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(54) **An improved fountain solution.**

(57) An improved fountain solution suitable for use in a lithographic offset printing press which solution contains from about 0.5 to about 10 percent by volume of an isopropanol replacement, and between 0.005 and about 1 percent by weight of a water-soluble/miscible polymer selected from hydroxyethyl cellulose, hydroxypropyl cellulose, methylcellulose, hydroxypropyl methylcellulose, hydroxybutyl methylcellulose, poly (ethylene oxide), poly(acrylamide), poly(vinyl alcohol), guar gums, acid thickening polymers and chemically modified gums. The fountain solution provides increased viscosity over current fountain solutions which results in improved operating latitude and decrease of problems associated with isopropanol replacements.

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AN IMPROVED FOUNTAIN SOLUTIONBACKGROUND OF THE INVENTION

This invention is directed to an improved fountain solution suitable for use in a lithographic printing press. This fountain solution is essentially free of volatile alcohols, such as isopropanol. The fountain solution uses less volatile alcohols, polyols, diols, glycols, glycol ethers, and glycol ether esters of varying degrees of water solubility and mixtures thereof with a particular high molecular weight water-soluble/miscible polymer that increases the viscosity of the fountain solution and permits operation of a printing press in a manner more like that of conventional alcohol-modified fountain solutions.

Lithographic printing press operations require the use of a dampening or fountain solution to achieve proper operation of the press, so as to yield good, acceptable, commercial quality prints. The purpose of the fountain solution is to keep the ink in the image area and to keep the non-image areas of the printing plate free of ink. The compositions of fountain solutions have been described in the literature and generally contain solutions of salts, phosphoric acid, and low molecular weight water-soluble polymers, such as gum arabic. Alcohol, such as isopropanol, is usually included at levels of 10 to 30 percent by volume of the fountain solution. It is possible to print without alcohol in the fountain solution but it is extremely difficult to do so, and constant attention must be given to keeping the press in adjustment. Use of alcohol increases operating latitude in that good quality prints can be made over a range of press adjustments, especially fountain solution feed rate.

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Considerations of toxicity of these volatile alcohols and their attendant flammability have provided the impetus to find alcohol replacements. A number of patents pertaining to alcohol substitutes for fountain solutions attest to the desirability of eliminating volatile alcohols. In commercial practice these alcohol substitutes may range from a single component such as Butyl Cellosolve to more complex mixtures as taught in U.S. Patent 4,278,467 which describes isopropanol-free fountain solutions utilizing glycol(s) and glycol ether(s) or mixtures thereof. Thus, the prior art enables the formulation of alcohol-free fountain solutions that can perform in commercial printing operations. However, the common problem observed in the use of the alcohol-free fountain solutions is decreased operating latitude, especially on presses equipped with a Dahlgren dampening system. The Dahlgren dampening system is a means of transporting the fountain solution to the printing plate by first picking up fountain solution from a reservoir, then mixing the fountain solution (emulsifying it) with the ink so that ink and fountain solution are carried together to the plate where the physical mixture of ink and fountain solution separate with ink going to the image area and fountain solution going to the non-image area of the plate.

The Dahlgren roll (fountain solution supply roll) speed is set separately from the speed of the rolls of the ink-train assembly. When alcohol substitutes are used, it is commonly observed that much higher speeds are needed on the Dahlgren roll to prevent a problem known as scumming. Scumming is the deposition of excess ink on the printed surface due to insufficient fountain solution transport. The necessity of operating at increased Dahlgren roll speeds

reduces latitude, which is essentially the working range of Dahlgren roll speed settings over which commercial quality prints can be obtained. Latitude also includes the adjustments of gaps, and speed setting of the other rolls of the press. A low degree of latitude coupled with the need to run the Dahlgren roll at significantly higher speeds makes the continuing production of commercial quality printed matter very difficult.

DESCRIPTION OF THE INVENTION

It has now been found that incorporation of low levels of relatively high molecular weight water miscible/soluble polymers in the fountain solution allows significant reduction in Dahlgren roll speed setting and increases the latitude of press operation.

A wide variety of water miscible/soluble polymers exist which can effectively thicken alcohol-free fountain solids when used at low levels. Low levels of thickening are preferred so as to minimize adverse interaction between the polymer and ink. These polymers include cellulosic polymers, such as hydroxyethyl cellulose, hydroxypropyl cellulose, methylcellulose, hydroxypropyl methylcellulose, hydroxybutyl methylcellulose, carboxymethyl cellulose, and other water-soluble/miscible polymers such as poly(ethylene oxide), poly(acrylamide), poly(vinyl alcohol), and guar gums and chemically modified gums. These polymers constitute from about 0.005 to about 1 percent by weight of the fountain solution.

The fountain solution contains between about 0.5 and about 10 percent by volume of the isopropanol replacement.

According to special embodiments of the fountain solution of this invention it contains a polymer selected from poly(ethylene oxide) with a possible range of molecular weight between 8000 and 100 000, poly(acrylamide) with a possible range of molecular weight between 500 000 and 2 000 000 and poly(vinyl alcohol) with a possible range of molecular weight between 120 000 and 300 000. If chemically modified gums are used as water-soluble/miscible polymers preferably gums etherified with non-ionic, cationic or anionic reagents usually providing hydroxyalkyl modifications are used. The

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Preferably, the replacement is a mixture of a polyol and/or glycol ether partially soluble in water and a polyol and/or glycol ether completely soluble in water. The polyol and/or glycol partially soluble in water includes, for example, one or more of 2-ethyl-1,3-hexanediol, Esterdiol-204, i.e., $\text{HO-CH}_2\text{C}(\text{CH}_3)_2\text{CH}_2\text{OCOC}(\text{CH}_3)_2\text{CH}_2\text{OH}$, Hexyl Cellosolve, Hexyl Carbitol, Propasol B, and the like. The polyol and/or glycol ether which is completely soluble in water includes, for example, one or more of propylene glycol, ethylene glycol, dipropylene glycol, diethylene glycol, hexylene glycol, triethylene glycol, tetraethylene glycol, tripropylene glycol, 1,5-pentanediol, Methyl Cellosolve, Cellosolve solvent, Butyl Cellosolve solvent, Propasol B, Propasol M, and the like.

The solubility is measured by determining the percent by weight of the polyol and/or glycol ether which is soluble in water at 20°C. A polyol and/or glycol is characterized as partially soluble in water if its solubility in water at 20°C is from about 0.99 to about 28.0 weight percent.

From about 0.08 to about 10 parts by volume of the polyol and/or glycol ether, which is partially soluble in water, is used per part by volume of the polyol and/or glycol ether which is completely soluble in water.

The fountain solutions are preferably used as aqueous acidic solutions. Phosphoric acid is a preferred acid for use in acidifying the formulation. Other acids which can be used include inorganic as well as organic acids, such as acetic acid, nitric acid, hydrochloric acid, and the like. A buffering agent, such as ammonium acetate, can also be included.

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The fountain solution is generally maintained at a pH of from about 2 to about 5. However, the particular pH at which a given solution will be maintained will depend upon factors, such as the type of water-soluble polymer used, other ingredients in the solution, as well as the type of substrate employed in the lithographic printing plate, and the like.

Other additives which may be used in the fountain solution include preservatives such as phenol, sodium salicylate, and the like; corrosion inhibitors such as ammonium bichromate, magnesium nitrate, zinc nitrate, and the like; hardeners, such as chromium, aluminum, and the like; organic solvents, such as cyclic ethers, e.g., 4-butyrolactone, and the like; low molecular weight aldehydes, such as formaldehyde, glutaraldehyde, and the like. These additives are generally used in amounts of from about 0.1 to about 10 percent by volume.

EXAMPLES

The following examples serve to illustrate specific embodiments of this invention and it is not intended that the invention shall be limited by the examples.

The viscosity of water, of an isopropanol/water mixture, of a conventional fountain solution, and of an alcohol substitute fountain solution is presented in Table 1.

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TABLE 1
Viscosity, Centistoke, 29°C
 (Measured with an Ubbelohde Capillary Viscometer)

1) Deionized Water	0.87
2) 20% Volume Mixture of Isopropanol/Deionized Water	1.67
3) <u>Conventional Fountain Solution</u> 2.0 oz Varn Wonderline(a) etch per gallon of 20% Volume Isopropanol/Water Solution	1.66
4) Alcohol Substitute I(b)	
1.1 oz/gal of water	0.87
2.2 oz/gal of water	0.90
3.4 oz/gal of water	0.92
a) <u>Varn Wonderline</u> : A commercially available solution of a mixture of acid, salts, gum solution, etc.	
b) Composition of Alcohol Substitute I.	

	<u>Weight Percent</u>
Dipropylene glycol	32
2-Ethyl 1-3-hexanediol	18
n-Hexyl Cellosolve	5
Water	45

The finding from the data of Table 1 is that water or alcohol substitute-based fountain solution has only half the viscosity of alcohol solution or alcohol-modified fountain solution.

A number of water-miscible/soluble polymers were tested at low concentrations to determine the viscosity of the resulting water solutions. Data are presented in Table 2.

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TABLE 2
Dilute Solution Viscosity of Selected Grades of
Poly(Vinyl Alcohol) and Hydroxyethyl Cellulose

<u>Polymers</u>	<u>Concentration in Water Weight %</u>	<u>Viscosity,* Centistokes 29°C</u>
(a)		
Gelvatol 20/90	0.1	0.95
	0.2	1.05
	0.5	1.37
(b)		
Cellosize QP-100M	0.05%	1.37(c)
QP-52M	0.07%	1.92(c)
QP-4400	0.05%	1.25(c)
QP-4400	0.08%	1.56(c)
QP-09	0.08%	0.96(c)
QP-3L	0.31%	1.52
QP-3L	0.31%	1.50(c)

*Measured with an Ubbelohde Capillary Viscometer.

a) Gelvatol (Monsanto) 88% hydrolyzed poly(vinyl alcohol).

b) Hydroxyethyl Cellulose from Union Carbide Corporation.

c) With 1.0 oz/gal of Alcohol Substitute I from Table 1.

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Using the polymer concentration/viscosity data of Table 2 as a guide, other water-soluble/miscible polymers were evaluated to determine the concentration required to approximate the viscosity of the conventional fountain solution.

Appropriate concentrations of polymer solution were then blended with a commercially available etch and an alcohol substitute to prepare fountain solutions for evaluation on a printing press. Formulations are shown in Table 3. The viscosity of each formulation is shown in Table 4.

The fountain solutions of Table 3 were evaluated on a Miehle Favorite 25-inch sheetfed press. Table 5 presents a listing of results of the press trial. Example 1 amply illustrates the wide operating latitude of a conventional isopropanol-modified fountain solution. Example 2 illustrates the performance of another isopropanol substitute with thickener.

Example 3 illustrates the low viscosity and narrow latitude of a commercial quality alcohol substitute. Examples 4 and 5, and 8 through 14 show a significant increase in press operation latitude compared to Example 3. Examples 6 and 7, which yielded poor quality prints, illustrate that viscosity control alone is not the sole reason for improved performance, but that the polymers must have an affinity for the ink, etch, and the alcohol substitute in order to realize an improvement.

The foregoing has amply illustrated the interdependence of thickener, ink, etch, and the organic components of alcohol substitutes on overall performance. It further shows that as any component is varied, so also may print quality vary, and fountain solution formulation adjustment may be needed along

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with a proper matching of thickener species. Operating latitude is but one aspect involved in press performance. Other characteristics such as dot spread, optical density, tinting, banding, scumming, selection of ink, etc., determine the optimum choice of fountain solution components.

TABLE 3
Fountain Solution Composition in Fluid Ounces

<u>Example</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>
Water	100	111	123	114
Varn Wonderline etch	2	-	-	-
*Prisco R855A etch	-	3	3	3
Butyl Cellosolve	-	5	-	-
**Alcohol Substitute I	-	-	2	2
1% Soln. Cellosize QP-4400	-	9	-	9
Isopropanol	26	-	-	-

	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>
Water	118	118	120	116	119
Prisco R855A etch	3	3	3	3	3
Alcohol Substitute I	2	2	2	2	2
1% Soln. Cellosize QP-4400	5	-	-	-	-
1% Hercules 7M CMC	-	5	3	-	-
1% Polyox Coag Soln.	-	-	-	7	4

	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>
Water	120	115	120	116	115
Prisco R855A etch	3	3	3	3	3
1% Jaguar 507 Guar Gum	5	10	-	-	-
1% Klucel M Hydroxy- propyl Cellulose	-	-	5	9	-
1% Tylose Methyl Cellulose Soln.	-	-	-	-	10

*Commercially available etch solution containing a mixture of acid, salts, gums, etc.

**From Table I.

TABLE 4
Viscosity of Fountain Solutions*

<u>Example</u>	<u>Viscosity, Centistokes, 19°C</u>
1	1.66
2	1.71
3	0.89
4	1.57
5	1.15
6	1.07
7	1.09
8	1.43
9	1.16
10	1.20
11	1.65
12	1.20
13	1.45
14	1.11

*Formulations shown in Table 3. Viscosity measured with an Ubbelohde capillary viscometer.

TABLE 5
Press Trial Results of Fountain Solution Evaluation

<u>Example</u>	<u>Range(a)</u>	<u>Latitude(b)</u>
1	33-90	57
2	60-100	40
3	70-80	10
4	<60-80	20+
5	<70-100	30+
6	-	very poor print quality
7	-	very poor print quality
8	<80-100	20+
9	<85-100	15+
10	<40-100	60+
11	<60-100	40+
12	<70-100	30+
13	>60-80	15+
14	<80-100	20+

(a) Dahlgren roll speed settings over which good quality prints were obtained. Settings below lower speed limit tend towards scumming, values higher than upper limit tend to wash out or develop banding.

(b) Total operating range over which good quality prints are made.

CLAIMS

1. An improved fountain solution suitable for use in a lithographic offset printing press which comprises from about 0.5 to about 10 percent by volume of an isopropanol replacement selected from alcohols, polyols, diols, glycols, glycol esters, and glycol ether esters and from about 0.005 to about 1 percent by weight of a water-soluble/miscible polymer selected from hydroxyethyl cellulose, hydroxypropyl cellulose, methylcellulose, hydroxypropyl methylcellulose, hydroxybutyl methylcellulose, poly(ethylene oxide), poly(acrylamide), poly(vinyl alcohol), guar gums, and acid thickening polymers and chemical modified gums.

2. A fountain solution as defined in claim 1 wherein the isopropanol replacement comprises a mixture of one or more polyols and/or glycol ethers partially soluble in water and one or more polyols and/or glycol ethers completely soluble in water.

3. A fountain solution as defined in claims 1 or 2 wherein the water-soluble polymer is hydroxyethylcellulose.

4. A fountain solution as defined in claims 1 or 2 wherein the water-soluble polymer is guar gum.

5. A fountain solution as defined in claims 1 or 2 wherein the water-soluble polymer is poly(ethylene oxide).

6. A fountain solution as defined in claims 1 or 2 wherein the water-soluble polymer is hydroxypropyl cellulose.

7. A fountain solution as defined in claims 1 or 2 wherein the water-soluble polymer is methycellulose.

8. A fountain solution as defined in one or more of the claims 1 - 7 wherein the isopropanol replacement is Butyl Cellosolve.

9. A fountain solution as defined in one or more of the claims 1 - 7 which contain 0.1 to about 20 percent of isopropanol.