

1 TITLE OF THE INVENTION

Recording Liquid

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to a recording liquid (hereinafter referred to as ink) for performing record on recording media such as paper, plastic films, and the like by using an ink-jet recording system or a writing tool such as a fountain pen, felt pen, or the like.

Description of the Prior Art

The ink-jet recording system comprises forming ink droplets by any of various ink-discharging techniques and causing a portion or all of the droplets to deposit on a recording medium such as paper or the like to record an image thereon. Inks known and used for ink-jet recording systems are solutions or dispersions of various water-soluble dyes or pigments in liquid mediums such as water and mixtures thereof with water-soluble organic solvents.

Similar inks are also in use for recording with writing tools such as fountain pens, felt pens, and ball pens.

25 A variety of performance characteristics are naturally required for these inks. The most greatly required characteristic, is liquid stability not to

1 form any precipitate that may clog a nozzle or an
orifice of an ink-jet recorder or may deposit on a
pen point during recording or at an intermission
thereof for a short or long period. This character-
5 istic is specially important to an ink-jet recording
system wherein thermal energy is employed for dis-
charging ink, since the temperature change therein
tends to cause deposition of foreign matter on the
surface of the heating heads. However, inks of prior
10 art: need incorporation of some additives in order to
satisfy various requirements on the discharge charac-
teristics, long-term storage stability, surface
tension, and electrical properties of the ink, the
distinctness and optical density of recorded images,
15 etc. Moreover various impurities are contained in
dyes used in prior art inks. Accordingly, these inks
involve a number of difficulties such as clogging at
nozzles or orifices of ink-jet recorders, deposit
formation on the surface of the heating heads, and
20 emergence of precipitates during prolonged storage
of the inks. This is one of the reasons why ink-
jet recording systems have not come into wide use
even with their many superior characteristics.

25 SUMMARY OF THE INVENTION

The primary object of the invention is to
provide an ink which will overcome the above noted

shortcomings of inks of prior art and which even at a high concentration, will exhibit such superior stability during service and long-term storage as not to cause clogging of nozzles or orifices and not to form any deposit on heating heads of ink-jet recorders which are actuated by thermal energy.

According to one aspect of the invention there is provided a recording liquid composition containing a water-soluble dye and a solvent, the composition having a total concentration of calcium, magnesium, manganese, iron, aluminium and silicon of 20 ppm or less.

According to another aspect of the invention, there is provided a recording liquid composition containing a water-soluble dye and a solvent, wherein said liquid composition has a magnesium concentration of 4 ppm or less.

According to a further aspect of the invention, there is provided an ink-jet recording method comprising forming droplets of ink to perform recording, the ink comprising a recording liquid composition in accordance with the invention.

1 As a result of intensive studies to achieve
the above and other objects, it was discovered that
the foregoing problems arise mainly from various
impurities (organic compounds and inorganic compounds,
5 e.g. surfactants and leveling agents) contained in
the commercial dye used in the ink. Further it was
found that divalent and higher valent metal ions or
compounds, particularly magnesium ion, of the above
impurities contained in inks are most responsible
10 for clogging of nozzles or orifices, formation of
precipitates during storage of inks, and in par-
ticular the deposition of foreign matter on heating
heads in ink-jet recording systems utilizing thermal
energy. The present invention is based on the above
15 finding.

Hereinafter the invention is described in
more detail.

The fundamental components per se constitut-
ing ink of the invention are already known. One of
20 these components is a water-soluble dye, typical
examples of which are direct dyes, acid dyes, basic
dyes, and reactive dyes. Dyes specially suitable as

1 components of the inks for ink-jet recording and
satisfactory in brightness, water-solubility,
stability, light resistance, and other required
properties are, for example, C.I. Direct Black 17,
5 19, 32, 51, 71, 108, and 146; C.I. Direct Blue 6, 22,
25, 71, 86, 90, 106, and 199; C.I. Direct Red 1, 4,
17, 28, and 83; C.I. Direct Yellow 12, 24, 26, and
98; C.I. Direct Orange 34, 39, 44, 46, and 60; C.I.
Direct Violet 47 and 48; C.I. Direct Brown 109; C.I.
10 Direct Green 59; C.I. Acid Black 2, 7, 24, 26, 31, 52,
63, 112, and 118; C.I. Acid Blue 9, 22, 40, 59, 93, 102,
104, 113, 117, 120, 167, 229, and 234; C.I. Acid Red
1, 6, 32, 35, 37, 51, 52, 80, 85, 87, 92, 94, 115,
180, 256, 317, and 315; C.I. Acid Yellow 11, 17,
15 23, 25, 29, 42, 61, and 71; C.I. Acid Orange 7 and
19; C.I. Acid Violet 49; C.I. Basic Black 2; C.I. Basic
Blue 1, 3, 5, 7, 9, 24, 25, 26, 28 and 29; C.I. Basic
Red 1, 2, 9, 12, 13, 14, and 37; C.I. Basic Violet
7, 14, and 27; and C.I. Food Black 2. These examples
20 are particular preferred dyes in the present inven-
tion but do not restrict it.

Such water-soluble dyes are used generally
at a concentration of about 0.1 to 20 % by weight in
inks of prior art. In the present invention,
25 these dyes can be used, on the basis of discovery of
the invention, not only in the above concentration
range but also in higher concentrations, the ink of

1 the invention even at such a high dye concentration
is superior in liquid stability to inks of prior
arts and forms no precipitate.

The liquid medium used in the ink of the
5 present invention is water or preferably a mixture
of water with a water-soluble organic solvent such
as a polyhydric alcohol having the effect of
retarding the drying of inks. Desirably, water
used herein is not common water containing various
10 ions but deionized water. Suitable water-
soluble organic solvents for use in mixture with
water are; C_1 - C_4 alkyl alcohols, e.g. methanol,
ethanol, n-propanol, isopropanol, n-butanol, sec-
butanol, tert-butanol, and isobutanol; amides, e.g.
15 dimethylformamide and dimethylacetamide; ketones or
keto-alcohols, e.g. acetone and diacetone alcohol;
ethers, e.g. tetrahydrofuran and dioxane;
polyalkylene glycols, e.g. polyethylene glycol and
polypropylene glycol; alkylene glycols having 2-6
20 carbon atoms in the alkylene group, e.g. ethylene
glycol, propylene glycol, butylene glycol, triethyl-
ene glycol, 1,2,6-hexanetriol, thiodiglycol,
hexylene glycol, and diethylene glycol; glycerol;
lower alkyl ethers of polyhydric alcohols, e.g.
25 ethylene glycol methyl (or ethyl) ether, diethylene
glycol methyl (ethyl) ether and triethylene glycol
monomethyl (or monoethyl) ether; N-methyl-2-

1 pyrrolidone; and 1,3-dimethyl-2-imidazolidinone.

Of these various alcohols, preferred are polyhydric alcohols such as diethylene glycol and lower alkyl ethers of polyhydric alcohols such as triethylene

5 glycol monomethyl (or monoethyl) ether.

The content of the water-soluble organic solvent in the ink is in a range of generally 0 to 95 %, preferably 10 to 80%, particularly preferably 20 to 50%, by weight based on the whole weight of
10 the ink.

The water content in the ink is chosen from a wide range, depending on the nature and composition of the ink medium and desired properties of the ink, but is generally 10 to 100%, preferably
15 10 to 70%, particularly preferably 20 to 70%, by weight based on the whole weight of the ink.

The ink of the present invention, having fundamental components as described above, is characterized primarily in that the total content
20 of divalent and higher valent metals therein is 20 ppm or less.

According to the present invention, the stability of ink compositions, dyes used in inks of prior arts, being produced originally for the purpose of fiber
25 dyeing, contain additives, e.g. surfactants and leveling agents, and further diversified impurities such as sodium chloride, sodium sulfate, and salts

1 of alkaline earth metals, and such impurities are
known to cause various difficulties in ink-jet
recording and writing with a pen or the like.
Ink compositions were prepared from dyes highly
5 purified by removing the impurities. These ink
compositions, although reducing significantly the
above difficulties, were not satisfactory enough
in preventing the deposition of foreign matters
on the heating heads in ink-jet recording systems,
10 particularly those actuated by thermal energy.
The present inventors further discovered that
commercial dyes contain considerable amounts (tens
to hundreds of ppm) of divalent and higher valent
metal ions (e.g. calcium, magnesium, manganese,
15 iron, aluminum, and silicon metal ions) or compounds
thereof (e.g. colloidal oxides and hydroxide), and
that these substances, magnesium in particular, are
the primary cause for formation of deposits on the
surface of the heating heads and affect most
20 strongly the formation of foreign matter. This
finding has led to the present invention.

The total content of the above bothering
substances in the ink is controlled by the following
procedure.

25 First a dye is precipitated from its aqueous
solution at a desired concentration by adding
sodium sulfate. The precipitate is filtered, washed

1 with a saturated aqueous sodium sulfate solution,
and dried. A prescribed amount of the dried dye
solid is dissolved in a water-soluble organic
solvent, and the solution is filtered. Any water-
5 soluble organic solvent may be used herein, as long
as it is a poor solvent for sodium sulfate and a
good one for the dye. An optimum solvent depending
on the structure of the dye can be freely chosen
arbitrarily. Usually alcohols, glycols, and glycol
10 ethers, as mentioned before, are favorable. The
obtained filtrate may be filtered again after stand-
ing for 1 to 3 days.

Subsequently the filtrate, combined with a
prescribed amount of water, is stirred and then
15 passed through a layer of a cation exchange resin.
An additive is incorporated, as required, into the
effluent with stirring to prepare an ink. The
contents of divalent and higher valent metals in
the ink is determined by atomic absorption spectro-
20 photometry or the induction plasma emission spectral
analysis to ascertain the total contents being
not more than 20 ppm, and to put the ink into
service.

The magnesium content in the ink may be
25 adjusted as follows:

First a dye is precipitated from its
aqueous solution of a desired concentration by

1 adding sodium sulfate. Then the precipitate is
filtered, washed with a saturated aqueous sodium
sulfate solution, and dried. A prescribed amount
of the dried dye is dissolved in a water-soluble
5 organic solvent, and the solution is filtered.
Also in this case, any water-soluble organic
solvent may be used, as long as it is a poor
solvent of sodium sulfate and a good solvent of the
dye. An optimum solvent depending on the structure
10 of the dye can be arbitrarily chosen. Usually
alcohols, glycols, and glycol ethers, as mentioned
before, are favorable.

Subsequently, the thus obtained filtrate,
combined with a prescribed amount of water, is
15 stirred and then passed through a layer of a cation
exchange resin. The effluent, after proper PH
adjustment, is left standing for 7 to 10 days and
filtered. Then an additive is added, if necessary,
to the filtrate with stirring to prepare an ink.
20 The ink is put into service after the content of
magnesium therein has been ascertained by atomic
absorption spectrophotometry or the induction
plasma emission spectral analysis to be not more
than 4 ppm.

25 In the treatment procedure described above;
the first salting-out treatment is intended
primarily to remove sodium chloride which is a

1 representative impurity contained in large amounts
in usual commercial dyes; the second treatment with
a water-soluble organic solvent is intended prima-
rily to remove both of sodium sulfate originally
5 contained as an impurity in the dye and added in
a large amount in the preceding salting-out treat-
ment; the long standing of the filtrate after
filtration of the dye dissolved in the organic
solvent and the long standing of the liquid treated
10 with a cation exchange resin in the case of the
magnesium content control, both followed by
filtration are intended primarily to remove the
colloidal substances containing divalent and higher
valent metals and to remove colloidal magnesium,
15 respectively; and the treatment with a cation
exchange resin is intended to remove divalent and
higher valent metal ions, particularly magnesium
ions.

A method for controlling the content of
20 divalent and higher valent metals or the content of
magnesium, in the ink, has been described above.
The controlling method, however, is not limited to
the above, and any other method may be employed
which permits removing said ions or colloidal
25 compounds of divalent and higher valent metals,
particularly ions or colloidal compounds of
magnesium. Such other methods include, for example,

1 aeration, sedimentation by use of a flocculant,
filtration, lime softening, and electrolysis.

Besides the impurities contained in the
dyes, those contained in the water are considered
5 as sources of the contamination of inks with ions
or compounds of divalent and higher valent metals,
particularly ions or compounds of magnesium. This
contamination can be avoided by using distilled
water, deionized water, or both of them. The
10 greatest source of ink contamination with divalent
and higher valent metals, particularly magnesium
are impurities contained in the dyes to be used.
In particular when the used dyes are unpurified
commercial products, markedly large amounts of such
15 metals are often contained in the inks. For
instance, analysis showed as high as several
thousand ppm of these impurities contained in a
certain dye powder.

While the above description has been given
20 chiefly on the removal of divalent and higher
valent metals, particularly magnesium, contained in
inks, it is desirable in practice to remove them
simultaneously with various other inorganic salts
such as sodium chloride and sodium sulfate.

25 Besides the basic components described above,
the ink of the present invention is allowed to
contain various known additives, if necessary, such

1 as a dispersant, surfactant (cationic, anionic,
or nonionic), viscosity modifier (e.g. polyvinyl
alcohol, cellulosic compound, or some other water-
soluble resin), surface tension modifier (e.g.
5 diethanolamine or triethanol amine), pH condi-
tioner (e.g. a buffer solution), and antimold
agent.

An inorganic salt such as lithium chloride,
ammonium chloride, or sodium chloride is added as
10 a resistivity modifier to inks which will be
used in a type of ink-jet recording system wherein
electric charge is given to the inks for the
ejection thereof. For use in a type of ink-jet
recording system wherein inks are ejected by the
15 action of thermal energy, thermal properties (e.g.
specific heat, coefficient of thermal expansion,
and heat conductivity) of the inks are conditioned
occasionally.

The ink of the present invention, prepared
20 as described above, is sufficient for solving the
problems of the prior art and is excellent and
balanced as such in recording characteristics
(signal responsiveness, stability of droplet
formation, discharge stability, workability in
25 continuous recording for many hours, and discharge
stability after a long intermission), storage
stability, fixability on recording media, light

1 and weathering resistance of resulting recorded
images, and so forth. Thus, the present ink is
useful for various types of ink-jet recording
systems and for writing tools, particularly for
5 the ink-jet recording systems utilizing thermal
energy, wherein the formation of deposits from inks
is a most undesirable matter.

The present invention is illustrated in
more detail with reference to the following
10 examples. In these examples, parts and % are all
by weight.

a) Example 1a² Preparation of ink a)1 =

Sodium sulfate was added to a saturated
aqueous solution of a commercial dye (Direct Fast
15 Yellow R supplied by Sumitomo Chemical Co., Ltd.)
with stirring to precipitate the dye. This pre-
cipitate was filtered, washed with a saturated
solution of sodium sulfate in pure water, and dried.
This dried solid was weighed out in such a pre-
20 scribed amount that the dye concentration in the
intended ink would be 3%, and was dissolved in a
mixture of ethylene glycol and N-methyl-2-
pyrrolidone (3:1). This aqueous solution was
filtered under pressure through a Teflon^(RTM) filter
25 having an average pore diameter of 1 μ m. The
filtrate was weighed in a plastic container,
allowed to stand in a cold dark room for 3 days, and

1 filtered again through a Teflon filter (average
pore diameter 1 μm). Then 60 parts of water was
added to 40 parts of the filtrate with stirring to
give an ink. This ink was passed through a layer
5 of a cation exchange resin C464 (supplied by
Sumitomo Chemical Co., Ltd.). The effluent was
adjusted to pH 9.8 with an 0.1 N aqueous NaOH,
and measured for the total content of divalent and
higher valent metals by induction plasma emission
10 spectral analysis. The found content was 20 ppm.
The following characteristics $T_1 - T_5$ of the thus
obtained ink were examined by using (for $T_2 - T_5$)
a recorder provided with on-demand type multiheads
(discharge orifice diameter 35 μm , resistance of
15 heat-generating resistor 150 ohm, driving voltage
30 V, frequency 2 KHz) which perform recording with
ink droplets discharged by applying thermal energy
to the inks fed therein. The ink was found good in
all the characteristics $T_1 - T_5$.

20 (T₁) Long-term stability: Samples of the
ink, sealed in plastic bags, were stored for 6
months at temperatures of -30°C and 60°C. In both
the cases, neither insoluble matter nor change in
physical properties including color was observed.

25 (T₂) Discharge stability: The discharge
was conducted continuously for 24 hours in atmos-
pheres of room temperature, 5°C, and 40°C. Under all

1 the conditions, high quality recording could be continued steadily throughout the operation.

(T₃) Discharge responsiveness: The discharge was conducted at intervals of 2 sec and
5 also conducted after 2 months' standing of a sample of the ink. In both the cases, none of the orifices were clogged and images were recorded uniformly and steadily.

(T₄) Quality of recorded image: Images
10 recorded on recording media shown later in Table 1 were high in optical density and distinctness, and percentages of decrease in the optical density were up to 1% after 6 months' exposure of the images to indoor light.

15 (T₅) Fixability on various recording media:

An image was recorded on each of recording media shown later in Table 1a, and 15 sec later, was rubbed with a finger, and the aberration and blotting of the image were checked. On any of the
20 recording media, neither the aberration nor the blotting was observed. Thus the ink showed superior fixability.

Examples 2a - 5a

In the same manner as in Example 1a, inks
25 were prepared from commercial dyes shown later in Table 2a, and were tested for the characteristics T₁ - T₅. All the inks gave superior results

1 similarly to Example 1a.

Example 6a

Inks of Examples 2a, 3a, 4a, and 5a were tested as yellow, magenta, cyan, and black inks, respectively, for the characteristics $T_1 - T_5$ in the same manner as in Example 1a except that recording was conducted by using a recorder having an on-demand type head (discharge orifice diameter 50 μm , driving voltage for piezoelectric oscillators 60 V, frequency 4 KHz) which discharges ink droplets by means of piezoelectric oscillators to perform recording. All these inks gave superior results.

Example 7a

Copies of a full-color photograph were made by using inks of Examples 2a, 3a, 4a, and 5a as yellow, magenta, cyan, and black inks, respectively and by means of the ink-jet recorder used in Examples 2a - 5a. The obtained image was bright in each color and good in color reproduction.

20 Example 8a

Felt pens were filled respectively with different-color inks prepared in Examples 2a - 5a, and were allowed to stand for 10 days with the caps removed. With these pens, writing could be carried out smoothly without being blurred.

25 Comparative Example A

Sodium sulfate was added to a saturated

1 aqueous solution of the same dye (Direct Fast
Yellow R) as used in Example 1a, with stirring to
precipitate the dye. This precipitate was filtered,
washed with a saturated solution of sodium sulfate
5 in pure water, and dried. The dried solid was
weighed out in such a prescribed amount that the dye
concentration in the intended ink would be 3%,
and was dissolved in a mixture of ethylene glycol
and N-methyl-2-pyrrolidone (3:1). This solution was
10 filtered under pressure through a Teflon filter
(average pore diameter 1 μ m). Then 60% of water
was added to 40% of the filtrate to prepare the
intended ink.

The content of divalent and higher valent
15 metals in this ink was 30 ppm as measured by atomic
absorption spectrophotometry. The characteristics
 $T_1 - T_5$ of this ink were examined in the same manner
as in Example 1a. As to T_1 , insoluble matter
appeared in the ink after one month's storage
20 thereof. As to T_2 , the ink discharge stopped
frequently, hence requiring a change (increase) in
the driving voltage. On microscopic observation of
the surface of a heating head, a brown deposit
was seen adhering thereto. As to T_3 , the ink left
25 standing for one month caused orifice clogging and
the discharge of the ink was found unstable.

Further, two inks were prepared from the

1 above original dye by following the treatment
procedure of Example 1a except that the standing
treatment was neglected for one of the inks and the
cation exchange treatment for the other ink. The
5 total content of divalent and higher valent metals
was found to be 23 ppm in the former ink and 25 ppm
in the latter ink. Results of the same $T_1 - T_5$
tests indicated that these inks were inferior in
these performance characteristics to the ink of
10 Example 1a, i.e. the ink prepared without neglecting
any of the treatment steps of Example 1a.

Example 1b Preparation of ink

Sodium sulfate was added to a saturated
aqueous solution of a commercial dye (Direct Fast
15 Yellow R, supplied by Sumitomo Chemical Co., Ltd.)
with stirring to precipitate the dye. This
precipitate was filtered, washed with a saturated
solution of sodium sulfate in pure water, and dried.
The dried dyes was weighed out in such a prescribed
20 amount that the dye concentration in the intended
ink would be 3%, and was dissolved in a mixture
of ethylene glycol and N-methyl-2-pyrrolidone (3:1).
This aqueous solution was filtered under pressure
through a Teflon filter (average pore diameter 1 μ m),
25 and 60 parts of water was added to 40 parts of the
filtrate with stirring to give an ink. This ink was
passed through a layer of cation exchange resin

1 C-466 (supplied by Sumitomo Chemical Co., Ltd.).
The effluent was adjusted to pH 9.8 with 0.1N
aqueous NaOH, allowed stand for 10 days in a
plastic container, and filtered again under pressure
5 through a Teflon filter (average pore diameter 1 μ m),
thus preparing an ink of the present invention.

The magnesium content in this ink was 3.8
ppm as measured by atomic absorption spectro-
photometry.

10 This ink was tested for the characteristics
 $T_1 - T_5$ in the same manner as in Example 1a, giving
similarly good results. In the Tests of T_4 and T_5 ,
recording was conducted on the same recording media
as used in Example 1a which are shown in Table 1a.

15 Examples 2b - 5b

In the same manner as in Example 1b, inks
were prepared from commercial dyes shown later in
Table 2b and and were tested for the characteristics
 $T_1 - T_5$. All the inks gave superior results
20 similarly to Example 1b.

Example 6b

Inks of Examples 2b, 3b, 4b, and 5b were
tested as yellow, magenta, cyan, and black inks,
respectively, for the characteristics $T_1 - T_5$ in the
25 same manner as in Example 1b except that recording
was conducted by using a recorder having an on-
demand type head (discharge orifice diameter 50 μ m,

1 driving voltage for piezoelectric oscillators 60V,
frequency 4 KHz) which discharges ink droplets by
means of piezo-electric oscillators to perform
recording. All these inks gave superior results.

5 Example 7b

Copies of a full-color photograph were made
by using inks of Examples 2b, 3b, 4b, and 5b as
yellow, magenta, cyan, and black inks, respectively,
and by means of the ink-jet recorder used in
10 Examples 2b - 5b. The obtained image was blight in
each color and good in color reproduction.

Example 8b

Felt pens were filled respectively with
different-color inks prepared in Examples 2b - 5b,
15 and allowed to stand for 10 days with the caps
removed. With these pens, writing could be carried
out smoothly without any ink-deficient character.

Comparative Example B

Sodium sulfate was added to a saturated
20 aqueous solution of the same dye (Direct Fast
Yellow R) as used in Example 1b, with stirring to
precipitate the dye. This precipitate was
filtered, washed a saturated solution of sodium
sulfate in pure water, and dried. The dried solid
25 was weighed out in such a prescribed amount that the
dye concentration in the intended ink would be 3%,
and was dissolved in a mixture of ethylene glycol.

1 and N-methyl-2-pyrrolidone (3:1). This solution
was filtered under pressure through a Teflon filter
(average pore diameter 1 μ m). Then, 60% of water
was added to 40% of the filtrate to prepare the
5 intended ink.

The magnesium content in the ink was 6.1
ppm as measured by atomic absorption spectrophoto-
metry. The characteristics $T_1 - T_5$ of this ink
were examined in the same manner as in Example 1b.

10 As to T_1 , insoluble matter appeared in the
ink after one month's storage thereof. As to T_2 ,
the ink discharge stopped frequently, hence requir-
ing a change (increase) in the driving voltage.
On microscopic observation of the surface of a
15 heating head, a brown deposit was seen adhering
thereto. As to T_3 , the ink left standing for one
month caused orifice clogging and the discharge of
the ink was found unstable.

Further, two inks were prepared from the
20 above original dye one by employing cation exchange treatment
and the othre by employing electrostatic treatment, respec-
tively in addition to the above-mentioned treatment. The
magnesium content was found to be 4.8 ppm in the
former ink and 5.1 ppm in the latter ink. Results
25 of the same tests for $T_1 - T_5$ indicated that the
perfomance characteristics of these inks were
insufficient for the practical use, though found to

- 1 be improved to a certain extent: as compared with those of the ink subjected to none of the above additional treatment.

Table 1a

5	Recording medium (tradename)	Nature of recording medium	Maker for recording medium
	Ginkan	High quality	Sanyo Kokusaku Pulp Co., Ltd.
	Seven Star	High quality	Hokuetsu Paper Mfg. Co., Ltd.
10	Hakubotan	Medium quality	Honshu Paper Mfg. Co., Ltd.
	Toyo Filter paper No. 4	non-sized paper	Toyo Roshi Co., Ltd.

Table 2a

15	Example No.	Dye	Total conc. of divalent and higher valent metals in ink
	2a	Water yellow 6	19 ppm
	3a	Chugonol Fast Red 3B	20 "
	4a	Kayarus Turquoise Blue GL	17 "
20	5a	Special Black 7984	20 "

Table 2b

	Example No.	Dye	Mg content in ink
	2b	Water Yellow 6	3.9 ppm
25	3b	Chugonol Fast Red 3B	2.1 "
	4b	Kayarus Turquoise Blue GL	3.5 "
	5b	Special Black 7984	2.9 "

CLAIMS

1. A recording liquid composition containing a water-soluble dye and a solvent, the composition
5 having a total concentration of calcium, magnesium, manganese, iron, aluminium and silicon of 20 ppm or less.
2. A recording liquid composition containing a water-
10 soluble dye and a solvent, wherein said liquid composition has a magnesium concentration of 4 ppm or less.
3. A liquid composition according to Claim 1 or 2,
15 wherein the solvent is water.
4. A liquid composition according to Claim 1 or 2,
wherein the solvent is a mixture of water and a water-soluble organic solvent.
20
5. A liquid composition according to Claim 3 or 4,
wherein the water is distilled water and/or water deionized by ion exchange.



6. A liquid composition according to any preceding claim, comprising 0.1 to 20% by weight of the water-soluble dye.
- 5 7. An ink-jet recording method comprising forming droplets of ink to perform recording, the ink comprising a liquid composition according to any preceding claim.
- 10 8. An ink-jet recording method according to Claim 7, wherein the droplets of the ink are formed by the influence of thermal energy on the ink.
- 15 9. A recording liquid composition according to Claim 1 or 2, substantially as described with reference to any of the Examples.
- 20 10. A method of ink-jet printing according to Claim 7, substantially as described with reference to any of the Examples.
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