WATER CHARACTERISTICS SUITABILITY FOR TEXTILE WET PROCESSING AND ITS REMEDY MEASURES

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Numerous impurities always occur in various sources of water. Water is a unique solvent, which dissolves most of the inorganic and organic compounds. These comprise acidic and alkaline compounds, and dissolved oxygen. The content of impurities in the water used in textile wet processing was investigated, because of their possible destructive effect on wet processes, machineries, boilers and other related materials. The present study was carried out according to standard titrimetric and redox reaction methods. Remedial measures were also studied for water adequacy.

Keywords: acidity, alkalinity, dissolved oxygen, textile wet processing

INTRODUCTION

Water, the most common and vital solvent for wet processes, such as dyeing, printing, rinsing, sizing, desizing, finishing, bleaching and many other purposes,[1] has a great influence over textile processes. Water impurities affect the boiler, in which deposits/scale – like $CaSiO_3$, $CaCO_3$, $CaSO_4$, $Mg(OH)_2$ – formation occur, due to hard water,[2,3] as well as the properties of finished textile products. The extent to which the presence of impurities affects the boiler depends on the concentration of the impurities present in the water.[4,5] Therefore, the quality of water should be necessarily maintained. In this context, water, containing high concentrations of the above-mentioned impurities, much over the accepted limits, should be softened to remove them, for obtaining quality products and for minimizing the problem as much as possible. Water can dissolve so many elements and compounds, due to its covalent as well as polar nature and, ultimately, water can be affected by the presence of various impurities, *e.g.* suspended solids, by their properties (acidity, alkalinity, hard water), and by dissolved oxygen, all manifesting pronounced effects on textile wet processing.[4,6-8] Out of these, acidity, alkalinity and dissolved oxygen are responsible for corrosion, usually occurring at high temperature, due to either $CaCO_3$ deposition or scale formation in the system. Calcium and magnesium chlorides or sulphates exist in water in soluble form, both in the presence and absence of carbon dioxide.[9,10]

Alkalinity is mainly caused by the presence of the OH^-, CO_3^{-2} and HCO_3^- ions, which induce hydroxide alkalinity, carbonate alkalinity and bicarbonate alkalinity, respectively. Carbonate alkalinity can occur along with that of either hydroxides or bicarbonates, although bicarbonate and hydroxide cannot exist together.[5,11] Consequently, alkalinity may be induced by the presence of any of them, by a mixture of carbonate and hydroxide, or by the carbonate and bicarbonate. Usually, acidity is not measured like alkalinity.[6,1] Undoubtedly, water is a vital solvent for textile wet processing, due to its ability to solubilize other compounds.[12] To save industrial machinery, it is much more important to use high-grade quality water.[13] The substances suspended in water occur as harmful impurities in finishing processes.

The presence of suspended solids may vary with the water sources, their number being possibly higher in waste waters. The amount of suspended solids may also vary with filter porosity.[12,14] Total dissolved solids (TDS) produce a complex in wet processing chemicals.[15,16]

The level of dissolved oxygen depends on the physical, chemical and biochemical properties of water.[6,1] If oxygen is present in the system, non-protective Fe_2O_3 is formed and only 0.1 ppm of oxygen is required to increase the corrosion rate in a dynamic system. As a result, water becomes contaminated by Fe_2O_3 which, in turn, forms iron stains in contact with the cloth. The analysis of acidity, alkalinity and dissolved oxygen was carried out to solve the problem of water in textile wet processing and also for suggesting remedial measures.

MATERIALS AND METHOD

Materials

Water samples, required reagent grade chemicals, *e.g.* potassium iodide, manganese sulphate, methyl orange and alcoholic phenolphthalein indicator, etc., glassware and other devices were used in the investigation. Acidity, alkalinity and dissolved oxygen analyses were performed according to literature.[6,10]

Phenolphthalein acidity

50 mL of suspended solid free water were put in a 250 mL conical flask, and 2-3 drops of alcoholic phenolphthalein were added. Titration was carried out with a 0.1N NaOH solution, until a faint permanent pink color appears, at pH 8.3.

Alkalinity

2-3 drops of an alcoholic phenolphthalein solution and aqueous methyl orange solution were added to 50 mL of suspended solid free water, then titrated with a 0.1N HCl solution up to an orange pink end point.

Dissolved oxygen test

The test was carried out according to the redox reaction method. According to the procedure with alkaline potassium iodide, a manganese sulphate solution and a 3:1 H_2SO_4 acid solution were added to the sample, and the thus liberated iodine was titrated with a standard sodium thiosulphate solution (0.01 N), using starch as an indicator. The result was calculated by the redox reaction method. Simultaneously, a blank test was conducted under identical conditions.

RESULTS AND DISCUSSION

To solve out the problem of the water used in textile wet processes, a study on impurities – acidic, alkaline and dissolved oxygen – was carried out, the results being listed in Tables 1-3.

Table 1
Acidity (phenolphthalein acidity) of the water used in textile wet processing

Test sample	Water temperature, °C	pH	Phenolphthalein, %	Sample volume, mL	NaOH volume	NaOH (N) concentration	Acidity as $CaCO_3$, ppm
1	24.5	6.98	0.50	50	0.52	0.02	10.4
2	24.5	6.98	0.50	50	0.52	0.02	10.4

Table 2
Water alkalinity

Test sample	Water temperature, °C	pH	Phenolphthalein, %	Methyl orange, %	HCl sol. volume, mL	HCl sol. (N) concentration	Sample volume, mL	Alkalinity as $CaCO_3$, ppm
1	24.5	6.98	0.50	0.05	1.85	0.1	50	185
2	24.5	6.98	0.50	0.05	1.85	0.1	50	185

Table 3
Dissolved oxygen in water

Test sample	Water temperature, °C	pH	$Na_2S_2O_3$ volume used for sample V_s, mL	$Na_2S_2O_3$ volume used for blank V_b, mL	Total volume of sample, mL	$Na_2S_2O_3$ (N) concentration	Dissolved oxygen, ppm
1	24.5	6.98	5.65	1.10	(300+300) = 600	0.50	6.056
2	24.5	6.98	5.65	1.10	(300+300) = 600	0.50	6.056

The formula for dissolved oxygen:

$D.O_2$ ppm = $(V_s – V_b)$ x N x 16000/(S + B) – 0.0104

where 0.0104 is the correction factor for the oxygen introduced with the reagents;

V_s and V_b = volume of $Na_2S_2O_3$ solution used for sample and blank, respectively;

S and B = volume of sample and blank, respectively;

N = normality of $Na_2S_2O_3$ solution.

CONCLUSIONS

As water is capable of dissolving most of the organic and inorganic materials, it might have some adverse effect on the wet processes. The temperature and pH of the sample were measured during sample collection. Water acidity is the capacity of water to donate protons. At room temperature, a fading and non-permanent end point was noticed when phenolphthalein was added to the water sample, as due to the presence of iron and aluminum sulphate.

On the other hand, alkalinity represents the capacity of water to accept protons. The pH of any water source is the measure of alkalinity, *i.e.* a higher pH means higher alkalinity, which is usually imparted by the components or compounds of the carbonates, bicarbonates and hydroxides. As, during titration with phenolphthalein, the sample was colorless, the titration was carried out with methyl orange. The range of pH accepted for many textile wet processings is from 6.5 to 8.6, while alkalinity ranges between 0 and 65 ppm, as expressed in $CaCO_3$. Over this range of alkalinity, uniform scale or deposit formation will result at room temperature and, hence, high-alkalinity water should be softened. The effect of the oxygen presence was already mentioned in the introduction. Therefore, for the safety of industrial machinery, remedial measures should be taken. To avoid the harmful effect of the above-mentioned impurities, the following precautions are recommended:

1. Demineralization might reduce the effect of excessive alkalinity, the boiler feed water being conditioned by lime soda or Zeolite processes. Demineralization is also useful for removing the effect of acidity, which causes corrosion.

2. The amount of dissolved oxygen could be reduced by adding reducing agents, such as sodium sulphite or hydrazine, or oxidizing catalysts such as copper salts; water softening is the best way to prevent corrosion, due to the presence of dissolved oxygen and of other elements/compounds.

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