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Effect of Water Hardness on the Offset Printing Quality

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In offset printing, water hardness of the fountain water has an essential influence on the printing process as well as the resulting printed product. Too low and too high water hardness values, trouble-causing carbonates, varying water hardness values and a too high chloride content will disturb the stability. It is known that high calcium monorails will interact with the calcium carbonate in the paper resulting in Milking or Whiting of the blankets. Printers, today, should treat their water (soften, purify, *etc.*) before printing.

Key Words: Offset printing, Water hardness, Fountain solution, Printing quality.

INTRODUCTION

Lithography is based on the principle that the oil and water do not mix with each other. The image areas on the printing surface *i.e.* plate must be oleophilic as well as hydrophobic. At the same time, the non image areas on the plate must be oleophobic and hydrophilic. The main task of the dampening solution in the offset printing is oleofobization of the free surfaces on the printing plate. On the press, the operator strives to achieve optimum ink-water balance during printing. Ideally, the ink should have about 15 % water accepting capacity *i.e.* water in ink emulsification. The fountain solution keeps the non-image areas on the plate hydrophilic as well as oleophobic. Its ingredients other than water also perform various functions[1-4].

Oil-based ink is then deposited on the same surface in the same manner and properties of the liquids and the solid plate determine the quality of the print. This transfer of two fluids to the plate and then to the substrate is of crucial importance for a successful printing. The basic flow regimes of roll-coating or nip flow have been studied and analyzed[2]. Ideally, the dampening solution should possess a water hardness of 8º to 12º dH and a pH-balance of 4.8 to 5.53. In fact, lithography is a chemical process with potential for many variables, which may affect production and the quality of offset printing. Offset printing has many aspects but, probably, none of them is as prone to variation as fountain solution. A proper emulsifying damping solution gives a proper ink viscosity, stickiness, gloss and drying contribution and allows the standardization of colourimetric parameters of the ink on the print[2].

Water and water hardness: Water consists of hydrogen and oxygen but the tap water reaches the printer in different qualities and different degrees of purity depending on its origin (groundwater or other). Soluble gases and dirt particles exist even in clean rainwater. Groundwater is situated below the surface of the earth. The geological layers of the earth through, which the water seeps, determine the composition of the water. As water seeps through these layers, soluble salts are absorbed as well as large amounts of carbon dioxide. Dissolving behaviour of the water depends on the type of stone it passes through. Limestone, for instance, is insoluble in clean water, but if carbon dioxide is present, the limestone is transformed into the lightly soluble calcium hydrogen carbonate.

Total hardness and its effect on printing: It is the first parameter to be controlled as it constitutes the 85 % of the tank water. Changes to occur in the quality of spring water will influence the offset printing quality directly. In offset printing, the most important characteristic is the water hardness in terms of tank water settings.

Dissolved calsium and magnesium salts presenting in the water determine the hardness of water. $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ gives temporary hardness or carbonate hardness and cloride, sulfate, nitrate, phosphate and silicates of calsium and magnesium gives permanent hardness or constant hardness. These two hardness properties are called as entire hardness. In Germany, total hardness is defined in the German hardness degree (dH)[5]. Ideal hardness ranges from 8 dH to 12 dH for offset printing. When water with high total hardness is used, micro grains on the surface of the ink rollers become level and glossy in the course of time as they are obstructed by calcium and magnesium ions within the water. Thus, they prevent stable and homogenous ink from residing on the roller surface.

There are two ways available in order to overcome these problems: (1) Tap water that is used can be softened or deionized; (2) Special solution additives prepared in order to prevent the composition of calsium salts that are dissolved insufficiently can be used.

Agents, which give hardness to the water are mainly alkaline earth salts. Al, Mn and Fe also give hardness to water but either they are included in the water in small amounts or they are not included at all. Various hardness values (Table-1) are used in order to express the water hardness.

TABLE-1
HARDNESS DEGREE OF WATER[6]

Water hardness	1 soft	2 average	3 hard	4 very hard
Total hardness as:				
*mmol alkaline-earth ions/L	0-1.3	1.4-2.5	2.6-3.7	> 3.7
German hardness (°d)	0-7	8-14	15-21	> 21
English hadness (°d)	0-9	10-18	19-26	> 26
French hardness (°f)	0-13	14-25	26-37	> 37

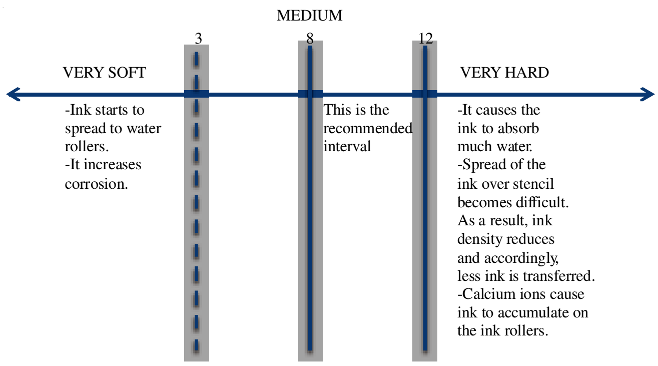
*mmol/L = 1/1000 of the molecular weight in g/L.

Fountain solution functions: (1) Keeping the plate image area ink receptive and keeping the plate background water receptive in order to reduce pH value; (2) Lowering the water surface tension to maintain wetting characteristics of plate non-image area; (3) Minimizing the corrosive action of acid on plates to extend plate life and to improve print quality; (4) Preventing the non-image area from accepting ink; (5) Clean the ink off the background quickly during press starts; (6) Help the water to spread fast over the plate surface; (7) Help the water flow evenly through the dampening rollers; (8) Lubricate the plate and blanket; (9) Control the emulsification of ink and water[4,6-8].

The fountain solution properties in the offset printing

Fountain solution is the most important elemental material for the lithographic printing. Wetting water for providing moisture on a printing master to utilize the repulsion action between water and oil is playing an important role in the offset printing process. Therefore, printing operators should know the basic properties of the water and properties and control of the offset dampening water properly (Table-2). Operating of a purification system and technical properties of dampening water has been given below:

TABLE-2
EFFECTS OF THE HARDNESS DEGREE OF DAMPENING WATER ON THE PRINTING QUALITY



(1) All values of the water coming to the machine should be evaluated and water should have these ranges of values: 8-10 dH German hardness, conductivity: 350-400 microsiemens, pH:4.8-5.3; (2) If water does not have these values, it should be purified and conditioned once more. More appropriate water should be combined with one that is not appropriate; (3) The product to be tried is dosed by a water mix device and measured when dosing ends. Objective is to see the accuracy of a product dosing whose all properties are different and to control the dosing; (4) During operating, problems to arise at the beginning can largely result from rollers that have adapted to negative operating conditions. In order to avoid these problems, product can be started with tolerance at a level slightly below the maximum performance during the transition period. For example, it is dosed at 2.5 % instead of 2 % alcohol mixture ratio in total fountain solution. It should be started at 6-7 % instead of 5-6 % at maximum.

The fountain solution contains small amounts of gum Arabic or synthetic resins, acids and buffer salts to maintain the pH of the solution and a wetting agent or dampening aid to enhance the spread ability of the fountain solution across the plate[10].

The fountain solution itself can consist solely of water but such solutions lose their effectiveness on any but the shortest press runs. Other chemicals added to the solution keep the plate desensitized much longer than water alone. In addition to water, fountain solutions typically consist of:

ˆ An acid or base (depending upon the desired pH of the fountain solution).

ˆ A gum (such as gum arabic) which desensitizes the non-image areas of the plate.

ˆ A corrosion inhibitor (such as magnesium nitrate), which prevents oxidation or other chemical reactions, which may damage the plate.

ˆ A wetting agent (commonly an alcohol such as isopropanol or an alcohol substitute), which reduces the surface tension of the solution and enables it to flow more easily.

ˆ A fungicide, which helps kill any organic growth in the fountain or elsewhere in the dampening system.

ˆ An antifoaming agent which, as its name indicates, reduces the tendency of the solution to foam or bubble, which can cause distribution problems on press.

ˆ Non-piling or lubricating additives.

ˆ Viscosity builders.

ˆ Solvents.

ˆ Dyes[6,11].

Conclusion

The proportion of lime in the water can cause problems during printing. For example: inking rollers run blank (calcification), deposits occur on the rubber blanket, it effects the pH-balance, it leads to fluctuation in the pH-balance, the proportions of chloride, sulphate, or nitrate are too high, which in addition, leads to corrosion. Overall hardness of the water may be measured simply by using test strips. Dip the hardness-strip briefly (1 s) into the water and read the results after 2 min. In order to ensure that the dampening solution possesses the the ideal degree of hardness, the principle of reverse osmosis is used for water desalinization[12]. In this process, the water is pressed against a membrane. Water treated in this manner contains only a very low residual salt content. Subsequently, this osmosis water is reconditioned with salts until it reaches a degree of hardness ranging from 8º dH to 12º dH.

Obtaining and maintaining the proper balance of ink and fountain solution on an offset lithographic printing press depend on many factors such as the press, dampening system, rollers, ink, paper, water quality and operator training and skill1[13]. It is probable that water hardness is associated with other situations in the lithographic process. For instance, water hardness may influence linting, which is the deposit on the blanket of paper in the non-image area, paper pick and pile in the image area, ink oxidation rates and ultimate scuff resistance[14].

The water chemistries of most urban water systems are so sufficiently stable that they can be used "as they are." Other areas of the country experience fluctuations, sometimes daily but often seasonally, in water quality and this could upset the chemistry of the fountain solution and perhaps the ink-water balance on press[15].

Is your water soft, medium or hard? Different types of etch are required for different hardnesses of water. If the water hardness changes substantially, you'll need a different fountain solution to compensate the different water hardness[16].

Hardness of the dampening water indicates that it contains excessive amounts of calcium and magnesium and these excessive amounts cause the pores of the ink rollers to be obstructed by limestone and make them hydrophilic, which, in turn, impedes the homogenous transfer of the ink over the paper[16].

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