

ECOLOGICAL AND ECONOMICAL SOLUTIONS FOR FILM RADIOGRAPHY

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Abstract: Film radiography may be perceived as technology with environmental concerns, involving the application of chemicals and the discharge of drained waters with high silver levels. Ecological legislation concerning silver content of the wash water differs from country to country.

GE Inspection Technologies now offers industrial radiographers several ways to address regulatory limits silver in drained waters.

First, two brand new film processors, the Agfa NDT Si and M eco, are introduced to the NDT market. Both machines are equipped with Cascade Fixing Technology, which reduces silver content in the wash water and increases the ability to comply with stricter discharge standards. Next the new eco Film System is presented. This system is based on the new machines, specially adapted films and carefully developed new chemicals. Eco stands for ecological and economic performance. The customer can now process films in a very short cycle, saving money while increasing its ability to comply with environmental limits on discharges of silver into drained waters.

This paper will also address other means to reduce the silver freight in the wash water.

Opportunities but most of all issues involved in the application of these technologies will be highlighted.

Thus the presenter of this paper will demonstrate how film radiography responds to environmental concerns without causing extra financial burdens for the user.

Introduction: Molecules carrying the silver ion are the basic sensitive materials used in today's radiographic films. During film processing, silver is released and may be discharged into the facility's sewers.

Local and/or National legislation or directives and implementing regulations and permits often require careful monitoring of the silver concentration discharged. Some laws prescribe an absolute amount of silver that can be discharged per volume of film processed (maximum loading) while most state a maximum silver concentration per litre of water coming to the sewer. The latter form is mostly expressed in amount of silver released with each litre of water (g/l or ppm).

A typical conventional processor releases approximately 20 ppm of silver with the wash water. The silver is carried over into the wash water by the film coming from the fixer solution. To limit the amount of silver in the wash water, one may go for post treatment, such as electrolysis, ion exchange, metallic replacement, precipitation or distillation. Not only do these methods implement high start-up and exploitation costs, the flow of the wash water is too high to be handled by these technologies. (1) The better solution to meeting silver concentration limits is to reduce the amount of silver carried over from the fixer by limiting the silver concentration in the fixer itself.

Can closed loop silver recovery reduce the silver concentration in the fixer?

Yes, it can. In-line or closed loop silver recovery, where the fixer is led through an electrolysis cell for silver recovery before being pumped back into the fixer tank, can reduce the consumption of fixer by as much as 50%. There is, however, a significant downside which needs to be considered. In order to recover sufficient silver, one has to gradually increase the current for the electrolysis process. However, this response will consume all sulphite in the fixer, which increases the acidity of the solution until sulphur precipitates. In addition sulphate will be conversed, not only contaminating the electrodes and thus destroying the electrolysis cell, but also lowering radiographic archivability by keeping non-soluble salts in the film. Forced

regeneration of the fixer solution by nearly doubling the replenishment rate may help but is economically less desirable.

How to reduce silver concentration in the fixer solution?

Different parameters determine the actual silver content of the fixer and the resulting ppm concentration in the wash water. First, and actually supplier of all silver: the optical density of the film processed. Fig. 1 shows a relation between the average optical density of film processed and the resulting silver concentration in the wash water.

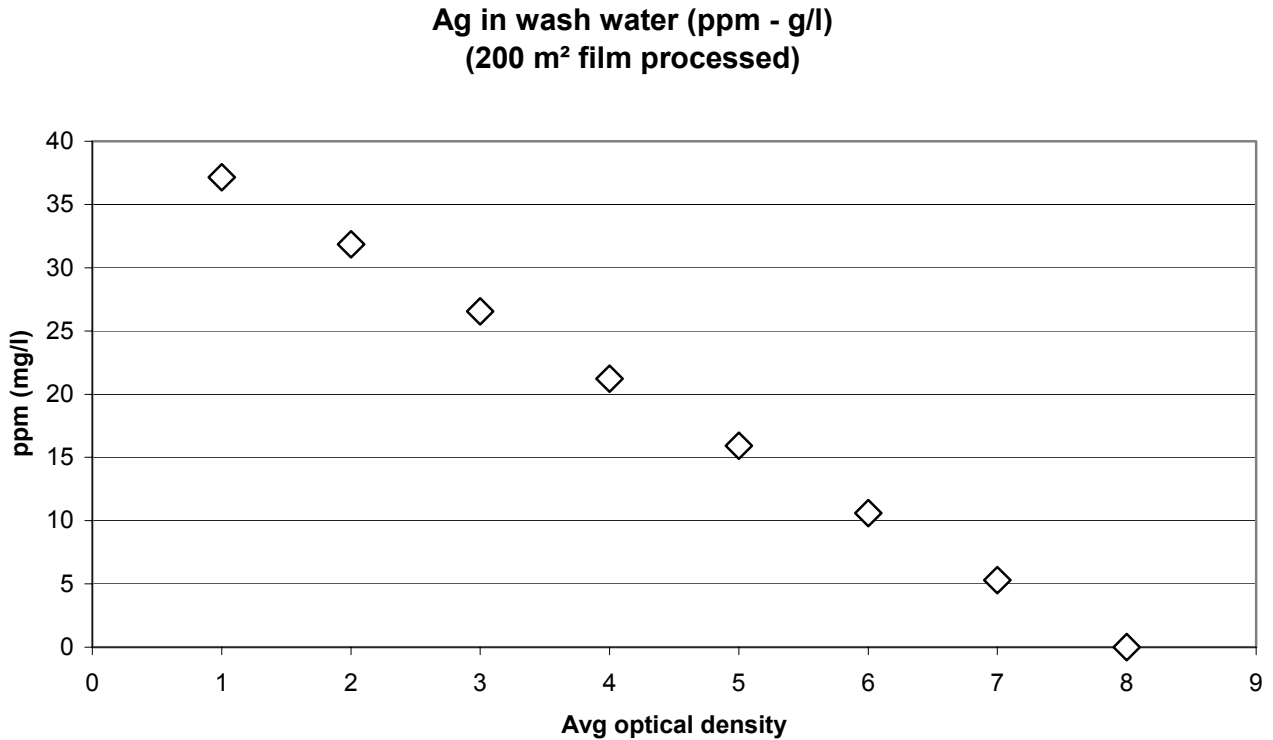


Figure 1: Relation between Average optical density and silver Ag⁺ concentration in wash water

Obviously, the density of the film processed cannot be chosen freely and is completely depending from the specifications of the radiographic application involved. Given a certain density, one may influence the silver concentration in the water by diluting the fixer with fresh fixer. This is feasible by increasing the regeneration rate of the fixer. Fig. 2 gives a relation between both. One can deduce that a low enough silver concentration requires a fixer replenishment which is more than twentyfold of the usual settings (1200 ml/m²)!

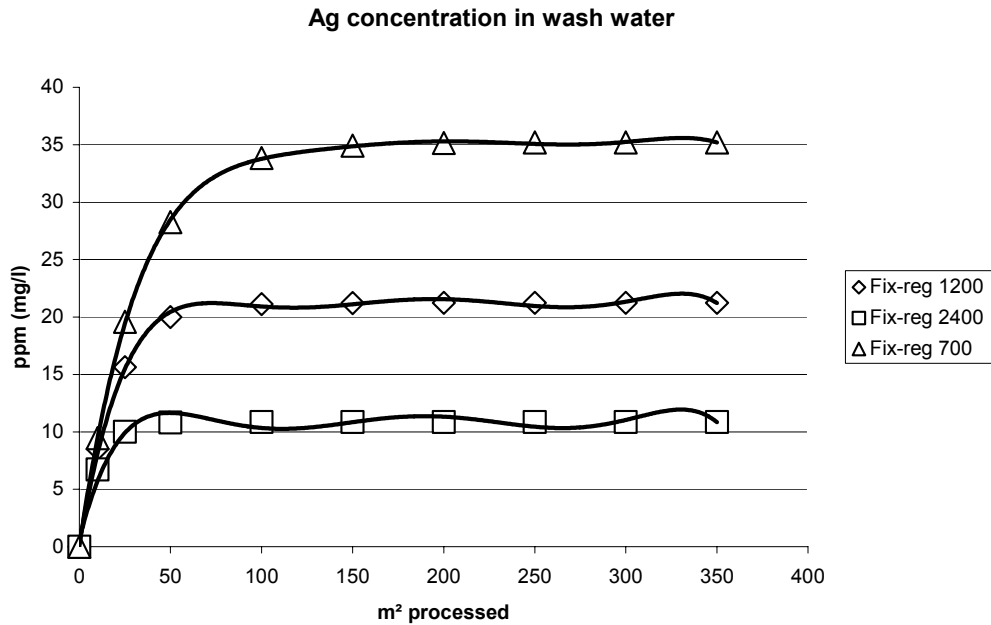


Figure 2: Relation between Fixer regeneration and silver concentration in wash water

Since all silver is being introduced into the wash tank by the film carrying over the silver from the fixer tank, and one therefore is compelled to reduce the silver concentration in the fixer tank, an obvious solution is using a cascade fixing system. Such a system, as used by the Agfa NDT Si and M eco processors, consists out of two consecutive fixer tanks. The replenishment of the fixer is done counterflow-wise regenerating the second fixer tank, of which the overflow will regenerate the first fixer tank. The resulting silver concentration in the wash water is significantly reduced as shown in Fig. 3. The combined effects of the cascade fixing and the counterflow regeneration significantly lower the silver content in the wash water as a result. For this mathematical model, the volume of the fixer tanks were chosen in such a way that their total equals the volume of the non-cascade example. In reality these volumes are bigger and thus the silver concentration is even much lower.

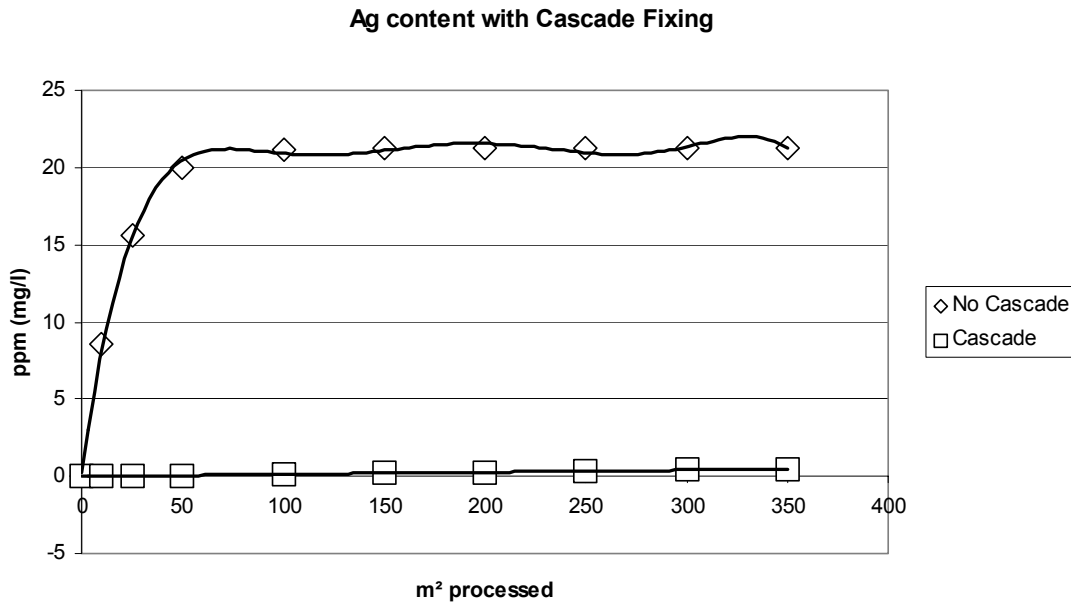


Figure 3: Effect of Cascade Fixing on silver content

The Agfa NDT eco Film System

Using the Agfa NDT Si machine as described above, the Agfa NDT Films and the newly developed chemicals: ecoDEV and ecoFIX, the eco Film System is formed. Thanks to the technology of the Cascade Fixing, environmental discharge limitations on silver are addressed. It is not apparently how the addition of boron adds to the environmental performance, for boron is also a regulated pollutant. Most spectacular however is the economical advantage offered when using this system. Both ecoDEV and ecoFIX allow a significant reduction in replenishment when used in the short 5-minute cycle. At replenishment rates for developer and fixer equalling 550 and 700 ml/m², the system performs in an equal way to the standardised 8-minute cycle with 900/1200 replenishment rate settings! Thereby the customer gets multiple benefits in one go. Thanks to the Agfa NDT eco Film System he will be better able to meet increasingly restrictive discharge limits without having to use additional chemicals. The user is even offered a substantial reduction in the amount of chemicals consumed. The best thing about this film system is that in spite of all these advantages and savings, the user does not have to sacrifice any quality: the eco Film System is a fully certified film system complying to all international standards on film system classification: EN 584-1; ASTM E1815; ISO 11699. One can say therefore that the “eco” does not stand for ecology alone, also economical benefits are offered with this system, allowing the user to maintain the quality of a certified system with shorter cycle times, reduced chemistry consumption and a higher throughput.

References:

- (1) Susan M. Morgan, “Need for & efficiency of silver recovery, or silver sampling faux pas & fundamental conclusions”, *16th College and University Hazardous Waste Conference*, July 20, 1998, New Orleans LA, USA