CONTROLLING BUFFERED FOUNTAIN CONCENTRATES

Abstract

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After dealing with the traditional pressroom method of
(chemical) control of acidic lithographic fountain
solutions the contribution is concerned with a system
based on the electrical conductivity of advantageously
buffered fountain mixes. Detailed basis of the above
is given with that of a non-subjective comparative
system - using purpose designed instruments suited to
pressroom conditions and the responses of everyday
dilutions of buffered concentrates. Data is shown in
respect of a representative range of lithographic
chemicals and concentrates as well as isopropanol and
Techfount. It is suggested that standardised (constant
pH) acidic fountain solutions, and a standard control
system are feasible. Accuracy is achieved via monitoring
instruments.

For forty years, it has been accepted that the acidity of
the fountain solution needs to suit the printing process
and operators have checked the pH of said fluids. (1)
When apparently necessary, adjustment of pH has been done
by altering the quantity of the chemicals (i.e. the
fountain/etch concentrate) in the final solution. This
method of control dates from the 30's. In 1945 for
instance lithographers were following chemical formulas
with 'the Ph measuring stick' (2). The pH parameter is
still frequently used today to control the quantity of
the chemical concentrates, at the same time as the degree
of acidity (3). It is based on the view that unsuitable
degrees of acidity can contribute to press problems.

Chemists of the 50's realised that some chemicals caused the fountain solutions to be slightly buffered and that this assisted press operators to keep the pH under control, i.e. near the chosen level - giving an apparently wider mixing tolerance, and making the printing operation less variable. When metal plates are used, acidity levels between pH4 and neutral are common, and in relation to anodised aluminium surfaces, levels between 4.5 and 5.5 (inclusive) are general. The corrosion resistance of these surfaces has enabled the widespread adoption of concentrates which produce strongly buffered fountain solutions.

Some 25 years ago it was demonstrated that with a (4) constant quantity of desensitising chemical, variation of acidity between pH4 and 7 can make no difference in the ability of a fountain solution to prevent plate scumming. It was likewise shown that the quantity of desensitising material in the fountain solution is a major factor in respect of the scum resistance of metal plates when the pH is constant. It follows that the traditional control system, which unavoidably changes the quantity of desensitising material(s) when adjusting the pH, is suspect in principle.
This contribution also points out:-
a) that since the 60's surfactants have been introduced into fountain solutions to eliminate oxydation scumming, (5) this necessitating accurate control. To alter the amount of surfactant according to a logarithmic and unrelated variable (pH) parameter is not clever.
b) that the accuracy of the current system is seriously hazarded by the everyday operating method which is

subjective and assesses the acidity with colourimetric
indicator strips.
c) that strongly buffered acidic and neutral concentrates
cannot be controlled by the traditional system (6).

The following suggests a basis for a better - purpose
built and perhaps standardised - fountain control system
for use with buffered fountain concentrates.

According to the degree of dilution, strongly buffered
acidic concentrates can yield solutions with pH responses
similar to those in figure 1. These were obtained whilst
using a representative commercial concentrate diluted
in accordance with proven recommendations using randomly
chosen tap water. This significant percentage change has
only a small effect on the pH, from 5.0 to 4.4. When more
accurate percentage differences are required they cannot
be discerned and achieved with certainty via the pH strip
system. With short range strips the accuracy is little
better than 0.5 pH unit (7).Therefore, the amount of
desensitising and other chemicals can change considerably
before it is likely to be detected by the traditional
control system. With strongly buffered formulations this
feature is much worse. This being demonstrated by taking
undiluted   citrate/gum concentrate buffered at pH 5.0,
and finding its pH to be 4.9; after dilution to form
10% and 2% solutions the pH levels were close to 5.1.

Realisation that this feature is associated with the
undoubted advantages obtained by using well buffered
concentrates to achieve near constant pH, has lead to
the development of a purpose built 'measuring' instrument
which avoids the subjective technique as well as the pH

parameter. Howson-Algraphy have called their Mark I manual
version a Fount Monitor (8). See illustration.

According to Selley (9) the electric conductivity of a
solution of any strong electrolyte is roughly
proportional to its concentration since it depends on the
quantity of ions available to carry the current.

Whilst considering electric conductivity meters in the
above context after the manner of Bates and Blom (10)(11)
and Scarlett (12) the particular relevance in respect to
buffered acidic concentrates of conductivity became
apparent. It was noticed that the chemicals employed in
buffered formulations in the quantities necessary to
provide the correct lithographic and desired pH buffering
properties, imparted readily measurable (and
characteristic) degrees of conductivity to the press
ready solutions. These being several times greater than
the conductivities of straight water(s).

Representative conductivities of a random selection of 51
local waters are given in table 1, instrumentally
corrected to international standard $25^O C$. Infrequently
are they greater than 600 micro-seimens/cm (μS/cm). The
histogram in figure 10 demonstrates this point. Assuming
that this selection is adequate enough to indicate the
general situation, the mean conductivity is (rounded – it
is not critical)400 μS/cm. This assumption is based on
the histogram being accepted as a discreet approximation
to a skewed normal distribution, see dotted line. These
typical conductivities were obtained from nine countries.

Because such a distribution is to be expected, the given figures have been accepted as an adequate basis for the remainder of this appreciation and the adoption of 400 µS/cm water as 'average' water.

Investigation found that a conductivity meter yielded read-outs in respect of press ready solutions of a significant number (greater than 20) of commercial acidic and neutral buffered concentrates, several times larger than those of the straight waters. It also showed that variations in conductivity of water from 'pure' (10µS/cm) to 'hard' (600µS/cm) had little effect on the magnitude of the relationship. Figure 2 shows typical magnitudes when using two different 600 µS/cm waters, one made by adding magnesium sulphate and the other by adding sodium bi-carbonate to 'pure' water. At normal 1.5% dilution of the representative concentrate (13), the conductivity relationships are 2.7: 1 and 3.0: 1. Similar relation-ships were found when calcium sulphate,potassium nitrate and other chemicals were used to create different 600 µS/cm waters. It can be seen that these compare well with the relationship obtained when local 600 µS/cm 'hard' water was used.

The above lead to the modification of a conductivity meter to obtain a purpose built device for monitoring the quantity of buffered acidic concentrate in fountain solutions made with average water, thereby providing a comparative fount control system using an instrument designed to suit buffered fountain solutions and the requirements of every-day pressroom conditions.

Taking water with a conductivity of 400 μS/cm (25°C) and using it to produce appropriate fountain solutions with numerous randomly chosen buffered concentrates (the dilutions according to the instructions of suppliers), the ensuing conductivities were found to approximate to 1800 μS/cm.

Adopting 1800 μS/cm as a standard for buffered fountain solutions in average water and adjusting a conductivity meter to cause it to register near the middle of an expanded 0 to 3.000 μS/cm range of electrical responses, provided the basis of a monitoring device. Because this adjustment made nonsense of the nomenclature of the scale and because it was apparent that electrical units are unnecessary and unsuitable for pressroom usage, the expanded scale was substituted by one of the same dimensions, reading 0 to 3 arbitrary fount monitor units. By this means the meter became a suitably accurate comparative monitor. Normal strength buffered fountain solutions registering close to the middle of the scale, weaker solutions reading significantly less and stronger solutions more.

In due course, with the object of providing a valid means of standardising the above, a standard buffered acidic fountain concentrate was obtained by adopting a simple (buffered pH5) formulation. This comprising well known lithographic chemicals.

          Citric acid (mono-hydrate)   5g
          Tri-sodium citrate (crystals)17g
          Water (demineralised)   93mls

yields a solution on dilution to 1½% by volume using 400
µS/cm water, giving a conductivity very close to 1800
µS/cm. See figure 3. With this nominally standard
concentrate and water registering between 10 and 600
µS/cm the deviations in the read out (at the same
dilution) were found to be small – within plus or minus
50 µS/cm.

Table 2 lists conductivities of appropriate dilutions of
a representative range of twenty commercial buffered
acidic and neutral concentrates using the same quality
water, conveniently a 600 µS/cm tap water. These vary
between 1,000 and 2.300 µS/cm and are on average 2.9
times the magnitude of the conductivity of the tap water.

Table 3 sets out conductivities obtained when various
specimens were used with 400 µS/cm water. The closeness
of these determinations with those obtained when typical
'hard' and 'pure' waters are employed, shows that the
variations arising from these differences in quality of
water are small. This is important, because the
conductivities of local waters change from day to day and
a successful fount control system cannot be unduly
sensitive to such variations.

Table 4 lists the conductivities of various chemicals
commonly found in buffered acidic concentrates at
dilutions close to those normally employed. Other
materials (e.g. dyestuffs, biocidals and surfactants) can
contribute to the conductivity of a diluted concentate;
however, the amounts of these are of necessity low. It
can be seen that the presence of gum arabic has

negligible affect (also see figure 7).

The foregoing prompts the concept of a standard fountain
/etch monitoring system for use with buffered concentr-
ates. This is based on the fact that it is the quantity
of the chemicals in the final buffered solution that
governs plate and press performance. Chemical analysis
having shown that buffered acidic concentrates supplied
by the majority of manufacturers contain not dissimilar
quantities of various materials from the same group of
chemical compounds. The quantity of chemical present,
being more accurately indicated via the electric
conductivity principle (with a suitable device) than by
the traditional and subjective colourimetric strip
technique. Accuracy is important. (16).

The preferred device is not a straight conductivity meter.
Although it employs the conductivity principle it does
not indicate the electric conductivity of a fountain
solution. It has been designed to be a simple comparative
monitoring instrument suitably responsive to the
concentration of chemicals in the damping solutions
employed by press operators, avoiding the use of
electrical terms unfamiliar to press-men and the
unnecessary and confusing over-sensitivity of normal
conductivity meters.

The scale of the instrument is not logarithmic and it
indicates the degree of dilution of a concentrate when
working with water of a reasonable quality i.e. with a
conductivity between about 10 and 600 µS/cm. As such,due
to differences and variation in water quality it is not

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perfect, but experience has shown that the changes which
cause a variation of plus or minus one sub-division (0.2
unit) and less, are not important. Variations greater
than this usually relate to a shortfall or excess of
fountain concentrate.

The monitor is therefore not a meter in the sense that
the term meter implies precise scientific accuracy. It
is a robust and specifically designed instrument for
press room use. By employing it to check solutions on a
comparative basis before they are used for printing, the
operator can control the quantity of buffered fountain
concentrate and the working characteristics much more
accurately that is possible via the dubious pH indicator
technique. This can be seen from figures 4, 5, and 6.

Figure 4 refers to a traditional buffered acidic citrate
/gum arabic mixture, (13) as employed earlier in this
contribution. Reasonably linear (and perfect linearity
is not necessary), the marked relationship of the degree
of dilution to the read-out of the monitor is obvious.
The unimportant changes in pH, that cannot be reliably
discerned by the subjective pH strip technqiue are shown.

Figure 5 relates to a different proven fountain concent-
rate containing mono-sodium phosphate and sodium EDTA.
This yields working solutions buffered close to pH 4.5.
Changes in the quantity of concentrate are easily seen
on the monitor scale.

To add to the usefulness of this report figure 6
illustrates the case with a well buffered alkaline

concentrate (14). Again, the widely spaced fount monitor
readings are easily determined.

Figures 7 and 8 indicate the responses obtained when the
monitor is used with different quantities of simple,
unbuffered and buffered concentrates. When these two
figures are compared, the suitability of the device for
use with buffered acidic mixtures is obvious.

Figure 9 shows a typical influence of increasing amounts
of isopropanol. These relationships fit well with those
published elsewhere in respect of the conductivities of
mixes of water and isopropanol.

The slight influence that 1% of the GATF substitute for
isopropanol has on the monitor read out is shown in
table 5. Specimen 'V' is the alkaline concentrate (14)
and 'I' is the citrate/gum concentrate (13).
In its Mark I (manual) form, the preferred instrument
comprises a strong metal box having a large read-out
dial and a proven electronic circuit. See figure 11.
This is wired to a rugged and accurately made, inert
carbon electrode conductivity cell using alternating
current (to minimise cell differences, polarisation and
proximity effects) and containing a thermistor which
compensates to 25° for variations in temperature between
10° and 70^OC. It is operated by push button.

Although not essential, it is recommended that it is
used with well buffered concentrates of preferred pH.
This avoids the necessity of constantly checking the pH
of the working solutions.

Insufficient concentrate causes the instrument to read low (e.g. 0.7) and this can be expected to coincide with scumming and plugging as well as undue biological contamination of the press. Wasteful and excessive use of concentrate will cause the needle to veer to the right and register high - say 2.7. An unduly strong concentrate will have the same effect, and such a reading will relate to delayed drying, ink-water problems and premature image failure. The operating readings obtained when using typical buffered concentrates will be located near the centre of the scale.

To avoid problems due to the quality of water, the instrument can be used as a checking device. Very pure and natural 'soft' water usually register near zero, normal/average waters around 0.2, 'hard' water close to 0.3 and 0.4 whilst very 'hard' water returns a reading of 0.5 and even 0.6. When significantly different from 0.2 the final readings may (according to the chemistry of the concentrate) need to be appropriately higher or lower to obtain best performance. When near or at the extremes, i.e. zero or 0.6, it is recommended that a suitable so called 'soft' or 'hard' concentrate be used.

To express the latter readings in terms of approximate number of parts per million of 'total dissolved solids', 0 can be taken as 70, 0.2 as 200, 0.4 to be 330 and 0.6 virtually 460 ppm. (Note: Fount Monitor readings, conductivity readings and total dissolved solids determinations, have no precise relationship to water 'hardness' or 'softness').

For economy, the quantity of concentrate can be precisely adjusted to record suitably left of centre, in a position found by experience with the local water supply to provide adequate short and long term plate and press performance. When adverse press conditions prevail this may not be possible and it may be necessary to employ a suitably high reading. With weak concentrates the quantity used is likely to need increasing to obtain the best printing. (Of course, if the weak concentrate is appropriately cheaper the outcome may be unimportant).By employing a dilution which gives a reading only one sub-division lower – failing to show via the pH strip technique – a plant consuming say 3,000 litres of concentrate per year, would save the cost of 250 litres of concentrate.

A few words of warning are necessary. The probe needs to be kept clean – once per shift, and the device needs to be used with care in re-circulating/pan fountains due to possible slight effects of contamination by materials from paper and board (15). There can be no doubt however that it gives users the ability to check the performance of auto-dosing equipment and manual mixers, and that it is well suited for non-contact fountains e.g. spray.

Bearing in mind the need for accuracy and the trend towards uniform fountain solutions (16) the technique appears to provide a step towards appropriate standard-isation. A down to earth feature of the fount monitor is that it enables users to make up consistent fountain solutions under day to day working conditions even when dosing equipment is defunct, or mal-adjusted or missing,

and when the capacity of the reservoir(s) are unknown.

To summarise - the foregoing is concerned with a purpose
designed comparative system for indicating the strength
of buffered fountain solutions in press environments.

Thanks are necessary to the Directors of the Howson-
Algraphy Group of Vickers PLC for their recognition of
the importance of the foregoing in respect of plate and
press performance. The provision of the necessary
facilities and the co-operation of the analytical and
technical departments must not be forgotten.

Note.

Because the electrical conductivity term seimens is the
SI unit and considered to be more correct by electrical
engineers than 'umhos', it has been employed in the
above.

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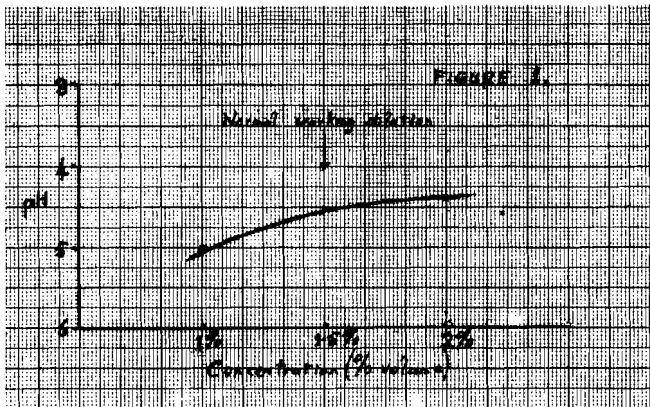
REFERENCES

1. C. W. Latham LTF Advanced Pressmanship 1946 p.74

2. D. J. MacDonald and C. W. Latham LTF Press Operating
   Vol. 1. 1945 p.51

3. J. Marshall. Kodak Bulletin for the Graphic Arts
   No. 33 1976 p.5.

4. A. H. Smith. PATRA Lithography 1960 p.144 – 146

5. W. H. Banks et al. PIRA 10th Printing Research
   Conference 1969 p.15 – 38

6. D. G. Shaw and L. E. Lawson. Printing World
   17 Feb. 1982 p.17

7. P. J. Hartsuch GATF Chemistry of Lithography 1961 p.55

8. Reducing Fountain Waste. Litho Printer Week
   10 June 1981 p.29

9. N. J. Selley Experimental approach to Electro-
   chemistry (E. Arnold)

10. J. B. Bates and B. E. Blom. Newspaper Production
    July 1976 p.22

11. J. B. Bates and B. E. Blom Graphic Arts Monthly
    March 1978 p.50-53

12. T. Scarlett. Graphic Arts Monthly Oct. 1977 p.48

13. F5 fountain concentrate Howson-Algraphy Group
    Vickers PLC 1979

14. Kaline fountain concentrate Howson-Algraphy Group
    Vickers PLC 1979

15. Blom, Wilhelmi & Bartley. TAGA 1978 p.422

16. J. MacPhee Litho Dampening trends offset Printer
    Feb. 1982

Sample / Conductivity		Sample / Conductivity		Sample / Conductivity	
1.	300	19.	55	37.	340
2.	518	20.	115	38.	360
3.	415	21.	250	39.	190
4.	320	22.	780	40.	890
5.	520	23.	290	41.	500
6.	120	24.	530	42.	1180
7.	1000	25.	600	43.	660
8.	291	26.	425	44.	920
9.	388	27.	600	45.	1150
10.	40	28.	600	46.	400
11.	365	29.	460	47.	450
12.	63	30.	460	48.	450
13.	161	31.	380	49.	600
14.	732	32.	610	50.	100
15.	354	33.	420	51.	115
16.	362	34.	510		
17.	480	35.	190		
18.	280	36.	420		

Samples 1 to 9 from reference 10

Table 1. Typical water conductivities.

Buffered Concentrate with 600 μS/cm water	SP. Conductivity (μS/cm) 25°C
Specimen 'A' (2%)	1,400
" 'B' (tablets)	1,130
" 'C'	1,530
" 'D' ($2\frac{1}{2}$%)	1,610
" 'E' (3%)	1,330
" 'F' (3%)	1,160
" 'G' ($6\frac{1}{2}$%)	1,350
" 'H'	1,430
" 'I'	1,690
" 'J'	1,830
" 'K'	1,890
" 'L' (2%)	2,030
" 'M'	2,230
" 'N'	2,150
" 'O'	2,040
" 'P'	2,180
" 'Q'	2,330
" 'R' (4%)	1,340
" 'S' (4%)	1,250
" 'T'	1,380

TABLE 2 Press ready concentrations
($1\frac{1}{2}$% volume unless different according to
published instructions).

Specimen	Sp/Conductivity (μS/cm) 25°C			Overall Variation	
	600 μS/cm 'hard' water	400 μS/cm water	10 μS/cm 'pure' water	μS/cm	Fount Monitor Unit
'A' (2%)	1,500	1,400	1,300	200	.2
'C'	1,530	1,550	1,450	100	.1
'D' (2½%)	1,610	1,530	1,510	40	.04
'E' (3%)	1,330	1,450	1,700	370	.37
'H'	1,430	1,310	1,430	120	.12
'I'	1,690	1,730	1,930	240	.24
'J'	1,830	1,740	1,650	180	.18
'K'	1,890	1,720	1,730	170	.17
'L' (2%)	2,030	1,970	1,930	100	.1
'M'	2,230	2,180	2,110	120	.12
'N'	2,150	2,030	1,980	170	.17
'O'	2,040	2,130	2,110	90	.09
'P'	2,180	2,030	1,880	300	.30
'Q'	2,330	2,310	2,530	220	.22
'R' (4%)	1,340	1,230	1,210	130	.13
'S' (4%)	1,250	1,230	1,160	90	.09
'T'	1,380	–	1,240	140	.14

TABLE 3. Typical variations 1½% v/v dilutions unless stated.

Chemical	S p/Conductivity (25° C)
Gum arabic	400
Cellulose gum	715
Citric acid (0.05%)	360
Tartaric acid (0.05%)	460
Phosphoric acid (0.025%)	680
mono-Sodium phosphate	1,080
di-Sodium phosphate	1,050
tri-Sodium phosphate	1,750
Sodium h-m phosphate	1,040
Sodium pyrophosphate	1,400
tetra-Sodium polyphosphate	2,500
Ammonium citrate	1,970
tri-Sodium citrate	1,900
Sodium tartrate	1,380
Potassium nitrate	2,460
Ammonium nitrate	3,170
Magnesium sulphate	1,320

TABLE 4. Fountain chemicals, (0.2%) solutions
in 400 μS/cm water
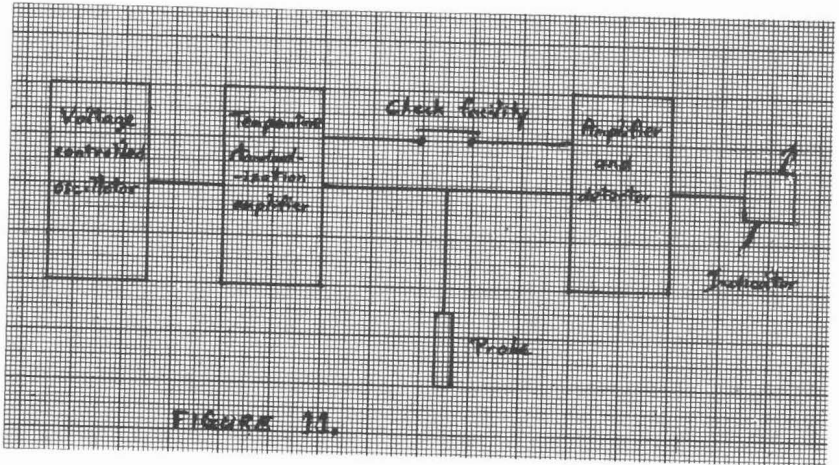
FIGURE 11.

Fountain Solution		Fount with Techfount	Monitor without Techfount
2%	'C'	1.55	1.6
1½%	'H'	1.0	1.05
1½%	'I'	1.25	1.3
2%	'J'	1.8	1.9
1½%	'O'	1.7	1.75
1½%	'Q'	1.8	1.85
1½%	'U'	1.2	1.25
1½%	'V'	1.4	1.45

Table 5

TEST

READ

FOUNT MONITOR

Howson Algraphy

FIGURE 2

FIGURE 3

FIGURE 4.

pH 5·0

pH 5·3

MONITOR

Concentration (% volume)

FIGURE 5.

pH 4·4

pH 4·6

MONITOR

Concentration (% volume)

FIGURE 6.

pH 10·3

pH 9·7

MONITOR

Concentration (% volume)

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FIGURE 7.

Gum arabic solution
(SG. 1·106)

Citric acid
(crystals—1%)

MONITOR

Concentration (% volume)

FIGURE 8.

Citrate/gum
(15% ½ citrate)

Citrate
(10% ½ citrate)

MONITOR

R di-ammonium
hydrogen citrate crystal

di-sodium phosphate (10% w/v)
crystals

Concentration (% volume)

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FIGURE 9.

Monitor

8%
2% } volume of
citrate/gum
buffered pH 5
concentrate in
1% scavenge water.

Isopropanol (% volume)

Mean flowggm

FIGURE 10

Frequency

0 - 300 300-500 600-800 900-1100 1200 +

Conductivity of blood spread water (y/s)

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