pH, Conductivity and Offset Printing

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Introduction

- At heart, lithography is a chemical process with potential for many variables which may affect production and the quality of offset printing.
- Of the many facets of offset printing perhaps none is as prone to variation as fountain solution, but while the cause and nature of these variations may seem complicated, controlling them is relatively simple.

Agenda

- What is the purpose of fountain solution?
- How important is the water source?
- What is pH, and determining pH?
- What is conductivity and how do we measure conductivity?
- Problems caused by incorrectly mixed fountain solution?

Overview

- In 1796, Alois Senefelder applied an oil type ink on stone, and found that water adhered to the non-image area only. With trial and time, more sophisticated methods were developed. This was done by using chemicals in the water, in conjunction with metal plates which have oleophilic (ink receptive) and hydrophilic (water receptive) surfaces.

Overview

- In Senefelder's day he went to the well, got a bucket of water, and was ready to go. If things were only that simple. We will look at how we can make the complex variables of fountain solution simple.



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What is the purpose of Fountain Solution?



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Fountain Solution

- The dampening of the offset plate is one of the most critical factors in quality offset printing.
- A solution of a fountain concentrate mixed with water is created that performs several essential functions on press.
- The most important of these is the wetting and desensitizing of the non-image area of the plate.

Fountain Solution

- Fountain solution lubricates the plate and blanket, helping to reduce image wear and prolong plate life.
- Fountain solution cools and helps to maintain the working properties of ink.
- Fountain solution aids in proper blanket release, which reduces piling on the blanket.

Fountain Solution

- The pH and conductivity of the fountain solution are of major importance if the fountain solution is to properly fulfill it's function of preventing plate non-image areas from accepting ink.
- Mixing solution should be done on a daily basis for small duplicators, and tested daily on large presses with holding tanks.
- The fresher, the better!

Fountain Solution Components

- Most fountain solutions are made up of five basic ingredients and water.
  - ✓Acid.
  - ✓A wetting agent (surfactants).
  - ✓Plate conditioners (chemical salts).
  - ✓Gum arabic.
  - ✓A buffering agent.

Fountain Solution Components

- Acid.
  - ✓Usually a mild acid, which helps reduce the pH and keeps the image area sensitive to ink and the non-image area more sensitive to water.

Fountain Solution Components

- A wetting agent.
  - ✓Sometimes referred to as surfactants, these are used to lower the surface tension of the water allowing it to maintain the wetting ability of the fountain solution in the non-image areas, while allowing you to run less water. Common agents used are: Isopropyl Alcohol, Glycerin, and various Glycols.

Fountain Solution Components

- Plate conditioners (chemical salts).
  - ✓These are used to minimize the corrosive action of the acid on the surface of an aluminum or metal plate. This is designed to increase the print quality and to extend the life of the plates. Most solutions also contain anti-foaming and anti-fungus ingredients.

Fountain Solution Components

- Gum arabic.
  - ✓Gum arabic has already been added to most fountain solution concentrates made today. It's function is to adhere to the plate's non-image area and protect it from accepting ink. Gum also serves to protect the plate from humidity and chemical attack during press stops.

Fountain Solution Components

- A buffering agent.
  - ✓A substance capable of neutralizing acids and bases in solutions and thereby maintaining the acidity or alkalinity level of the solution.
  - ✓Keeps the pH constant or within a certain range regardless of how much acid is added.
  - ✓Neutralizes the effects of paper, inks, gases, and humidity.

Fountain Solution Components

- Alcohol in dampening solutions.
  - ✓Alcohol is added to the fountain solution as a surfactant. It makes the water wetter. By reducing the surface tension of the water the water will spread out to a thinner film.

Fountain Solution Components

- Alcohol in dampening solutions.
  - ✓Isopropyl alcohol is a volatile organic compound. As a VOC alcohol pollutes our pressroom and our environment. It is recommended to use alcohol substitutes.

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How important is the Water source?

Water

- Since approximately 98% of a working fountain solution is water, being aware of your water condition is of vital importance.
- Water can be either hard or soft, acid or alkaline. In fact, water quality can vary seasonally, monthly, weekly, or even daily.

Water

- Understand that tap water can be a variable when used in fountain solution because some minerals and chemicals in the water may not be compatible with the chemicals in the fountain solution concentrate.

Water

- There are three stable substitutes for tap water: De-ionized, Distilled, and Reverse Osmosis water.

Water

- De-ionization, or the demineralization process.
  - ✓A complex chemical process that uses two ion exchange resins to remove minerals from water. The cost of this method is considerably less than the cost of producing distilled water.

Water

De-ionization, or Demineralization unit



Water

- Distilled water.
  - ✓Produced in a laboratory by boiling ordinary tap water in a water still. The steam that rises from the boiling water is almost free of the mineral matter present in the tap water. The steam is fed through condenser coils where it is converted into liquid, distilled water. Some fountain solutions do not work well with distilled water.

Water

Distilled Water Unit



Water

- Reverse Osmosis water.
  - ✓The best method of water purification. In this process the water is filtered through a membrane to remove most of the positive and negative ions, un-ionized dissolved solids (sugars), suspended matter, and bacteria leaving only pure water.
  - ✓Sometimes referred to as "RO water".

Water

Reverse Osmosis Unit.



Water

- What is Hard Water?



Hard Water Is:

- ✓Tap water is rarely pure.
- ✓Ions associated with minerals and inorganic compounds in water make it “hard”.
- ✓Through formation of oleaginous (oily) soaps, hard water can play havoc with press operations (roller stripping, halftone fill-in).
- ✓Water hardness is rated in terms of total concentration of calcium carbonate ions.

Water

- How do we evaluate water hardness?



We evaluate water hardness by:

- ✓Water hardness usually is indicated in parts per million (PPM) (or milligrams pre liter (mg/l) or grains/gallon) of calcium carbonate.
- ✓Water hardness varies from locality to locality.
- ✓The best source for determining water hardness is the local water company.
- ✓Water hardness can be estimated by using a conductivity meter.

We evaluate water hardness by:

WATER HARDNESS TABLE

DEGREE OF HARDNESS	GRAINS/GAL	MG/L OR PPM	CONDUCTIVITY MICROMHOS/CM
SOFT	0 - 7.9	0 - 135	0 - 225
MEDIUM	8.0 - 15.9	136 - 272	226 - 450
HARD	16.0 - ≥ *	273 - ≥ *	451 - ≥ *

*Water with readings in excess of 29.2 grains/gal. or 500mg/L or 500 PPM are unsuitable for Lithography.

Water Softener.



Water

- What is water alkalinity?



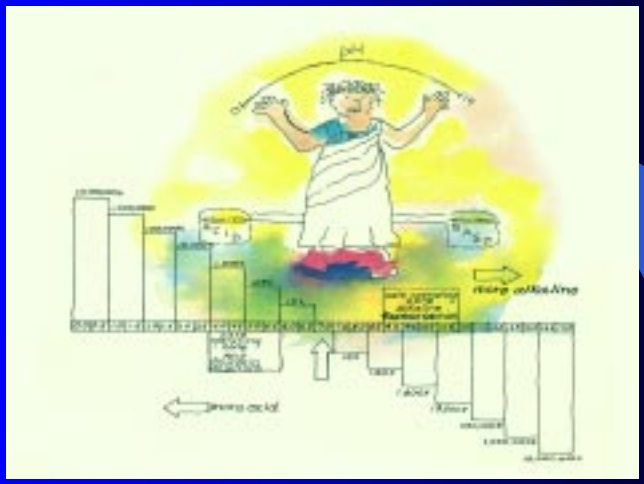
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Water alkalinity is:

- ✓Alkalinity neutralizes acids.
- ✓Tap water with high levels of alkalinity are most common in areas with limestone deposits.
- ✓Alkalinity is measured and expressed in PPM, mg/l or grains/gallon.
- ✓In areas with alkaline water, alkalinity is more important than water hardness because excessive levels shift pH towards neutral.

What is pH?



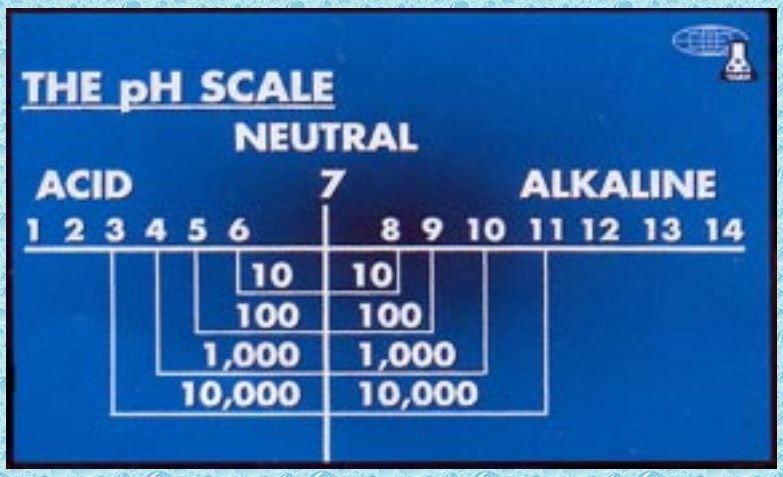
What is pH? (History)

- For those who wonder how the term pH came by its odd spelling, the Romans knew pH as "potentia hydrogenii," or "potential for Hydrogen," and thus the small "p" and capital "H".
- All the press operator really needs to know about pH is that it is a measure of the degree of acidity or alkalinity of fountain solution.

What is the pH Scale?

- ✓ The pH scale runs from 0 to 14.0.
- ✓ 7.0, the mid-point on the pH scale, is neutral.
- ✓ A solution with a pH of less than 7.0 is acid. A solution with a pH of more than 7.0 is alkaline (base).
- ✓ A whole-number change on the pH scale represents a tenfold change in pH. Small differences on the scale, in practical terms, may be quite large.

What is the pH Scale?



What is the pH Scale?

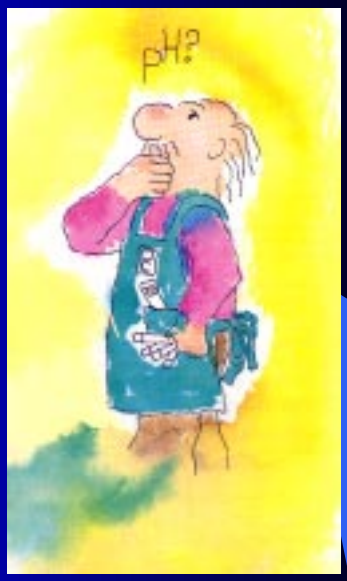
- ✓ Each whole number on the pH scale represents a tenfold change in acidity or alkalinity.
- ✓ A solution at (pH 5.0 is 10 times more acidic than a pH 6.0) and a solution at (pH 4.0 is 100 times more acidic than a pH 6.0).
- ✓ A solution at (pH 9.0 is 10 times more alkaline than a pH 8.0) and a solution at (pH 10.0 is 100 times more alkaline than a pH 8.0).

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Determining pH.





Determining pH.

- ✓ There are two basic methods for checking pH in the industry: with chemically-coated indicator papers (strips), and with electronic pH meters.
- ✓ Indicator papers and strips tend to be inaccurate.
- ✓ Battery-operated, portable pH meters are reliable and easy to use.

Determining pH.

- ✓ Ink-makers recommend a fountain pH of 4.5 – 5.0 for optimal performance.
- ✓ Certain duplicators, using paper plates, may require a slightly lower pH.
- ✓ Higher pH readings may cause scumming and toning, whereas pH readings of less than 4.0 may retard or inactivate ink drying by locking up the catalytic dryers in the ink.

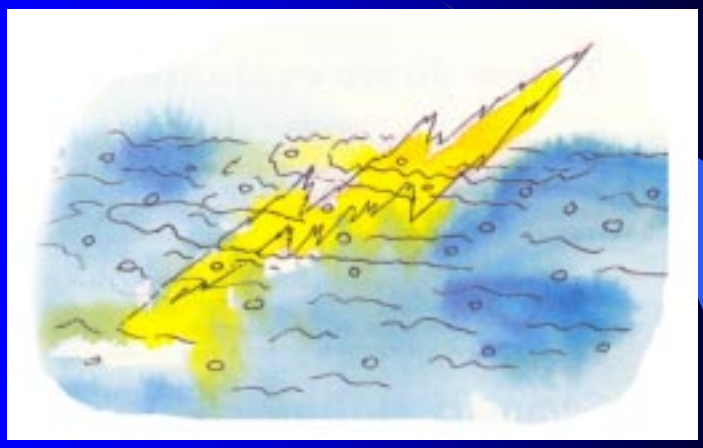
Determining pH. (Buffering)

- ✓ Without getting over-technical, buffers are chemicals that are used in fountain concentrates to help stabilize the pH level of the mixed solution.
- ✓ Buffers reduce the tendency of pH to drift (becoming more acidic or alkaline) due to the introduction of contaminants such as paper coatings, inks, wash-up solutions, and any other contaminant you can think of.

Determining pH.

- When purchasing fountain solution:
  - ✓Is it a buffered or non-buffered solution?
  - ✓Is it compatible with your water source?
  - ✓Does the fountain solution provide the correct pH level and compatibility specified by the ink and plate manufacturers?
  - ✓Do Not use a variety of different solutions! Find one that works for your type of printing.

What is conductivity?



What is conductivity?

- Conductivity is the ability to transmit or conduct an electrical charge.
- The degree of conductivity is determined by the number of ions present as a result of minerals or other compounds in the water.
- The higher the concentration of ions, the higher the degree of conductivity (and usually the harder the water).

What is conductivity?

- Water normally has a very low ion level and registers very low in conductivity.
- Alcohol does not conduct an electric charge and has a conductivity reading of 0, as does glycerin.
- Therefore alcohol and glycerin act to dilute, reducing the solution's conductivity reading.

Why the need for conductivity?

- With the new technology that has evolved in the printing industry, including buffered and neutral fountain solutions, pH is not enough in determining the best level of performance of a fountain solution.
- Conductivity gives a more accurate way to monitor the conductivity level throughout a press run.

Why the need for conductivity?

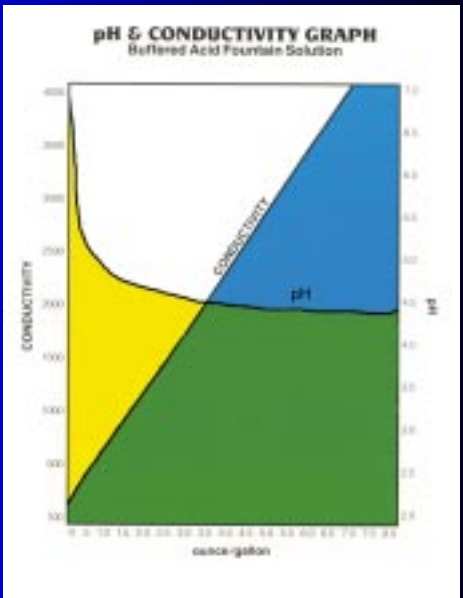
- Whether the press operator adds 3 or 8 ounces of solution to a gallon of water, the pH will remain the same, but the over-all chemistry is not correct for the type of press that you are trying to run!

Why the need for conductivity?

- Conductivity readings let us know where our starting solution should be, and if it becomes contaminated and problems arise we have a base number to refer back to regardless of the pH level.

Why the need for conductivity?

This chart shows a Fountain Solution buffered at a pH of 4.5



How do we measure conductivity?



How do we measure conductivity?

- The unit of measure for expressing electrical resistance is the “ohm”, and the unit of measure for expressing conductivity, the opposite of resistance, is the”mho”.

How do we measure conductivity?

- Because of the difficulty of measuring conductivity in terms of "mho" units, a fraction of a mho or a "micromho" is normally used.
- A micromho is equal to one millionth of a mho.

How do we measure conductivity?

- Conductivity meters are accurate, easy to calibrate, and simple to use.
- To take a reading just place the electrode in the solution and stir a few seconds.
- Most conductivity meters are digital and a reading will appear in the viewer.

How do we measure conductivity?

- The level of a solution is measured with a conductivity meter, which gives readings in micromhos per centimeter.
- Conductivity should be checked before and after adding alcohol due to the fact that alcohol dilutes the solution and will render a false reading.

How do we measure conductivity?

- The rule of thumb for good conductivity readings is about 900 to 1000 mmhos over the conductivity of the water.
- The conductivity range encountered by most printers will be under 3000 micromhos (mmhos).

How do we measure conductivity?

- The important fact to remember is that there is no conductivity standard. You must determine the individual standard for your press by conducting tests.

Fountain solution problems.

What happens when too much concentrate is used in the fountain solution?



Too Much Concentrate

- If the recommended dilution ratio of the fountain concentrate is 2 ounces per gallon, this does not mean that 4 ounces per gallon is twice as good.
- Excessive use of fountain concentrate will cause problems and increase chemistry, material, and labor costs.

Too Much Concentrate

- When an overdose of a buffered fountain concentrate occurs, the pH reading will not indicate this excess because the buffering salts limit the pH reading of the solution.
- A conductivity reading, on the other hand, will prove useful in determining excess concentrate.

Too Much Concentrate

- Possible problems from too much concentrate.
  - ✓Ink emulsification (especially reds and blues).
  - ✓Background tinting.
  - ✓Poor ink-acceptance in image area, resulting in mottling or blinding of the plate.
  - ✓Premature plate wear from lack of ink lubrication.
  - ✓Slow drying of inks and possibly, of chalking.
  - ✓Stripping of the ink rollers.

Fountain solution problems.

What happens when too little concentrate is used in the fountain solution?



Too little Concentrate

- Too little concentrate will cause many of the active ingredients found in the fountain solution to be inadequate in strength to do the job they are designed to do.
- Lack of adequate concentrate can be determined by both pH and conductivity.
- For best results, stay with a range of pH and conductivity that is most successful under your printing conditions.

Too little Concentrate

- Possible problems from too little concentrate.
  - ✓Filling in of reverses and halftone screens.
  - ✓Scumming.
  - ✓Tinting.
  - ✓Inadequate gum will leave plate non-image areas unprotected.
  - ✓Lack of anti-corrosive ingredients will lead to premature plate wear.

Safety First



Safety First

- Use care while mixing to avoid dangerous splashes.
- Measure out the required amount of water first.
- Add concentrate to the water.
- If other components are required, add them to the water/concentrate mixture.
- Stir or mix all components to achieve a uniform blend.

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Safety First

- Check pH and conductivity to be sure they meet the manufacturer's recommendation (or the pre-established standards for your press).
- If alcohol is required, add it after the solution has been mixed to the desired conductivity range.

Summary

- pH and Conductivity determinations are the first logical troubleshooting steps when press related problems arise.
- Most problems attributed to fountain solution are due to too much or too little fountain concentrate and the source water.
- Maintenance and cleaning of dampening systems will also eliminate a lot of dampening system problems.

Where to Get More Information

- The following companies have provided the information used in this presentation:
- ✓ Varn Product Company (201) 337-3600
- ✓ Kohl Madden (800) 367-4657
- ✓ Kodak Polychrome Corp. (414) 784-3720
- ✓ Van Son Ink (800) 645-4182
- ✓ GATF http://www.gatf.org

Thank You

- If you ever need Help!

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