Ferrania
Imaging Technologies

LabLine Training Series

Part Six

Process Troubleshooting

The Ferrania Imaging Technologies LabLine Training Series will provide a primer on many subjects related to photofinishing technology, theory and application. The subject discussed in this issue will be the last in the series on Chemical Process Quality Control. The principles and practices a lab may employ to troubleshoot the wet color negative processes, including C-41, RA-4 and EP-2, will be presented in this issue. A general knowledge quiz on the subjects covered in this issue will also be included. The information in this and following features will furnish the reader with a ready reference on the subject and supply a source of information and materials to train new employees.

Introduction

Process Troubleshooting is often one of the most challenging and interesting technical facets of operating a photo finishing laboratory. When a process goes out of control, or is trending that direction, the personnel responsible for quality control in the lab are faced with a challenge. That challenge is to identify the cause of an out of control or near out of control condition and to develop a course of action to remedy the condition as quickly as possible. This must be done, of course, without interrupting production or the delivery of a quality product to the customer.

The majority of potential control problems which may develop in a process can be prevented by practicing careful and consistent work habits when operating the equipment, mixing chemicals or performing quality control functions related to the process. However, occasional problems can and do arise. To be an effective process troubleshooter, an operator must be aware of the type of problems that can arise, how to interpret or identify them and what must be done to correct each of the specific problems.

This issue of the LabLine Training Series will discuss a common sense approach to troubleshooting the wet processes. The information presented is written in regard to the C-41, C-41B, C-41RA, EP-2 and RA-4 processes. This publication should not be used as a sole source for process troubleshooting. Most major film, paper and chemical manufacturers publish process monitoring and troubleshooting manuals which should be used in conjunction with this material.

Process Troubleshooting

When a process control form exhibits a problem with the process, the quality control personnel in the lab must first correctly identify and interpret exactly what the individual plotted values indicate. They must consider that there may be several types of conditions that could exhibit the same plot characteristics or there may be a combination of conditions which would yield those same characteristics. They must then, based on experience, determine which is the most likely cause. The suspected cause must then be verified as the actual cause. Then finally, a corrective action plan must be formulated and then implemented. The objective being, to implement a plan of action which will bring the process back on track.

For the inexperienced this may sound like a complicated process. However, it is typically routine for an experienced quality control staff. Previous experience with process control problems enables a lab technician to quickly evaluate a process and determine what the cause of a trending out or out of control process is. However, a good basic understanding of how the various processing factors affect each of the plot categories will enable even the inexperienced to make accurate evaluations of those situations.

Process Control Form Interpretation

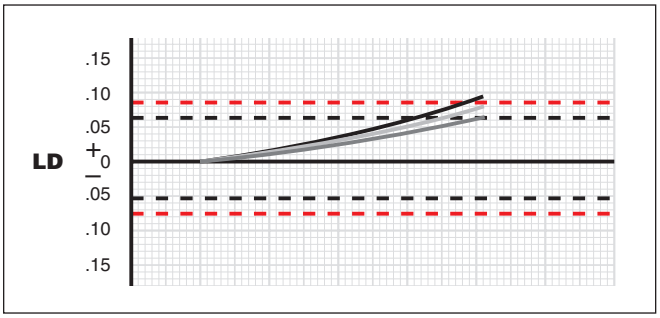
Good plot interpretation starts with a good understanding of what affects the individual categories plotted. Each of the categories plotted; density minimum, low density, contrast, leuco cyan dye, retained silver etc., may be affected by a processing

factor that is out of range. For example: A low bleach replenishment rate in the C-41 film process would likely cause the retained silver plot to be too high. A low developer temperature would cause the low density plot to be too low. However, there are several other situations that will cause both of these conditions. The key is to understand which processing factors influence which plot categories and how the individual plot categories interrelate when a problem surfaces.

Following are some general guidelines that should be followed when evaluating a process and determining a course of corrective action when a problem arises:

1. If a problem appears in the process that did not exist when the previous control strip was plotted, run and plot an additional control strip to verify the problem. The problem itself may have been with the control strip and not with the process. Therefore, always confirm that a problem actually exists before proceeding further.
2. Always verify that the batch number of the control strip just plotted matches the batch number of the reference strip from which the reference values were obtained.
3. Verify that the control strips were run correctly.
4. Verify that the control strips were stored properly.
5. Verify that your densitometer is in calibration.
6. When correcting an out of control process, always bring the low density back in control before working on other out of control plot categories.

Low Density



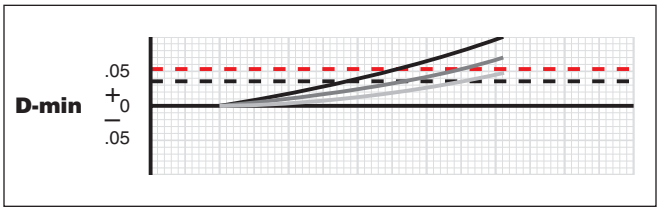
In general, low density is considered the primary indicator of the overall process. If low density is out of control, the whole process is considered out of control. In addition, low density must be in control if the other plot categories; D-min, HD - LD, D-maxR - D-maxG, D-maxB - YB etc., are to have any significance. In other words, the information derived from the plots of density minimum, contrast, leuco cyan dye, retained silver, etc., mean nothing unless the low density is in control.

For example, if a problem develops within the process and one of the symptoms is a low leuco cyan reading, it is very important that before any corrective action is taken that the low density is in control. If low density is not in control, the low leuco cyan dye reading may be due only to the fact that the whole process itself is out of control and not due to any factor that would normally cause a low leuco cyan condition to exist. In other words, even though the leuco cyan plot indicates a low leuco cyan dye condition, actually none could exist. It would only appear that the condition exists because the total process is out of control.

An operator will be able to narrow down the possible causes of a particular processing problem by making some assumptions on what will affect a particular plot category. The low density plot will be affected by all the processing factors as described in part four of this series. A long or short process time, a high or low solution temperature, a high or low agitation rate, a high or low chemical replenishment rate, improperly mixed chemicals or contaminated chemicals.

If the low density is out of control, the operator must systematically determine which factor needs to be adjusted to correct the problem. The determination process should be based on; common sense, previous experience, recorded information from the processing log book and gathered information from all personnel who work with that particular processor. Incorrect developer replenishment rates, improper developer chemical mixing procedures, developer contamination and low developer temperature due to poorly maintained chemical filters, are the most common reasons for an out of control low density plot.

D-min or Stain



If the low density is in control but the stain or density minimum (D-Min) is out of control, the cause will typically be one of the following:

1. A contaminated developer.

Generally a contaminated developer will cause the low density to be also out of control, but a slightly contaminated developer may only cause the low density to near the control limits. In this instance an operator may make a developer replenishment rate adjustment to bring the low density plot or process back in control. However, it is very likely that the D-Min plot will still be beyond the control limits.

2. An oxidized developer, bleach/fix or fixer.

During low volume periods, the rate of oxidation is faster than the rate at which the anti-oxidant or preservative is added back into the working tank through normal replenishment of these solutions. Oxidized materials in these solutions will stain paper or film.

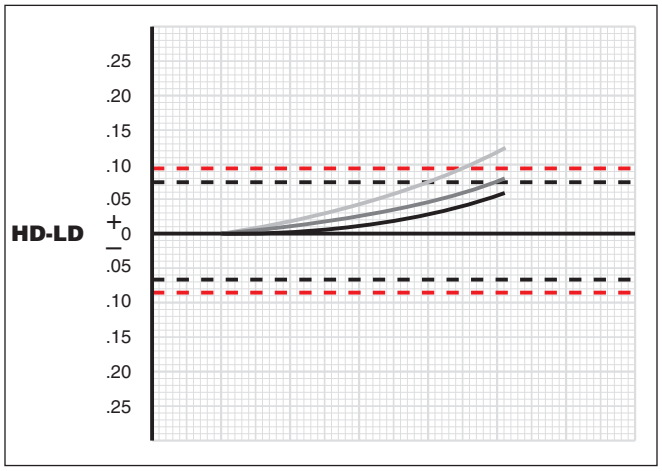
3. Excessive developer carryover.

If a processor's squeegees are not working properly or are worn, a larger than normal quantity of developer will be carried into the next solution by the film or paper. As this developer becomes oxidized in the bleach or bleach/fix, it may cause an increase in dye formation in the film or paper. This additional dye would be detected most readily in the D-Min readings.

4. An algae growth problem in the stabilizer.

If algae is allowed to grow uncontrolled in the stabilizer tanks, the algae will eventually begin to stain the paper or film. A regular stabilizer tank dumping procedure or chemical treatment will alleviate the problem. This condition is very common in minilabs.

HD - LD or Contrast



If the contrast plot is out of control, and low density in control, the following situations could cause this condition to exist:

1. A contaminated developer.

Generally a contaminated developer will cause the low density to be also out of control, but a slightly contaminated developer may only cause the low density to near the control limits. In this instance an operator may make a developer replenishment rate adjustment to bring the process back in control. However, it is likely that the contrast plot will still be beyond the control limits.

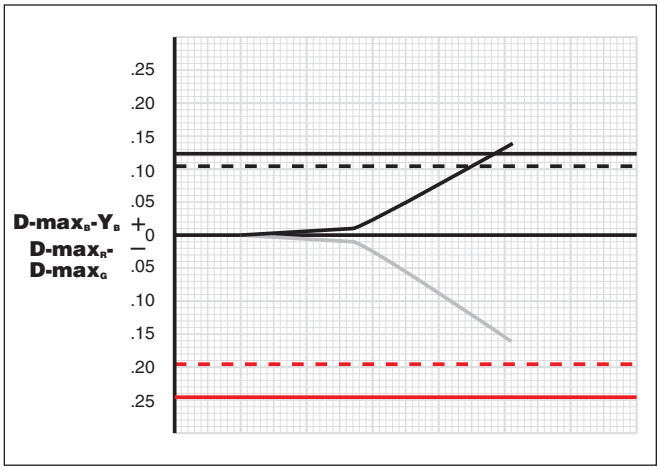
2. A low or high agitation rate.

The contrast plot is a product of the low density reading subtracted from the high density reading. Agitation affects higher density areas of the film or paper more than the lower density areas. If a high agitation condition exists in the developer, the contrast plot will be too high. If the developer solution is under agitated the contrast plot will be low.

3. Improper chemical mixing.

If the developer is mixed too weak or too strong, a change in replenishment rate will keep or bring the low density plot in control. However, the contrast will very likely be out of control. A regular review of chemical mixing procedures will prevent or lessen the occurrence of this common condition.

D-maxR - D-maxG or Leuco Cyan Dye (Film Process)



If the leuco cyan dye plot is low in the film process:

1. Over replenished or overconcentrated bleach.

If the bleach is over replenished or overconcentrated due to improper setting of rates, improper mixing or mechanical failure, leuco cyan dye formation will exist in the High Density and D-Max areas of the film due to a low bleach pH.

2. Under aerated bleach.

If the bleach is under aerated due to improper setting of aeration rate or mechanical failure, leuco cyan dye formation will exist in the High Density and D-Max areas of the film. This will generally be accompanied by a high retained silver reading.

D-maxB - YB or Retained Silver (Film Process)

If the retained silver plot is high in the film process:

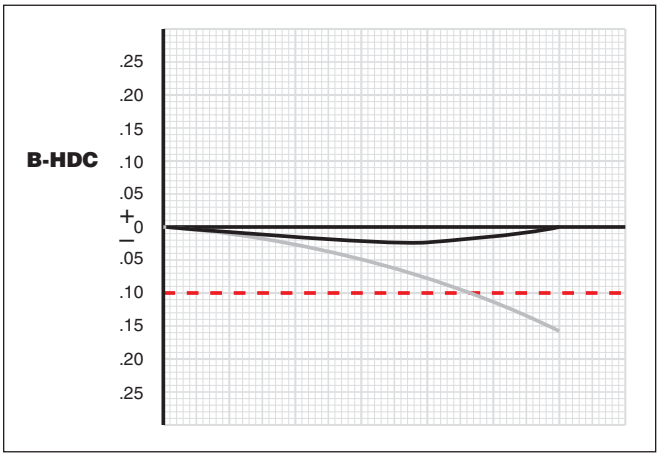
1. Under replenished or diluted bleach.

If the bleach is under replenished or diluted due to the improper setting of rates, improper mixing or mechanical failure, all the metallic silver in the film will not be converted to a non-metallic form. The fixer will not remove metallic silver. It will remain in the film after processing. (It is also possible that the bleach may be diluted due to excessive developer carryover caused by poorly maintained squeegees.)

2. Under aerated bleach.

If the bleach is under aerated due to improper setting of aeration rate or mechanical failure, all the metallic silver in the film will not be converted to a non-metallic form.

D-max Red, B - HDC or Leuco Cyan Dye (Paper Processes)



If the D-Max Red plot is low in the paper process:

1. Under replenished or diluted bleach/fix.
If the bleach/fix is under replenished or diluted due to improper setting of rates, improper mixing or mechanical failure, leuco cyan dye formation will exist in the D-Max areas. This is termed a Type 2 leuco cyan dye condition. (It is also possible that the bleach/fix may be diluted due to excessive developer carryover caused by poorly maintained squeegees.)

D-max Red and Red Contrast (Paper Processes)

If the D-Max Red or B-HDC plot is low and the Red Contrast is also low in the paper process:

1. Over replenished or overconcentrated bleach/fix.
If the bleach/fix is over replenished or overconcentrated due to improper setting of rates, improper mixing or mechanical failure, leuco cyan dye formation will exist in both the High Density and the D-Max areas. This is termed a Type 1 leuco cyan dye condition. ***Note:*** *Unlike EP-2 papers, most current RA-4 type color photographic papers are not sensitive to leuco cyan dye formation.*

This article has attempted to make the fundamentals of process troubleshooting more understandable and easy to apply. Unfortunately, the interactions of color photographic products are very complex and do not always yield themselves to simple explanations. Without a doubt, experience in finding the causes of processing problems is indispensable. On the other hand, the information presented in this series, along with specific instructions published in other process monitoring manuals and other aids can get anyone started on the pathway to process control and good quality production.

Process Troubleshooting Quiz

Indicate whether the following statements are True or False:

1. T F Low Density is the primary indicator of the over all process level.
2. T F A high developer replenishment rate will cause the low density plot to be too low.
3. T F If an out of control situation is indicated by a single control strip, a determination of cause and remedy should immediately be formulated.
4. T F It is possible that the cause of a control problem may be due to an improperly calibrated densitometer.
5. T F A slightly contaminated developer will have no effect on the D-min plot.
6. T F An oxidized stabilizer will cause a stain on photographic paper.
7. T F Algae in the processor can be eliminated or reduced by a regular stabilizer dumping procedure.
8. T F Any unusual occurrence in the lab should be recorded in the processing log book.
9. T F A process log book that is properly maintained can be a very useful resource when troubleshooting a process.
10. T F Always run an additional control strip to verify a problem if there is any doubt to the accuracy of a previously processed control strip..
11. T F Improper chemical mixing can cause the contrast plot to be high or low.
12. T F Retained silver can be caused by film bleach over replenishment.
13. T F A Type 1 leuco cyan dye will affect only the D-max plot.
14. T F Chemical mixing procedures once established need not be reviewed.
15. T F A systematic approach to process troubleshooting has little merit.

Answers:
True: 1,4,7,8,9,10,11 False: 2,3,5,6,12,13,14,15

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