Fountain Solution in Offset Printing
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Interaction between ink and water

The offset process is the only printing process in which two different liquids are used on the printing form. One of these liquids, the viscous ink, is – and is supposed to be – visible after completion of the press run, while the other one, the fountain solution, is only visible in the print image if something has gone wrong. When viewed this way, the fountain solution seems to assume a high degree of importance only whenever things don’t work out well.

The ‘water-bearing layer’ of a lithographic printing plate consists of anodised (electrochemically oxidised) aluminium and is porous. The printing-plate manufacturer determines the thickness of this layer, the fineness of the grain and, as such, what are known as the “dampening characteristics” of the plate. It is these characteristics, that the fountain solution must manage perfectly in the non-image areas, in order to prevent the ink from adhering to the aluminium oxide surface of the plate. In turn, this means that no ink can be transferred from the non-image areas of the plate to the blanket. The diagram opposite illustrates this principle, although it does ignore the complex processes of emulsification and interfacial surface tension. By contrast, the fountain solution (primarily water) does not adhere (or adheres only inadequately) to the image areas of the plate. The image areas can be inked freely and the interface between image and non-image areas is clean.

Grain: The fineness of the pores and roughness of the surface of a printing plate

Emulsion: A mixture of two, technically speaking, non-miscible liquids that are finely distributed and show no signs of separating

Interfacial surface tension: Forces that arise between surfaces of substances that are present in different forms – solid, liquid, gaseous
The basis – water

Water, as it flows out of the tap, differs greatly from region to region in terms of its make-up. It consists of the chemically defined combination of two hydrogen atoms and one oxygen atom, plus variable amounts of dissolved substances. Among these dissolved compounds, the majority are gases and various types of salt. Some of these constituents of water can have negative effects on the offset printing process, while others create conditions that need to be taken into account when adding fountain solution concentrates.

It is therefore highly advisable to analyse a number of parameters of your local tap water. The values of some of these parameters provide information as to how suitable the local tap water is for use in the lithographic process.

When does water need to be treated?

In some regions, the tap water values measured fluctuate so greatly throughout the course of the year that it is not possible to adapt to the prevailing water quality all the time. Some water supplies are derived from different sources (e.g. lake water and groundwater, depending on availability) and the values cited above are subject to large, unforeseeable fluctuations several times a day. In such cases, or if one of the above limit values is exceeded, water treatment or conditioning should be taken into consideration. Experience shows that softening of the water followed by reverse osmosis and controlled re-hardening produces the most reliable results.

The chart opposite shows the German scale for the total hardness of water compared with a common international unit of measurement,
“parts per million”. Only water that falls within the green zone guarantees trouble-free printing. If the hardness value of your tap water puts it in the white or red zone, we urgently recommend water treatment.

Benefits of water treatment

In practice, effects on the quality of a printed image can be observed, if fluctuations in water hardness or other quality of the fountain solution occur. For instance, dot gain is one factor that can experience marked effects from changes in the fountain solution. Since, in the quest to standardise the offset process, dot gain is one of the key parameters that have to remain within certain tolerances, it is important to “standardise” the fountain solution, too. This requires not only suitable measurement and control equipment for metering the correct quantities of fountain solution concentrate, but also a constant quality of the employed water, i.e. tap water. The decision to install a water treatment plant becomes unavoidable if the aim is, to achieve standardisation in accordance with the rules laid down in ISO 12647-2 to 5 and the quality of your tap water is only conditionally suitable or fluctuates.

Hardening

Hardening refers to the adding of calcium or magnesium ions to previously treated water. In regions with hard water, softened water can be rehardened to an appropriate level by cutting (blending) it with untreated water. Before it is used in the offset process, the virtually pure water derived from reverse osmosis is usually brought to the desired residual hardness of 8 to 12° dH by adding a hardening agent.

The technologies used to treat water vary. The method, type and design of the water treatment plant must be chosen in line with the specific purpose, requirements and quantities of service water required. We strongly advise you to consult an expert.

Demands on fountain solution concentrates

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<tr>
<th>Impact on the water</th>
<th>Setting and long-term stabilisation of the pH</th>
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<tbody>
<tr>
<td></td>
<td>Targeted setting of the surface tension</td>
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<td></td>
<td>Partial bonding of the hardness materials</td>
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<th>Impact in the press</th>
<th>Suitable for various dampening system models</th>
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<tr>
<td></td>
<td>Protection of steel parts, rollers and plastics</td>
</tr>
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<td>Ensuring optimum productivity</td>
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<th>Impact on the printing plates</th>
<th>Good wetting of non-image areas</th>
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<tr>
<td></td>
<td>Fast plate runoff</td>
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<td>Provides good corrosion protection for the printing plates</td>
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<th>Impact on offset inks</th>
<th>Formation of a stable water-in-ink emulsion</th>
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<td></td>
<td>Fast adjustment of the ink/water balance</td>
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<td></td>
<td>No deterioration of the ink drying characteristics</td>
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<th>Impact on the substrate</th>
<th>No partial dissolving of the paper coating</th>
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<td></td>
<td>Leaves no separating layer that could have a negative influence on ink adhesion</td>
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All the requirements on this list are met by deploying a mix of functional, chemical substances. The functions of the various substances can be grouped together into four main categories:

- **Buffer components** ensure a stable pH of the fountain solution
- **Plate protecting components** remain on the non-image area after the printing plate has dried and facilitate rapid re-dampening
- **Wetting agents** set the surface tension of the fountain solution and guarantee uniform wetting with a minimal amount of water
- **Solubility promoters** ensure that the wetting agents are miscible with the water and that the fountain solution concentrate has an adequate shelf life

### Monitoring parameters in the fountain solution

#### pH

The pH scale is used to measure the acidity or basicity (alkalinity) of a solution and goes from 0 to 14. The range from 0 to 7 is defined as acidic and 7 to 14 as alkaline (or basic), while pH 7 is neutral. Each drop in pH of one unit means a tenfold increase in acidity.

The pH influences a number of variables of relevance to the printing process. As the offset printing process has been further developed, the range between pH 5.0 and 5.3 has proven to be favourable. In the USA, however, printers frequently work with a pH of 3.5 and still produce good prints. That said, the domestic paper and ink industries there have adapted to these low values, because the pH has a significant influence on **inorganic metal compounds** in the paper coating and in the ink. Other branches of the industry in the USA, such as newsprinting, work with neutral or slightly alkaline fountain solution concentrates for various reasons related to the paper.

All this reveals that there is a variety of options and philosophies concerning this matter. In Europe, however, the pH range from 5.0 to 5.3 has become established among the manufacturers of fountain solution concentrates. With the quantity – normally expressed as a concentration (%) – of fountain solution to be added specified and constant, this solution must set the pH to the desired range and maintain it over a long period. For this reason, fountain solutions are **buffered**.
There are two methods available for measuring the pH of a fountain solution:

**Indicator strips** are available in many different versions and gradations. They are simple paper strips that have been impregnated with indicator liquids that change colour and indicate the pH value on being dipped into the fountain solution. Measurement errors of 0.5 pH units or more are frequently observed when measuring buffered or coloured fountain systems. This method is therefore suitable only as a rough guide and not for taking precise measurements.

**Electrical measurement** with the aid of a pH meter and suitable pH electrode is extremely accurate even if the solution being measured is buffered or coloured. It is, however, essential that the measurement equipment is stored, maintained and calibrated in accordance with specifications.

**Electric conductivity**

A fountain solution concentrate can only adequately satisfy the many demands made on it if the prescribed quantity for addition is complied with. Measuring the conductivity of a fountain solution indicates how well electrical charges can be carried by the solution. As the quantity of fountain solution concentrate in the fountain solution is increased, the conductivity of the solution rises proportionally.

At first sight this correlation appears to make electric conductivity a perfect monitoring and control parameter; however, use of this measurement method does have its limitations in practice, which users should be aware of and must take into account:

- Thanks to its specific composition, each particular **fountain solution concentrate** possesses its own range of conductivity. Changing the fountain solution concentrate, will usually also lead to the conductivity of the solution changing.
- Owing to the fact that water also contains various salts, the electric conductivity of the fountain solution is likewise dependent on the water quality used. Fluctuations in the salinity of the water lead to fluctuations in the conductivity of the fountain solution.
- As you know, **isopropanol** is miscible with water in any proportion. That said, the alcohol does not break down into ions like the salts from the buffer system do. Isopropanol (IPA) is not capable of transporting an electric charge and consequently, the conductivity of a fountain solution drops when alcohol is added.
- During the printing process, **contaminants** that get into the fountain solution can increase (dissolved constituents from pigments or paper coating) or lower (washup solutions, vehicles from inks) the conductivity of the solution.
- Changes in the **temperature** of the fountain solution alter its conductivity, even if its composition has not been changed. The higher the temperature, the more "mobile" the ions – and the more conductive the solution.
As long as these factors are taken into account, it does make sense to measure the electric conductivity of the (freshly prepared) solution in order to determine how much has been added. However, we do point out that unlike the pH value, the conductivity of the fountain solution is not a parameter that is directly relevant to the printing process and result.

**Alcohol in the fountain solution**

A very high percentage of the isopropanol used evaporates during the course of the printing process and finds its way into the atmosphere, with negative consequences for the environment. EU Directive 1999/13/EC on limiting the emissions of volatile organic compounds (VOCs) was aimed at reducing the solvent emissions of the member states by 50% compared with 1990 levels by the end of October 2007 and resulted in all branches of the chemicals industry taking a far more critical look at how they handle technical alcohol. There are already similar and more stringent rules in other countries around the world and in many countries, the use of isopropanol or ethanol in fountain solution has long been banned.

The fountain solution concentrates designed for alcohol-free printing contain special active ingredients for setting the surface tension and for controlling emulsification and transport of the solution. Alcohol substitutes are low-volatility, water-miscible substances that even in very low concentrations improve plate runoff and limit the amount of fountain solution inks take up. They do not slow down the drying process of the inks, nor are they harmful to health. What is more, they are suitable for use with all types of printing plate, but can slightly shorten the service life of the plate. The products available have proven how effective they are, but are often still viewed with great scepticism. A rethink in this regard is well overdue in some quarters!

If we restrict ourselves to reducing the concentration of isopropanol (<5%), the degree of accuracy offered by conventional alcohol metering units equipped with a float system is inadequate. In these cases, modern, advanced systems based on other measurement methods (e.g. infrared measurement) must be used. If we stop using isopropanol altogether, there is no need for expensive measurement and metering systems – and add to this the savings from no longer using alcohol.

**Corrosion protection in offset presses**

A working committee set up specifically to deal with this issue drew up as long ago as 1985 not only recommendations for anti-corrosion measures on offset presses but also testing methods and limit values applicable to fountain solution concentrates. These corrosion protection guidelines for offset presses – initially compiled for the newsprint sector – were broadened in 2001 to cover sheet-fed and web offset heat-set, too. Products that conform to the requirements of this guideline are listed as certified on the Fogra website (www.fogra.org).

In addition to a suitable water quality and the use of certified fountain solution concentrates, it is also important to use corrosion-inhibited cleaning agents (washup solutions) and maintenance products.
Microorganisms in the fountain solution

Fountain solution concentrates are incapable of killing germs when diluted for application. If this were not the case, they would have to contain large quantities of preservatives, necessitating special labelling and complex disposal procedures. Since this is far from desirable, fountain solution concentrates are set to perform the function for which they are intended. Under favourable conditions (or unfavourable, depending on how you see it), microorganisms can multiply between four and six times over every hour! Cooling the fountain solution helps stabilise it in this respect, but the degree of cooling should be chosen with a view to balancing the amount of energy (and its cost) invested and how effective the measure is at slowing down microorganism growth. We recommend that the entire system be cleaned thoroughly every 3 to 6 months (to protect the heat exchanger, too). If no special filtration is employed, alcohol-free fountain solution should be used for no longer than 200 operating hours. It is essential that metering of the fountain solution concentrate is conducted in full accordance with the manufacturers instructions, in order to ensure perfect function during production.

Metering fountain solution concentrates

If the offset printing process is to be standardised, the amount of fountain solution concentrate to be added should also be standardised. The recommended quantity of concentrate to be added to a product guarantees that all active ingredients are matched perfectly to this application concentration in the necessary dosage. Adding too much or too little concentrate is not advisable and both can lead to problems in the long term. Corrosion inhibitors and alcohol substitutes in particular require a minimum concentration for them to develop their full effect. We recommend the use of volumetric systems for metering purposes. The accuracy of metering systems should be tested at regular intervals, either by means of the conductivity of the fountain solution when freshly prepared or by means of volumetric checks. Your supplier’s technical staff will be pleased to offer you any assistance you may require.

Fountain solution waste from print shops

Owing to the fact that the fountain solution used in the offset process is completely used up during the process, fountain solution and/or rinsing solution is/are only left over as waste when the fountain solution system is cleaned. From the supplier’s point of view, used fountain solution or rinsing solution currently need to be disposed of as special waste – unless the print shop comes to some other arrangement with the local authority.