

Installation Procedure

This type of recovery installation will vary, depending on the needs of the laboratory. The diagram on page 5 shows a basic installation. Modification will be required if the desilvering is done at a site remote from the processor. In that case, a transfer pump and a small collection tank located at the processor will be required. In cases where the combined wash water and bleach-fix from one or more machines exceeds the maximum 4-gal/min flow rate, an additional pump and a pair of cartridges installed parallel to the first set will be needed to provide sufficient treatment time. To prepare the cartridge for this type of installation:

1. Remove the shipping plugs from the inlet and outlet ports in the cover of the cartridges.
2. Install a KODAK ¾-inch Hose Adapter Elbow in each of the inlet and outlet ports.
3. Connect the ¾-inch ID plastic hose from the pump to the hose adapter elbow on the center inlet port of the first cartridge.
4. Then connect a ¾-inch ID plastic hose to the adapter elbow of the off center outlet port of the first cartridge to the center inlet port of the second cartridge.
5. Connect a third piece of plastic hose to the off center port adapter elbow to direct the outflow solution to the drain.

Cartridge Exhaustion

When the silver concentration in the solution exiting the first cartridge reaches about 25 percent of the concentration of the incoming solution, the second cartridge should be moved to the first position and a new cartridge installed in the second position.

If the silver concentration of the cartridge effluent is not going to be monitored, the first cartridge should be removed after treating 20,000 gallons of combined bleach-fix and wash.

Under normal operating conditions, the silver concentration of the effluent from the second cartridge should not exceed 1 mg per litre.

RECHARGING THE CARTRIDGE

To avoid sending the cartridges containing several gallons of usable solution and silver sludge to the refining service, the silver sludge from several exhausted Type 3 cartridges can sometimes be collected for shipping in one drum. This is usually not possible with recovery from mixed bleach-fix and wash or recovery from wash water only since the steel wool does not disintegrate sufficiently in these applications. Kodak Cartridge Refills, Type 3, are available for recharging the cartridges. Recharging is accomplished as follows:

1. Remove the lid from the exhausted cartridge by unscrewing the bolt that holds the locking ring in place.
2. Pump or bail out the liquid part of the contents of the exhausted cartridge, taking care not to remove any of the silver sludge. The liquid thus removed can
be used to fill the fresh cartridge so that the chemical is not wasted and the fresh cartridge starts to recover silver immediately.

3. Pour the silver sludge into a spare empty KODAK Chemical Recovery Cartridge. Type 3. This cartridge can be kept for the accumulation of silver sludge from other exhausted cartridges and also for shipping the sludge to a silver refinery.

   NOTE: To prevent the stored sludge from oxidizing, which might result in a buildup of heat, cover the sludge with about an inch of liquid effluent. Then, replace the lid with the shipping plugs screwed in tightly and secure the locking ring. This unit is now ready for shipment.

4. Check to be sure that the plastic spacer dish is properly seated within the bottom of the drum to be recharged. Do not wash out the drum as the residue probably contains silver.

5. Press a new KODAK Cartridge Refill, Type 3, into the drum until the steel wool is in contact with the bottom spacer.

6. After removing the old gasket, thoroughly clean the groove in the cover with a wire brush. A new gasket is supplied with each KODAK Cartridge Refill, Type 3. Place this new gasket in position in the grooved rim of the lid. Then install the cartridge lid, being sure that the pipe attached to the underside is properly inserted into the cardboard core of the refill material.

7. Replace the locking ring and secure it by replacing the locking ring bolts. Take care not to crimp or pinch the sealing gasket beneath the cartridge lid.

8. If the recharged cartridge is to be used immediately, install the circulation unit on the cartridge lid, making sure to use the two new washers supplied with the refill unit. If not, replace the shipping plugs and store the unit until it is needed.

**SHIPPING THE SILVER SLUDGE**

Eastman Kodak Company will accept for refining silver sludge shipped in the stainless steel drum component of the KODAK Chemical Recovery Cartridge, Type 3, provided that the sludge was obtained by the silver/iron exchange method of silver recovery. The company does not accept bulk shipments of sludge, chemical recovery cartridges made by other manufacturers, or waste photographic materials for silver recovery. A detailed description of the recovery service offered by Kodak is given in Kodak Publication No. J-8, The KODAK Silver Recovery Program.

**Spare Parts**

for the KODAK Chemical Recovery Cartridge, Type 3.

<table>
<thead>
<tr>
<th>Part</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locking ring</td>
<td>764777</td>
</tr>
<tr>
<td>Cover gasket</td>
<td>764733</td>
</tr>
<tr>
<td>Cover plug</td>
<td>764775</td>
</tr>
<tr>
<td>Top spacer block</td>
<td>764613</td>
</tr>
<tr>
<td>Bottom spacer disc</td>
<td>764614</td>
</tr>
<tr>
<td>T-fitting for circulating unit</td>
<td>764774</td>
</tr>
<tr>
<td>Washer</td>
<td>764616</td>
</tr>
<tr>
<td>Sight glass (bleach-fix system)</td>
<td>527065</td>
</tr>
<tr>
<td>Plastic tubing, ¼-inch ID*</td>
<td>760477</td>
</tr>
<tr>
<td>Tubing clamp (Corbin type)</td>
<td>452638</td>
</tr>
</tbody>
</table>

*S 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, Parts Services, 800 Lee Road, Rochester, New York 14650. Telephone orders: 716-722-2635.
# RECOMMENDED OPERATING CONDITIONS

## Silver Recovery from used Fixers, Stop Baths, and Bleach-Fixes

Using the KODAK Chemical Recovery Cartridge, Type 3

<table>
<thead>
<tr>
<th>Used Silver-Containing Solutions</th>
<th>Maximum Capacity (Type 3 Cartridge)</th>
<th>Maximum Flow Rate for Efficient Silver Recovery (mL per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U.S. Gallons</td>
<td>Litres</td>
</tr>
<tr>
<td>KODAK EKTAPRINT 2 Bleach-Fix and Replenisher* (2 cartridges in series)</td>
<td>450</td>
<td>1,700</td>
</tr>
<tr>
<td>KODAK EKTAPRINT R-100 Bleach-Fix and Replenisher* (2 cartridges in series)</td>
<td>390</td>
<td>1,475</td>
</tr>
<tr>
<td>KODAK Fixer</td>
<td>660</td>
<td>2,500</td>
</tr>
<tr>
<td>KODAK FLOMATIC Stop Bath†</td>
<td>1,050</td>
<td>3,975</td>
</tr>
<tr>
<td>KODAK HI-MATIC Stop Bath†</td>
<td>1,050</td>
<td>3,975</td>
</tr>
<tr>
<td>KODAK Rapid Fixer</td>
<td>660</td>
<td>2,500</td>
</tr>
<tr>
<td>KODAK Microfilm Fixer and Replenisher</td>
<td>660</td>
<td>2,500</td>
</tr>
<tr>
<td>KODAK X-Ray Fixer</td>
<td>660</td>
<td>2,500</td>
</tr>
<tr>
<td>KODAK EKTAPRINT 2 Bleach-Fix and Replenisher NR</td>
<td>150 to 225</td>
<td>570 to 850</td>
</tr>
<tr>
<td>KODAK EKTAPRINT 2 Bleach-Fix and Replenisher NR and Wash Water Mixture‡ (2 cartridges in series)</td>
<td>15,000 to 20,000</td>
<td>57,000 to 76,000</td>
</tr>
<tr>
<td>Wash Water‡</td>
<td>25,000 to 30,000</td>
<td>95,000 to 113,500</td>
</tr>
</tbody>
</table>

Cartridge capacities are guidelines only. The actual volumes of solution that can be delivered will vary depending on the specific operating conditions.

*Used with the KODAK Bleach-Fix Regeneration Unit, Model 1.
†Silver recovery from KODAK FLOMATIC Fixer and Replenisher and KODAK HI-MATIC Fixer and Replenisher is not recommended.
‡If recommended wash rates are not strictly adhered to, the cartridge capacity will be higher but silver will be lost because of dilution.

KODAK Publications that relate to silver recovery:
- J-8, The KODAK Silver Recovery Program.
- J-9, Silver Recovery with the KODAK Chemical Recovery Cartridge, Type P.
- J-10A, Potential Silver Yield from KODAK Photographic Products.
- J-10B, Directory of Silver Services.

This priced KODAK Publication can be obtained through photo dealers or by sending a prepaid order (including state and local taxes and $2.95 handling charges) to Eastman Kodak Company, Department 454, Rochester, New York 14650. Price given is for a single copy and is subject to change without notice.

J-10, Recovering Silver from Photographic Materials. Discusses various methods of recovering silver from waste sensitized goods and used processing solutions. List price is $4.00.

**Complimentary single copies of these publications can be obtained from Department 412-L, Rochester, New York 14650. Amounts of 10 or more should be ordered from Department 454.**